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OPERATION OF THE TRANSPORT AND LOGISTICS SYSTEM OF «PODILLIA» ECONOMIC AND GEOGRAPHICAL REGION IN THE CONTEXT OF GREEN ECONOMICS

Abstract

The article proposes a comprehensive approach to assessing the development of the regional transport and logistics system of the economic and geographical region «Podillia». This approach is based on the use of a set of indicators that characterize the current state of the transport and logistics system from an environmental point of view. The obtained results of the conducted analysis

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reveal modern environmental problems in the operation of the transport and logistics system of the region.

Trends and patterns of development of world markets of green bonds, green loans and sustainable investment assets are studied. The peculiarities and features of green financing tools are considered in terms of the development of transport and logistics systems of different levels.

The research outcomes prove that an organizational and economic mechanism should be developed and implemented in order to ensure the effective operation of the transport and logistics system of «Podillia» economic region on the basis of green economics and balanced sustainable development. At its core, there is a symbiosis and integration of principles, functions, methods, means, and tools of management, as well as information systems and technologies aimed at reducing greenhouse gas emissions, improving environmental safety, making sound innovative decisions on sustainable management of logistics. It is established that in modern Ukrainian conditions the economic region of «Podillia» should use the best international practices to implement the mechanism of green financing of infrastructure projects. This will allow for a successful transformation of the regional transport and logistics system in the context of green economics and balanced sustainable development of the transport and logistics system.

Key words:

regional economy; economic and geographical region; transport and logistics system; green economics; sustainable development; ecological principles; transformation; green investment tools; green infrastructure projects; green technologies.

JEL: L91, Q25, Q28, R13, R40.

1 figure, 16 tables, 52 references.

Problem Statement and Literature Review

Problem Statement. Changing the modern paradigm of thinking leads to the reorganization of logistics processes and the need to implement a mechanism for financial support for the transformation of regional transport and logistics systems using non-traditional sources of funding, including «green» investments. The key instruments of «green» financing of modernization of transport infrastructure, which are effectively used in different countries of the world, include: «green» bonds, «green» loans, grants, guarantees, technical assistance, and «green» investment funds.

Modern operating conditions of regional transport and logistics systems in Ukraine require transformations in the context of concepts of green economics and balanced sustainable development. This is explained by the fact that the transport and logistics sector, on the one hand, has a negative impact on the environment (third in the world in terms of carbon dioxide emissions), and, on the other hand, has significant potential for implementing the model of green growth (Ministry of Economic Development and Trade of Ukraine, 2016).

A survey conducted by the consulting company PwC (2019) found that 41% of managers of transport and logistics companies in 85 countries were concerned about climate change and environmental damage associated with the prospects for growth of their business.

The World Economic Forum has established that greenhouse gas emissions from logistics account for 5.5% of global greenhouse gas emissions. According to UN estimates, the global transport sector generates 25% of total greenhouse gas emissions. Annually, the total loss from the negative effects of the transport industry is 7-10% of GDP. The damage to health caused by environmental pollution from mobile sources is 1 trillion USD per year. According to official Eurostat data, air pollution from road transport causes more than 400,000 premature deaths each year.

Therefore, large-scale investment programmes are being actively implemented in countries around the globe in order to modernize transport and infrastructure by «greening» them in order to minimize the negative impact on the environment and maintain competitiveness. Such programmes are usually based on the technologies of the third and fourth industrial revolutions. The «greening» of transport systems through the transition to hydrogen and electric transport can be considered one of the significant advantages of the third industrial revolution, as it contributes to a dramatic improvement in the quality of the environment. For example, the EU Transport Strategy envisages a reduction in greenhouse gas emissions by approximately 20% from their level in 2008, and by 2050 decrease of 80-95% to the level of 1990.

In addition, the European Commission supports the transition to sustainable mobility through the financial mechanism *Connecting Europe Facility*. The Facility allocates approximately 60% of its budget to infrastructure projects that aim to achieve sustainable development and play an important role in creating a European tariff network for alternative fuels and a highly productive and efficient combined transport system.

Notably, modernization of transport and logistics systems of various levels in Ukraine should be carried out within the framework of the European transport policy TEN-T, aimed primarily at rational use of resources and reduction of greenhouse gas emissions. This corresponds to the main provisions of Chapter 7 «Transport» of Title V of the Association Agreement between Ukraine and the EU, the Sustainable Development Goals of Ukraine until 2030 (creation of sustainable infrastructure), the State Strategy for Regional Development until 2027 (creation of a cohesive country in social, economic, environmental and spatial dimensions).

According to the 2030 National Transport Strategy of Ukraine, it is necessary to take into account the global trends of transport sector development, in particular the use of green modes of transport, prioritization of environmental protection, and preservation of valuable protected areas in the context of national transport infrastructure development. The strategy plans to reduce greenhouse gas emissions from mobile sources to 60% of the 1990 level.

Given this, it is advisable to search for innovative tools and scientifically sound green solutions, as well as to introduce fundamentally new organizational and management approaches and green technologies aimed at improving the efficiency of regional transport and logistics systems in Ukraine. We will consider this on the example of the economic and geographical region «Podillia».

Literature review. There are many approaches to the consideration of the environmental component of logistics in the scientific literature (Jianwei et al., 2011; Pulawska & Starowicz, 2014; Simão et al., 2016; Moroz & Polkowski, 2016; Urbanyi-Popiołeka, 2019; Liu et al., 2020). Greening logistics is recognized as a key driver of business development, as most consumers prefer the companies that use green transport and technologies that conserve natural resources for freight transportation.

The analysis conducted by the consulting company PwC PESTEL established that the emphasis on environmental sustainability and stringency of emission standards will force transport and logistics companies to move to environmentally friendly and safe decisions, i.e. to green logistics. Climate change is expected to continue affecting meteorological phenomena, which will lead to destabilization of supply chains. Reduction of natural resources will lead to an increase in prices for them and will promote recycling and more efficient allocation of resources. As a result, sustainable and environmental development will be in highly popular in the long run.

A public opinion poll commissioned by the e-commerce delivery platform Sendcloud found that the majority of British consumers support the introduction of green technologies in manufacturing and logistics. According to 57% of respondents, the growth of online purchases will lead to greater environmental pollution. Additionally, 38% of respondents are willing to pay extra for the delivery of goods on environmentally friendly transport.

It should be emphasized that the COVID-19 pandemic has also forced consumers to reconsider their attitudes towards sustainable development and to reflect on the impact of purchases on the environment, society and business.

According to a survey by the Internet provider *Orange Business Services* (of 320 managers of international companies, including in the field of transport and logistics), 85% of respondents are willing to invest in business sustainability. Moreover, 59% of respondents indicated that they could not allow the use of unethical and non-environmental technologies, as this would affect the profitability of companies.

An express survey of 8,738 consumers from 22 countries conducted by PwC in 2021 as part of the Global Consumer Behaviour Survey found that 55% of respondents buy products from companies with a clear environmental policy, and 54% prefer goods in eco-friendly packaging.

The above studies of international companies and think tanks confirm the imperativeness of the problem of green logistics development. The concept of green logistics began to take shape in the mid 1980's with the emergence of the terms «sustainable development» and «corporate social responsibility». As a result of research, scientists have found that the evolution of development, establishment, formation and further structuring of green logistics are closely intertwined with logistics principles.

Based on the analysis of literature sources (Janbo & Songxian, 2008; Brdulak & Michniewska, 2009; Sbihi & Eglese, 2009; McKinnon et al., 2010; Mesjasz-Lech, 2011; Ubeda et al., 2011; Lai & Wong, 2012; Christof & Ehrhart, 2012; Dekker et al., 2012; Ćirović et al., 2014; Harris et al., 2014; Jedliński, 2014; Seroka-Stolka, 2014; Zhang et al., 2015; Luthra et al., 2016; Geiger, 2016; Barzinpour & Taki, 2018; Pierre et al., 2019; Kobylynska, 2019; Sagaydack & Kharchenko, 2020) scientific views on the interpretation of the essence and content of the concept of «green logistics» are generalized. As a rule, scientists understand this term as (1) a scientific direction and one of the factors of environmental protection; (2) logistics based on resource-saving and environmentally friendly technologies; (3) an effective approach to resource flow management aimed at reducing environmental and economic losses; or (4) increasing environmental responsibility in the transport and logistics sector.

In addition, to date, researchers and practitioners have not identified a single approach to the classification of funding instruments for green projects, in-

cluding in the field of transport. For example, S. Venugopal, A. Srivastava, C. Polycarp, and E. Taylor (2012) divide financing instruments and mechanisms that encourage the attraction of private capital into 2 groups: mechanisms of public support and public financing instruments (loans, equity, investment instruments that exclude risks).

German scientist N. Lindenberg (2014) proposes to divide financing instruments for the implementation of green projects into 3 categories, namely instruments through which direct financing is carried out (shares, credit lines, loans and grants); instruments that do not provide direct funding, but can transfer knowledge or reduce risks (guarantees and technical assistance); and instruments used to attract additional private resources transferred to green projects through one of the other instruments (green bonds and structured funds). Scientists M. Voica, M. Panait, and I. Radulescu (2015) identified two main forms of green investment: green stocks and green bonds.

V. Kazlauskiene, A. Draksaite, and L. Melnyk (2017) generalized the different scientific points of view to the investment tools of green projects and distinguished green bonds, green stocks, green loans and budget financing instruments.

O. Nykyforuk, N. Kudrytska, and I. Dulska (2018) in their scientific report indicate taxation, infrastructure (corporate or municipal) bonds, the mechanism of concession relations, securitization of assets, and crowdfunding (royalties, public lending, equity crowdfunding) among the optimal tools for financing transport infrastructure.

Thus, the key instruments of green financing for modernization of transport infrastructure, which are effectively used in different countries (for example, in France, Brazil, Switzerland, Great Britain, China), include green bonds, green loans, and green investment funds.

All the above indicates that it is extremely important and necessary to develop and implement a mechanism for financial support for the transformation of global, national, regional and local transport and logistics systems using non-traditional sources of funding, marketing tools, qualitatively new management approaches, and digital technologies in the context of Industry 4.0 (Brandenburg & Rebs, 2015; Schaltegger et al., 2016; Tozanli et al., 2017; Dvulit & Levchenko, 2017; Gruchmann et al., 2018; Mazaraki & Kharsun, 2018; Andryeyeva et al., 2018; Gruchmann, 2019; Koev et al., 2019; Sandiuk et al., 2019; Sverdan, 2021; Goncharenko & Shapoval, 2021).

At the same time, the versatility, multifaceted and debatable nature of certain issues on the selected topic necessitate further research. Modern conditions of green transformation of regional transport and logistics systems in the context of the European Green Deal especially emphasize the search for the solution to this problem.

The aim of the paper is to analyse the features of the transport and logistics system of the economic region «Podillia» and determine the prospects for its further operation in view of the environmental considerations. To achieve this goal, methods of analysis and synthesis, systematic approach, statistical analysis, comparisons and observations, classification, structural and logical generalization were used.

Research Results

Analytical assessment of the current development of the regional transport and logistics system of «Podillia» in view of the environmental considerations

Statistical analysis shows that the overall volume of emissions of pollutants from mobile sources in the economic region increased by 2.9% in 2000-2020 (Ternopil region – 12.6% and Khmelnytskyi region – 2.9%), while emissions of pollutants from mobile sources in Vinnytsia region decreased by 2.1% (Table 1).

Table 1

Pollutant emissions from mobile sources in the economic region «Podillia» in 2000-2020, thousand tons

Year	Economic region	Including		
		Vinnytsia region	Ternopil region	Khmelnytskyi region
2000	151,1	65,4	34,1	51,6
2005	142,4	73,0	32,9	36,5
2010	192,2	82,1	45,4	64,7
2011	192,4	82,6	45,0	64,8
2012	188,8	81,4	44,1	63,3
2013	184,9	79,6	41,8	63,5
2014	175,1	72,1	40,9	62,1
2015	155,0	59,9	37,9	57,2
2016	143,0	53,6	38,0	51,4
2017	152,3	58,6	38,1	55,6
2018	159,2	65,9	38,2	55,1
2019	148,8	58,1	38,3	52,4
2020	155,5	64,0	38,4	53,1

Source: compiled by the authors using the data of Main Departments of Statistics of Vinnytsia, Ternopil, and Khmelnytskyi regions.

During this period, the share of emissions in Ternopil region increased by 2.1 percentage points or from 22.6% to 24.7% of total emissions of pollutants from mobile sources in the economic region «Podillia», while in Vinnytsia region, on the contrary, it decreased by 2.1 from 43.3% to 41.2%. The share of emissions in Khmelnytskyi region did not change and amounted to 34.1% of total emissions in the area.

Volumes of pollutant emissions into the atmosphere from the activities of transport and warehousing in the area decreased by 18.3% in 2017-2020. This is due to the reduction of emissions in Khmelnytskyi region by 38.4% and Vinnytsia – by 37.9%. In Ternopil region, the value of this indicator increased by 32.9% (Table 2).

Table 2

Emissions of pollutants into the atmosphere from the activities of transport and warehousing in the economic region «Podillia», tons

Region	Year			
	2017	2018	2019	2020
Economic region «Podillia»	7162,7	5840,9	6315,1	5852,5
including: Vinnytsia region	3431,4	2667,5	3276,3	2131,6
Ternopil region	1994,6	2150,3	2078,2	2651,8
Khmelnytskyi region	1736,7	1023,1	960,6	1069,1

Source: compiled by the authors using the data of Main Departments of Statistics of Vinnytsia, Ternopil, and Khmelnytskyi regions.

During the study period, the amount of carbon dioxide emissions into the atmosphere from the activities of transport and warehousing in the economic region decreased by 40.8% due to the reduction of emissions in Vinnytsia region by 67.2%. However, the volumes of such emissions in Khmelnytskyi region increased by 48.2% and Ternopil region – by 1.8% (Table 3).

According to the analysis of statistical data, the total amount of generated industrial waste in the area increased by 8.1% in 2010-2019. This was due to an increase of 47.8% in Vinnytsia region and of 0.8% in Ternopil region. The volume of waste generated in Khmelnytskyi region decreased by 37.3% as a result of lower industrial production (Table 4). At the same time, the volume of waste generated from the economic activity of enterprises in the economic region «Podillia» decreased by 10.2% in 2017-2019 due the reductions in Ternopil region (45.7%) and Khmelnitskyi region (2.2%). In Vinnytsia region, the value of this indicator increased by 15.7% (Table 5).

Table 3

Emissions of carbon dioxide into the atmosphere from the activities of transport and warehousing in the economic region, thousand tons

Region	Year			
	2017	2018	2019	2020
Economic region «Podillia»	640,4	581,4	976,1	378,9
including: Vinnytsia region	420,5	328,5	566,6	137,9
Ternopil region	183,0	184,0	351,8	186,3
Khmelnytskyi region	36,9	68,9	57,7	54,7

Source: compiled by the authors using the data of Main Departments of Statistics of Vinnytsia, Ternopil, and Khmelnytskyi regions.

Table 4

Waste generated in the economic region «Podillia» in 2010-2019, thousand tons

Year	Economic region	Including		
		Vinnytsia region	Ternopil region	Khmelnytskyi region
2010	4324,2	1834,6	1054,3	1435,3
2011	5192,2	2490,6	1104,8	1596,8
2012	5605,0	3132,6	1001,3	1471,1
2013	4709,2	2907,4	690,2	1111,6
2014	4548,9	2423,8	858,9	1266,2
2015	3720,1	1950,3	808,9	960,9
2016	4089,3	1927,5	862,2	1299,6
2017	5175,7	2341,7	1905,8	928,2
2018	4334,5	1782,2	1651,8	900,5
2019	4674,2	2711,2	1062,6	900,4

Source: compiled by the authors using the data of Main Departments of Statistics of Vinnytsia, Ternopil, and Khmelnytskyi regions.

Table 5

Volumes of waste generated by economic operations of enterprises and organizations, thousand tons

Region	Year		
	2017	2018	2019
Economic region «Podillia»	4774,4	3861,2	4288,7
including: Vinnytsia region	2206,8	1633,7	2554,1
Ternopil region	1784,6	1495,6	969,2
Khmelnytskyi region	783,0	731,9	765,4

Source: compiled by the authors using the data of Main Departments of Statistics of Vinnytsia, Ternopil, and Khmelnytskyi regions.

Examining the development of the regional system of industrial waste recycling, it was found that the volume of recycled waste in the economic region increased only by 1.8% in 2010-2019. This is due to a significant reduction (by 54.8%) in the volume of recycled waste in Vinnytsia region. However, in Ternopil region the value of this indicator increased by 85.9%, and in Khmelnytskyi – by 54.1% (Table 6).

Table 6

Volumes of recycled industrial waste in the economic region «Podillia», thousand tons

Year	Economic region	Including		
		Vinnytsia region	Ternopil region	Khmelnytskyi region
2010	871,3	461,8	149,4	260,1
2011	770,7	353,1	128,8	288,8
2012	1585,7	855,6	203,7	526,4
2013	912,9	225,0	195,7	492,2
2014	822,8	239,6	278,0	305,2
2015	854,6	368,2	140,5	345,9
2016	876,6	343,4	83,1	450,1
2017	856,2	360,5	98,7	397,0
2018	1223,3	481,7	240,7	500,9
2019	887,4	208,9	277,7	400,8

Source: compiled by the authors using the data of Main Departments of Statistics of Vinnytsia, Ternopil, and Khmelnytskyi regions.

It should be noted that there is a negative trend of a growing ratio of generated and recycled waste in the economic region. Thus, the value of this indicator increased in the district from 4.9 to 5.3 in 2010-2019. This is due to a significant increase in the ratio in Vinnytsia region (from 3.9 times to 12.9 times). Meanwhile, in Ternopil region this ratio decreased from 7.1 to 3.8, and in Khmelnytskyi – from 5.5 times to 2.3 times.

During 2010-2019, the volume of disposed industrial waste in specially designated locations or facilities increased by 104.5% in the economic region «Podillia» due to an increase of 9.3 times in Vinnytsia region. However, the volume of disposed industrial waste in Ternopil region decreased by 39.3%, and in Khmelnytskyi – by 11.8% (Table 7).

Table 7

Volumes of disposed industrial waste in specially designated locations or facilities in the economic region «Podillia» in 2010-2019, thousand tons

Year	Economic region	Including		
		Vinnytsia region	Ternopil region	Khmelnytskyi region
2010	374,5	53,5	48,3	272,7
2011	499,2	120,7	66,7	311,8
2012	891,0	554,2	42,7	294,1
2013	982,2	598,5	49,0	334,7
2014	959,8	610,4	30,5	318,9
2015	1195,2	870,9	28,7	295,6
2016	426,7	105,3	28,7	292,7
2017	409,9	152,1	29,2	228,6
2018	1207,5	913,6	29,4	264,5
2019	765,8	496,1	29,3	240,4

Source: compiled by the authors using the data of Main Departments of Statistics of Vinnytsia, Ternopil, and Khmelnytskyi regions.

According to the analysis, the amount of waste accumulated during operation in specially designated locations or facilities in the economic region «Podillia» decreased by 28.9% in 2010-2019 as a result of corresponding reduction in Khmelnytskyi region (72.5%). However, the amount of waste accumulated during operation in specially designated locations or facilities in Ternopil region increased by 25.2%, and in Vinnytsia – by 24.3% (Table 8).

Table 8

Total amount of waste accumulated during operation in specially designated locations or facilities in the economic region in 2010-2019, thousand tons

Year	Economic region	Including		
		Vinnytsia region	Ternopil region	Khmelnytskyi region
2010	58716,5	25951,6	462,3	32302,6
2011	46286,1	26752,7	252,2	19281,2
2012	35316,5	27443,1	323,4	7550,0
2013	35808,9	27832,8	289,9	7686,2
2014	36608,5	28652,6	252,0	7703,9
2015	39782,2	31152,6	476,4	8153,2
2016	38042,4	29042,2	500,2	8500,0
2017	40129,9	30957,8	523,0	8649,1
2018	41289,3	31839,6	555,1	8894,6
2019	41718,7	32254,4	578,9	8885,4

Source: compiled by the authors using the data of Main Departments of Statistics of Vinnytsia, Ternopil, and Khmelnytskyi regions.

The share of current expenditures for environmental protection in the field of transport and warehousing in the economic region in 2020 was only 0.3% of the total volume (in 2017 – 0.4%). Moreover, Khmelnytskyi region's share of current expenditures on environmental protection in the field of transport and warehousing in region increased by 55.3 percentage points or from 40.4 to 95.7% of total current expenditures in the economic region. At the same time, there were reductions in the shares of Vinnytsia region (47.4 percentage points, from 51.6% to 4.2%) and Ternopil region (7.9 percentage points, from 8 to 0.1%). In addition, the share of capital investment in environmental protection in the field of transport and warehousing in the economic region (of the total volume of capital investment in this region) is insignificant and amounted to 1.2% in 2020 (in 2017 – 0.07 %). Investments in environmental protection in the field of transport and warehousing were recorded in small amounts in 2017 only in Ternopil region, in 2018 – in Vinnytsia and Khmelnytskyi regions, and in 2020 – only in Khmelnytskyi region. In 2019, there was no funding for transport and warehousing in terms of environmental protection (Table 9).

Table 9

Current expenditure and capital investment for environmental protection in the field of transport and warehousing in the economic region «Podillia», thousand UAH (in actual prices)

Indicator / Region	Year			
	2017	2018	2019	2020
Current expenditure				
Economic region «Podillia»	2008,7	1495,9	1110,4	2103,1
including: Vinnytsia region	1036,5	657,1	277,6	89,2
Ternopil region	159,8	21,0	9,9	1,8
Khmelnytskyi region	812,4	817,8	822,9	2012,1
Capital investment				
Economic region «Podillia»	43,9	–	95,4	1076,3
including: Vinnytsia region	–	–	87,0	–
Ternopil region	43,9	–	–	–
Khmelnytskyi region	–	–	8,4	1076,3

Source: compiled by the authors using the data of Main Departments of Statistics of Vinnytsia, Ternopil, and Khmelnytskyi regions.

In the economic region of «Podillia», the situation with investing in measures aimed at protecting the air and climate change is deteriorating. For instance, according to the State Statistics Service of Ukraine, the share of capital investment in air protection and climate change in the economic region was 9.1% in 2020 (of total capital investment in all types of environmental measures), down by 39 percentage points compared to 2010. The share of capital investments in the region decreased by 1.6 percentage points in 2010-2020, from 2.1% to 0.5% of the total national volume of capital investments in this type of environmental measures.

The largest share of capital investments in air protection and climate change belongs to Khmelnytskyi region (61.6% of the total); followed by Vinnytsia region (38.2%) and Ternopil region (0.2%). In 2015-2019, there was no investment in this environmental measure in Ternopil region at all. The share of Khmelnytskyi region's capital investments in air protection and climate change increased by 5.0 percentage points (from 20.8% to 25.7% of the volume of capital investments in all types of environmental measures in the region); the share of Vinnytsia region, on the contrary, decreased by 55.8 percentage points (from 61.1% to 5.3%); Ternopil region's – by 0.7 percentage points or from 0.9% to 0.2% (Table 10).

Table 10

Capital investments in air protection and climate change in the economic region «Podillia» in 2010-2020, thousand UAH (in actual prices)

Year	Economic region	Including		
		Vinnytsia region	Ternopil region	Khmelnytskyi region
2010	23577,0	22604,2	65,2	907,6
2011	37841,1	36333,3	20,0	1487,8
2012	1318,0	178,5	20,0	1119,5
2013	948,7	884,3	41,7	22,7
2014	1102,3	648,2	434,5	19,6
2015	3634,5	3497,4	–	137,1
2016	20106,2	413,5	–	19692,7
2017	4798,8	321,9	–	4476,9
2018	12755,4	7543,7	–	5211,7
2019	12552,0	3243,2	–	9308,8
2020	25463,2	9731,0	59,5	15672,7

Source: compiled by the authors using the data of Main Departments of Statistics of Vinnytsia, Ternopil, and Khmelnytskyi regions; section «Environment» of the official website of the State Statistics Service of Ukraine.

Admittedly, the situation with financing the development of the waste management system in the economic region is better. For example, in 2020, the share of capital investment in waste management was 43.9% of total capital investment in all types of environmental measures, which was 39.9 percentage points higher than in 2010. The region's share of capital investments in the total national volume of capital investments in this type of environmental measures increased by 3.8 percentage points in 2010-2020 (from 0.4% to 4.2%).

At the same time, the share of capital investments in waste management of Vinnytsia region increased during this period by 54.8 percentage points, or from 28.4 to 83.2% of the total volume of these investments in the economic region. However, this indicator for Ternopil region decreased by 51.6 percentage points (from 54% to 2.4%), and for Khmelnytskyi – by 3.2 percentage points (from 17.6% to 14.4%) (Table 11).

During 2010-2020, the share of current expenditures on air protection and climate change in the economic region decreased by 1.3 percentage points (from 4.6% to 3.3% of total current expenditures for all types of environmental measures).

Table 11

Capital investments in waste management in the economic region «Podillia» in 2010-2020, thousand UAH (in actual prices)

Year	Economic region	Including		
		Vinnytsia region	Ternopil region	Khmelnytskyi region
2010	1974,0	561,1	1066,6	346,3
2011	1248,5	772,7	127,2	348,6
2012	10972,3	6150,6	2624,5	2197,2
2013	4690,3	–	727,9	3962,4
2014	5888,4	3044,9	268,0	2575,5
2015	7081,6	2223,6	1947,6	2910,4
2016	11106,1	2694,9	5091,0	3320,2
2017	19414,8	4875,4	5915,4	8624,0
2018	8637,7	2991,5	2833,0	2813,2
2019	24317,1	2949,8	4657,9	16709,4
2020	122578,9	101977,2	2901,6	17700,1

Source: compiled by the authors using the data of Main Departments of Statistics of Vinnytsia, Ternopil, and Khmelnytskyi regions; section «Environment» of the official website of the State Statistics Service of Ukraine.

During this period, the region's share of current expenditures in the total Ukrainian current expenditures for this type of environmental measures has not changed and in 2020 amounted to only 0.8%. At the same time, the largest share of current expenditures on air protection and climate change problems belongs to Khmelnytskyi region (50.2% of the total in the region); followed by Vinnytsia region (46.1%) and Ternopil region (3.7%).

The share of current expenditures on air protection and climate change in Ternopil region decreased by 4 percentage points, from 5.9% to 1.9% of the total environmental expenditures in the region; in Khmelnytskyi the change amounted to 1.2 percentage points (from 4.2% to 3%); in Vinnytsia – 0.9 percentage points (from 4.9% to 4%) (Table 12).

Statistical analysis shows that the share of current expenditures on waste management in 2020 was 40.3% of current expenditures on environmental protection of all types, 20.1 percentage points more than in 2010. The region's share of current expenditures (out of the total Ukrainian current expenditures on environmental measures) increased by 0.6 percentage points in 2010-2020, from 1.5% to 2.1%. The share of current expenditures on waste management of Vinnytsia region increased during this period by 7.5 percentage points, from 28.4% to 35.9% of the total current expenditures in the economic region, share of Khmelnytskyi – by 0.2 percentage points (from 54.7% to 54.9%). However, in the Ternopil region, the value of this indicator decreased by 7.7 percentage points from 16.9% to 9.2% (Table 13).

Table 12

Current expenditures for air protection and climate change problems in the economic region «Podillia» 2010-2020, thousand UAH (in actual prices)

Year	Economic region	Including		
		Vinnytsia region	Ternopil region	Khmelnytskyi region
2010	9132,9	3672,8	998,9	4461,2
2011	16891,9	11293,7	383,4	5214,8
2012	32032,0	2851,9	4878,2	24301,9
2013	39542,9	3136,9	3138,8	33267,2
2014	43234,1	3476,0	3125,0	36633,1
2015	49877,2	4664,8	761,7	44450,7
2016	31542,1	8807,8	617,3	22117,0
2017	31100,5	9301,5	516,1	21282,9
2018	28209,0	5525,6	548,3	22135,1
2019	38664,4	5341,5	947,0	32375,9
2020	19145,2	8834,6	701,3	9609,3

Source: compiled by the authors using the data of Main Departments of Statistics of Vinnytsia, Ternopil, and Khmelnytskyi regions; section «Environment» of the official website of the State Statistics Service of Ukraine.

Table 13

Current expenditures on waste management in the economic region «Podillia» in 2010-2020, thousand UAH (in actual prices)

Year	Economic region	Including		
		Vinnytsia region	Ternopil region	Khmelnytskyi region
2010	40234,6	11414,8	6825,1	21994,7
2011	54802,8	23392,8	5412,4	25997,6
2012	59266,7	17975,6	8197,7	33093,4
2013	99676,5	51443,1	8990,9	39242,5
2014	92913,7	45866,8	4532,7	42514,2
2015	113758,3	53578,0	6989,3	53191,0
2016	122067,9	62583,8	7100,4	52383,7
2017	138000,5	72211,8	7267,1	58521,6
2018	198017,2	110998,5	8144,5	78874,2
2019	228539,3	117305,3	10168,7	101065,3
2020	231373,1	83021,3	21301,5	127050,3

Source: compiled by the authors using the data of Main Departments of Statistics of Vinnytsia, Ternopil, and Khmelnytskyi regions; section «Environment» of the official website of the State Statistics Service of Ukraine.

The share of investments in capital repairs of fixed assets for environmental protection in the economic region «Podillia» increased by 1.9 percentage points in 2019 compared to 2010 (from 3.3% to 5.2% of the total volume of such investments in Ukraine). At the same time, the share of Khmelnytskyi region by 4.3% percentage points from 18.4% to 22.7% of the total volume of such investments in the economic region. However, the shares of Vinnytsia region and Ternopil region, on the contrary, decreased by 3.9 percentage points and 0.4 percentage points, respectively. Former fell from 74.8% to 70.9%, while the latter – from 6.7% to 6.3% (Table 14).

Table 14

Investments in capital repairs of fixed assets for environmental purposes in the economic region «Podillia», UAH million

Year	Economic region	Including		
		Vinnytsia region	Ternopil region	Khmelnytskyi region
2010	16,3	12,2	1,1	3,0
2011	17,1	16,7	0,2	0,2
2012	16,3	14,0	0,4	1,9
2013	8,7	7,7	0,8	0,2
2014	7,6	4,4	1,3	1,9
2015	16,1	12,2	0,9	3,0
2016	20,9	12,3	3,3	5,3
2017	28,5	16,1	2,4	10,0
2018	52,4	38,6	5,0	8,8
2019	75,7	53,7	4,8	17,2

Source: compiled by the authors using the data of Main Departments of Statistics of Vinnytsia, Ternopil, and Khmelnytskyi regions; section «Environment» of the official website of the State Statistics Service of Ukraine.

Analysis of the environment aspects of strategic documents of regional development in the field of transport and logistics

To date, the Regional Development Strategies approved until 2027 consider the creation of a safe living environment and increasing the level of environmental safety to be priority areas. These strategic documents are consistent with the main aspects of regional development, namely bringing the quality of life to European standards and developing human potential, increasing the competitiveness of the region's economy and sustainable development of settlements and communities (Table 15).

Table 15

Analysis of environmental aspects of regional development strategies for the period up to 2027 in the field of transport and logistics

Region	Strategic goal	Operational target
Vinnytsia	Competitive region based on innovation and sustainable development	Modernization of transport and logistics infrastructure taking into account internal, interregional and international relations
	Safe environment region	Ensuring clean and ecological welfare
		Conservation and rational use of water resources
Ternopil	Development of human potential and raising living standards	Creating comfortable and safe living conditions for the population
		Creating an optimal regional system of rational nature management and environmental protection
	Improving the competitiveness of the region	Stimulating investment
Khmelnytskyi	Increasing the competitiveness of the regional economy	Increasing the sales potential of regional products
	Improving the quality of life and preserving the environment	Environmental safety and environmental protection

The Strategy of Balanced Regional Development of Vinnytsia Region for the period up to 2027 pertains to the creation of proper and high-quality road infrastructure, reconstruction of Vinnytsia International Airport, development of transport and logistics technologies and multimodal transportation facilities, restoration and maintenance of a favourable hydrological regime and condition of rivers, development of regional cluster infrastructure for waste management, support for reuse and recycling, facilitation of a culture of responsible consumption and waste management.

The Ternopil Region Development Strategy for 2021-2027 emphasizes the need to develop road transport, logistics potential and the latest communication systems, implement a regional waste management plan until 2030, form an ecological network, ensure the protection and rational use of the natural resource potential of the region, as well as create and ensure the functioning of the region's environmental monitoring system.

The key tasks listed in the Development Strategy of Khmelnytskyi region for 2021-2027 include development of logistics and transport systems in the region; de-

velopment and implementation of waste management systems; improvement of air quality and mitigation of the negative factors influencing climate change; development of an ecological network and a nature reserve fund, preservation of biological and landscape diversity; improvement of the water conditions and water use systems; raising environmental culture and awareness of the population.

Thus, the results of previous studies (Hryhorak & Trushkina, 2020; Dźwigoł, Kwilinski et al., 2021; Dzwigol, Trushkina et al., 2021) and the conducted statistical analysis testify to inefficient modernization of the regional transport and logistics system in the economic region «Podillia» in the context of green economics and sustainable development. This is primarily due to the limited amount of funding for the creation of transport infrastructure and insufficient implementation of green technologies.

Trends in global markets of green bonds, green loans and sustainable investment assets

At present, it is advisable to develop and implement a mechanism for green investment in infrastructure projects, which means financing investments that provide environmental benefits in the broad context of environmentally sustainable development of various areas of economic activity. According to expert estimates (G20 Green Finance Study Group, 2016), only 1% of global bonds are marked as «green», while 1% of investments of institutional investors belong to the category of «green» infrastructure assets.

In 2017, 1,500 green bonds worth $173.6 billion were issued, which is 98.6% more than in 2016. In 2018, the global market for green bonds reached 175 billion USD. They are issued in 37 countries, namely Belgium, Hong Kong, Indonesia, Kenya, Nigeria, Morocco, Sweden, France, Poland, etc. At the same time, the growth rate of sustainable bonds for 2017-2018 was 51%. The share of these bonds increased during this period by 6 percentage points or from 12% to 18% of the global volume of green bonds (Table 16).

Table 16

Global market of green bonds

Year	Volume of green bonds, billion USD	Volume of sustainable bonds, billion USD
2017	173,6	20,8
2018	175,0	31,4

Source: ESG Debt: a User's Guide to Ever-Growing Menu of Bonds and Loans. – Bloomberg, 2019.

Instruments such as green loans are widespread in the United States, the United Kingdom, Spain, and India, which account for more than 40% of the global green loan market. The global volume of green loans increased by 30.5% in 2018 compared to 2017; loans related to sustainable development rose 8.4 times. The share of loans related to sustainable development increased by 59.2 percentage points from 10.9% to 70.1% of the total green loans in the world (Table 17).

Table 17

Global market of green loans

Year	Volume of green loans, billion USD	Volume of sustainable development loans, billion USD
2017	45,9	5,0
2018	59,9	42,0

Source: ESG Debt: a User's Guide to Ever-Growing Menu of Bonds and Loans. – Bloomberg, 2019.

Statistical analysis shows that the global volume of sustainable financing assets increased by 34.1% in 2016-2018, in particular, by 17.5% in Europe, by 37.9% in the United States, by 54.5% in Canada, and by 40% in Australia and New Zealand. The largest shares of sustainable financing assets belong to Europe (45.9% of global assets) and the United States (39.1%) (Table 18).

Table 18

Global distribution of sustainable investment assets, trillion USD

Region	Year	
	2016	2018
Europe	12,0	14,1
USA	8,7	12,0
Japan	0,5	2,2
Canada	1,1	1,7
Australia and New Zealand	0,5	0,7
Total	22,9	30,7

Source: Global Sustainable Investment Alliance. (2018). *Global Sustainable Investment Review 2018*. http://www.gsi-alliance.org/wp-content/uploads/2019/06/GSIR_Review2018F.pdf.

At the same time, as stated in the analytical report *«Green» Investments in Sustainable Development: World Experience and Ukrainian Context* (Markevych & Sidenko, 2019), in European countries, the most widely used investment approach is «negative screening»; in the USA, Canada, Australia and New Zealand – «integration of ESG-factors»; in Japan – «corporate interaction and shareholder action». Globally, there is a growing trend of investing in some green investment approaches. For instance, the volume of thematic sustainable investment increased 3.7 times in 2016-2018 (from 276.2 to 1017.7 billion USD); positive screening – 2.3 times (from 818 to 1841.9); targeted investment – 2 times (from 224.5 to 444.3 billion USD) (Global Sustainable Investment Alliance, 2018).

Organizational and economic mechanism for ensuring the functioning of the transport and logistics system of «Podillia» on the basis of green economics and sustainable development

For the effective functioning of the regional transport and logistics system (TLS) of «Podillia» in the context of green growth, it is advisable to develop an organizational and economic mechanism (Fig. 1).

This mechanism should be considered as a set of principles, functions, methods, means, management tools, information systems and technologies aimed at reducing greenhouse gas emissions, improving environmental safety, making sound innovative decisions on sustainable management of logistics.

Based on the above, we can conclude that it is appropriate to apply the best world experience in implementing the mechanism of green investment in infrastructure projects in modern Ukrainian conditions. This requires making appropriate changes and additions to the 2030 National Transport Strategy of Ukraine and the 2027 Strategies for Regional Development of Vinnytsia, Ternopil and Khmelnytskyi regions.

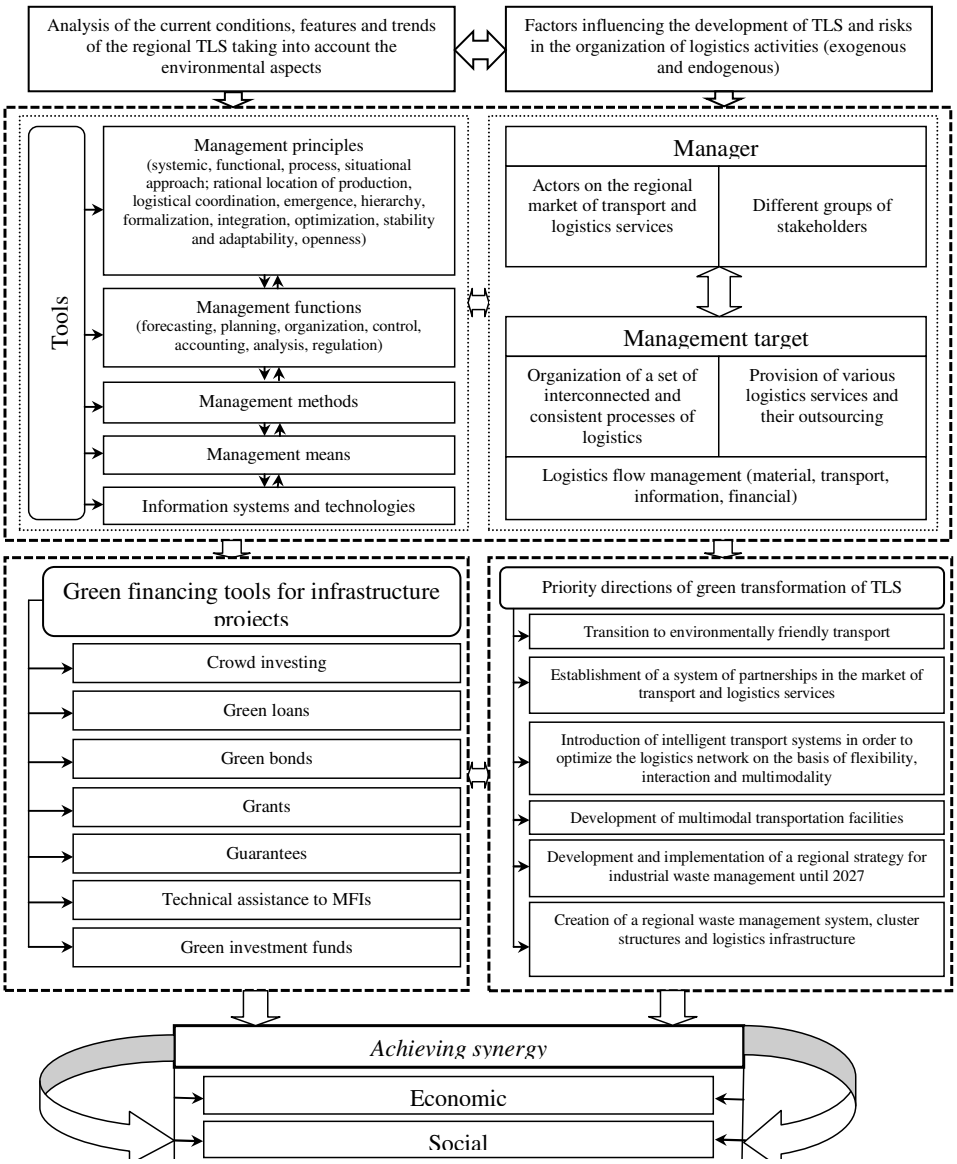
This will allow for a successful transformation of the transport and logistics system of the economic and geographical region «Podillia» on the basis of green economics and for a balanced sustainable development of transport infrastructure through the introduction of investment-attractive green solutions.

Conclusions

In the current conditions of rapid development of the green economics, the issues of environmental protection in the transport sector and in the organization of logistics activities in the economic regions of Ukraine are more relevant than ever. However, the study revealed numerous manifestations of non-compliance of the regional transport and logistics system of the economic and geographical region «Podillia» with the international environmental standards and requirements, including the global level of greening of logistics.

Figure 1

Organizational and economic mechanism for ensuring the functioning of the transport and logistics system of «Podillia» on the basis of green economics and sustainable development



Therefore, today regional and local authorities and stakeholders of supply chains need to pay attention to environmental factors in the creation and operation of transport and logistics systems. This would be in line with the main provisions of the European Green Deal.

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