

REGULATORS OF SUSTAINABLE DEVELOPMENT OF INFRASTRUCTURE OF TRANSPORT AND LOGISTICS SYSTEMS

РЕГУЛЯТОРИ СТАЛОГО РОЗВИТКУ ІНФРАСТРУКТУРИ ТРАНСПОРТНО-ЛОГІСТИЧНИХ СИСТЕМ

The article considers the environmental, social and economic aspects of the functioning of transport and logistics systems in Ukraine. The role of the "green logistics" approach in the implementation of the concept of sustainable development, which can help curb the destructive impact of economic development on the environment, is shown. The structure of the logistics services market of Ukraine is analyzed. The key factors contributing to the business interest in the concept of sustainable development are highlighted. All directions of the impact of the transport and logistics system on sustainable development goals are systematized. The dynamics of the negative consequences of transport and logistics activities for the territory of Ukraine during 2015 – 2019 is presented. The concept of achieving a reasonable balance between environmental, economic, social, cultural development and people's needs is proposed. The proposed system of factors for the sustainable development of supply chains is the basis for the development of criteria and indicators for evaluating transport and logistics activities.

Key words: concept of sustainable development, lean manufacturing, environment, transport, logistics, "green logistics" approach.

В статті розглядаються екологічні, соціальні та економічні аспекти функ-

ціонування транспортно-логістических систем в Україні. Показана роль «зеленого логістического» підходу в реалізації концепції сталого розвитку, котра може допомогти зменшити руйнівний вплив економічного розвитку на оточуючу середовище. Проаналізована структура ринку логістических послуг України. Виділені ключові фактори, що сприяють зацікавленості бізнесу в концепції сталого розвитку. Всі напрямки впливу транспортно-логістическої системи на цілі сталого розвитку систематизовані. Приведено динаміку негативних наслідків транспортно-логістическої діяльності для території України протягом 2015–2019 рр. Предложено концепцію досягнення вдалого балансу між екологічним, економічним, соціальним, культурним розвитком і потребами людей. Предлагается система факторов устойчивого развития цепочек поставок является основой для разработки критериев и показателей для оценки транспортно-логистической деятельности.

Ключевые слова: устойчивое развитие, бережливое производство, окружающая среда, транспорт, логистика, «зеленый логистический» подход.

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Стійкість соціально-економічної системи країни, її цілісність й адаптивність багато в чому залежать від стану обслуговуючих її комунікацій і, перш за все, транспортно-логістического комплексу країни. Логістична система України характеризується нерівномірним розвитком, що позначається на формуванні і розподілі вантажо- і пасажиропотоків. У статті розглядаються екологічні, соціальні та фінансові аспекти підтримки транспортної інфраструктури. Показана роль «зеленого логістического» підходу в реалізації концепції сталого розвитку, яка може допомогти зменшити руйнівний вплив економічного розвитку на навколишнє середовище. Проаналізовано структуру ринку логістических послуг України. Виділено ключові фактори, що сприяють зацікавленості бізнесу в концепції сталого розвитку. Всі напрямки впливу транспортно-логістическої системи на цілі сталого розвитку систематизовані. Приведено динаміку негативних наслідків транспортно-логістическої діяльності для території України протягом 2015–2019 рр, що дозволило довести негативний вплив транспорту на навколишнє середовище через поточні обсяги та стан перевезень, товаро- і вантажообігу в країні. Виділено основні негативні екологічні зміни. Найважливішими серед них є, зокрема: суттєва зміна клімату за останні кілька років, якість повітря і води, шумове забруднення, землекористування та екологічні патології. Окрім цього, продемонстровано, що соціально-економічні зміни також несуть негативний вплив для країни, а саме мають вплив на: низький рівень якості транспортно-логістических послуг; шкоду, заподіяну майну; соціальну напруженість, непрацевдатність, непродуктивність; медичні, страхові та інші витрати; штрафи й податки; ріст цін на енергоносії та відповідний транспорт, комплектуючі до них, тощо. Доведено, що розвинута транспортно-логістическа система країни має забезпечувати налагоджений розвиток і функціонування всіх видів транспорту з метою максимального задоволення транспортно-логістических потреб з мінімізацією витрат та нанесеної шкоди. Зважаючи на це, у статті запропоновано концепцію досягнення вдалого балансу між екологічним, економічним, соціальним, культурним розвитком і потребами людей. При цьому продемонстровано, що така система чинників сталого розвитку ланцюжків поставок є основою для розробки критеріїв і показників оцінки транспортно-логістическої діяльності.

Ключові слова: концепція сталого розвитку, осядливе виробництво, навколишнє середовище, транспорт, логістика, «зелений логістический» підхід.

Problem statement. The market of transport and logistics services is one of the most dynamic in the world. The role of transport is changing significantly with the development of logistics systems. In the context of the transition of the economy to an innovative path of development, transport is considered as the most important factor in the socio-economic growth of the state, ensuring: the unity of the country's economic space; improvement of interregional and international transport and economic relations; streamlining the distribution of productive forces; increasing the efficiency of using natural resources and the

socio-economic potential of the country's regions; development of entrepreneurship and expansion of international cooperation.

The transport logistics management system of the modern state operates using the concept of integration of transport, supply, production, and marketing, the search for optimal solutions in general throughout the process of movement of material flow in the service, circulation and production sectors, minimizing the cost of transportation, supply, marketing, production. The developed transport infrastructure of Ukraine allows to provide different

volumes of transportation. The largest share in the implementation of the country's transit potential has water (mostly, sea) transport – almost 67% and rail – 11%. Despite the favorable trends in the operation of certain types of transport, the transport system does not fully meet the existing needs and development prospects of the country.

Overview of recent research and studies. The works of both domestic (Vakulenko V., Karpenko O., Horbenko A., Vovk Y., Tson O.) and foreign scientists (Litman T., Kumar A., Vandycke N., Sands P., Rakhmangulov A.) are devoted to the study of the logistic aspects of the development of transport infrastructure and the factors affecting its vital activity.

Purpose statement. The main purposes of the study are: to analyze the basic reasons for low level of development of the country's transport and logistics systems; to analyze the state of transport logistics in Ukraine; to identify the general prospects for the further progress.

Statement of the main research material. The modern type of ecological and economic development of the economy can be defined as a technogenic type [1, p. 63]. Its characteristic features are, for instance: the use of artificial means of production created without taking into account environmental restrictions and the increasing depletion of non-renewable natural resources, the excessive use of renewable resources. The result of the development of any economic system of this type is environmental pollution as a result of human activity.

In the future, humanity needs to create an environmentally reasonable load on the biosphere, not exceeding its restoration ability. To reduce the load, it is necessary to change the technogenic type of development to a stable type of progress. This concept has received the most recognition in international practice [1, p. 64]. The idea is based on achieving a reasonable balance between environmental, economic, social, cultural development and people's needs. An important role in ensuring sustainable development is

assigned to the transport system, since transport is the most important tool for solving social, economic and technological problems, but its functioning is accompanied by a negative impact on the environment, the occurrence of road accidents, and damage to health.

An increase in the volume of transportations, goods and freight turnover in the world transport system, the negative impact of transport on the environment makes the task of identifying and justifying the factors of sustainable development of transport and logistics systems relevant. Currently, the key guideline for economic and environmental policymaking for most countries is the Sustainable Development Goals (SDGs). They are included in the global strategic program named “Transforming Our World: The 2030 Agenda for Sustainable Development” [2].

The SDGs are grouped in three aspects:

- environmental (clean water and sanitation; combating climate change; conservation of marine ecosystems; conservation of terrestrial ecosystems);
- social (elimination of poverty; elimination of hunger; good health and well-being; gender equality; affordable and clean energy);
- economic (decent work and economic growth; industrialization, innovation and infrastructure; reducing inequality; responsible consumption and production).

In the context of a rise in traffic volumes in the global transport system and in Ukraine [3, p. 59], increased competition between companies, the importance of ensuring the safety and environmental friendliness of cargo delivery is growing. Since the largest share in the logistics services market in Ukraine is in freight transportation (Figure 1), this makes the task of sustainable development of transport systems of Ukraine as part of the supply chain relevant.

According to overall opinion [4, p. 12], the sustainable development of transport systems means that meeting transport needs does not contradict the priorities of environmental protection and health,

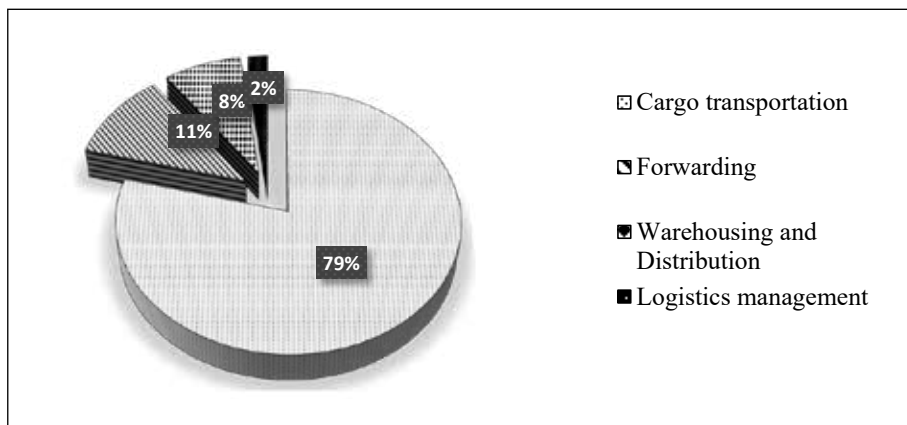


Fig. 1. The structure of the transport and logistics market in Ukraine by type of service

does not lead to irreversible natural changes and the depletion of irreplaceable resources.

As defined by the Canadian Center for Sustainable Development [5, p. 122], a sustainable transport system: allows society to meet basic needs in a secure environment while maintaining human and ecosystem health; affordable, efficient, offering a choice of modes of transport, and supporting a productive economy; contributes to emissions reduction, waste and noise exposure, reducing the consumption of non-renewable resources, the rational use of renewable resources and the efficient utilization and reuse of waste.

Studies show that the attitude of business to sustainable development is changing every year (Table 1).

A special role in the formation of sustainable transport systems is assigned to legal support. Currently, there is an extensive system of national and international environmental legislation [6]. Most of the agreements are bilateral (about 1 500 agreements) and regional in nature, and there are more than two hundred environmental agreements of a completely international nature. All key agreements were signed by about 70% of countries.

The generalizing principle in relation to the whole set of principles and norms of international environmental law is the protection of the environment for the benefit of present and future generations of people. It is gained by achieving the goals and objectives of sustainable development (Figure 2).

The functioning of the transport and logistics system is associated with the consumption of primary and secondary energy resources. In turn, the most energy-intensive element of the logistics system is the transport element. Currently, analysis and accounting of energy consumption of transport as a part of logistics systems is not performed, however, according to the IAE International Energy Agency, between 2000 and 2018, energy consumption of transport increased by almost 65% to 134 EJ [7]. Among sectors of the economy, transport accounts for up to 30% of energy consumption [8]. By the type of transport, the most energy-intensive is automobile (83% of the energy consumption of the transport industry), air

(accounts for up to 10%), water and rail transport (respectively, 4% and 3%) [8].

Analysis of water resources consumption by the type of economic activity [9, p. 58] shows that transport needs account for 5 to 7% of the total water consumption in Ukraine. In 2019, the volume of water withdrawal from natural sources amounted to 2914.18 million m³, and the volume of wastewater discharged into surface natural water bodies amounted to 218.12 million m³ [9, p. 51].

Moreover, transport and logistics activities cause environmental pollution by harmful substances. According to the reports of the Intergovernmental Panel on Climate Change [10], transport accounts for more than 15% of global greenhouse gas emissions (Figure 3).

The volume of emissions from transport in Ukraine for the period from 2015 to 2019 was changing sometimes significantly (Fig. 4). At last, in 2019 the emission indicators in Ukraine amounted to 148915.5 thousand tons (including 23617.4 thousand tons from road transport). Rail transport accounts for less than 1% of the total emissions, which is 13.4 thousand tons [9, p. 29].

The development of transport and logistics infrastructure entails a number of negative consequences, such as: land alienation, landscape changes, pollution of territories adjacent to transport communications, waste generation, leading to soil pollution [9, p. 210]. For the period from 2015 to 2019, the area of land withdrawn from productive turnover for transport infrastructure in Ukraine amounted to an average of 496.8 thousand hectares/year (Fig. 5).

The construction of infrastructure facilities leads to an increase in the volume of waste. From 2015 to 2019, the total amount of waste accumulated in Ukraine increased by 15% (Fig. 6) [9, p. 96]. In 2019, for instance, 359.2 thousand tons were formed, over than 7.6 thousand tons of which were attributable to the Transport and Communications sector.

The reduction in the number of infrastructure facilities under construction and reconstruction, as well as the rate of replenishment and renewal of vehicle fleets, has led to a significant deterioration in the technical condition of fixed assets (age structure,

Table 1

The main factors of change

Aim	Activity
monitoring compliance with environmental laws	restrictive (fines) and incentive measures (tax benefits)
improving the quality of services and products	organizations that produce environmentally friendly products increase the brand image
reputation improvement	increasing the company's capitalization, improving its financial performance in the long-term, as a rule, perspective
the demands of partners in the supply chain	strengthening relationships with suppliers and customers, the formation and development of social corporate responsibility
competitive advantage	positioning services and products as environmentally friendly allows to conquer new markets

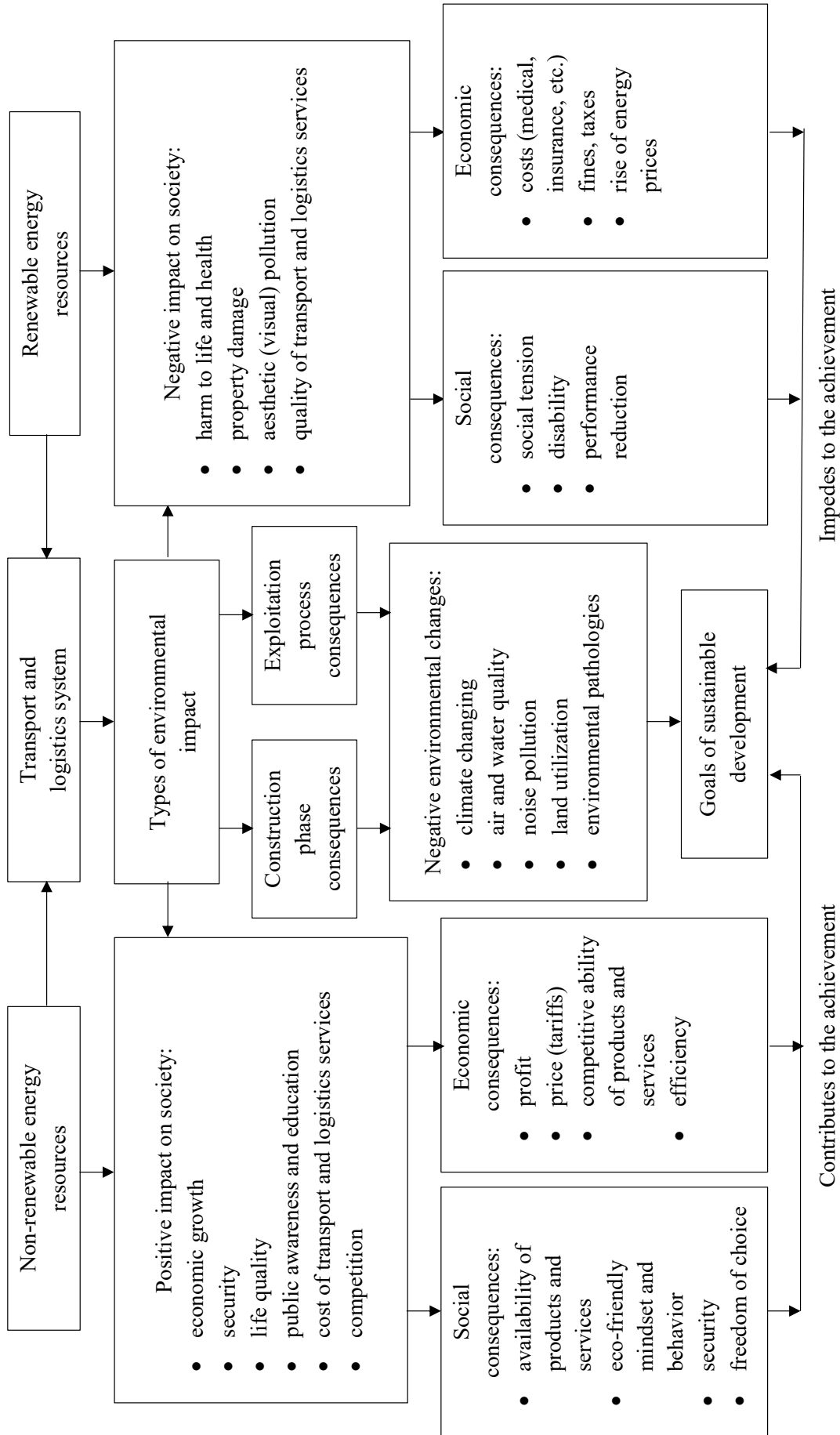


Fig. 2. Scheme of the transport and logistics system impact on sustainable development

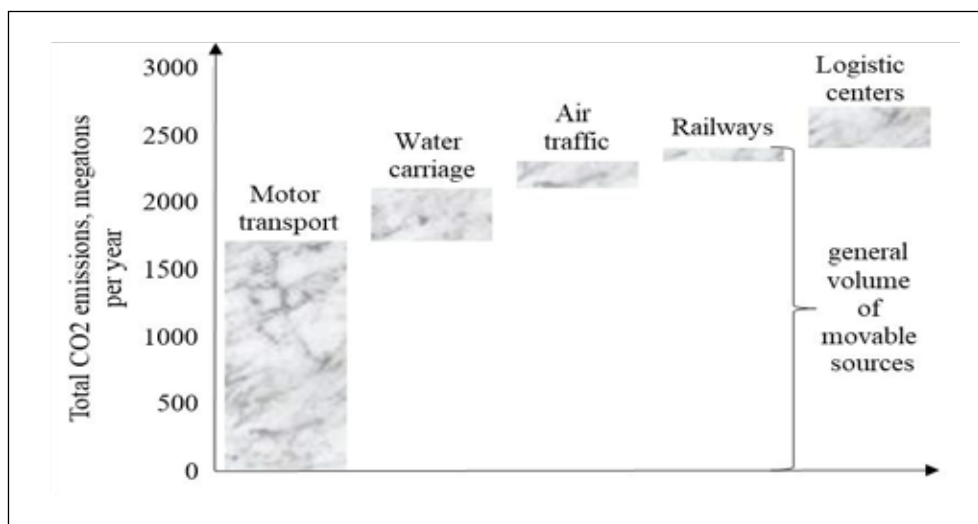


Fig. 3. Distribution of CO₂ emissions as a result of transport and logistics activities

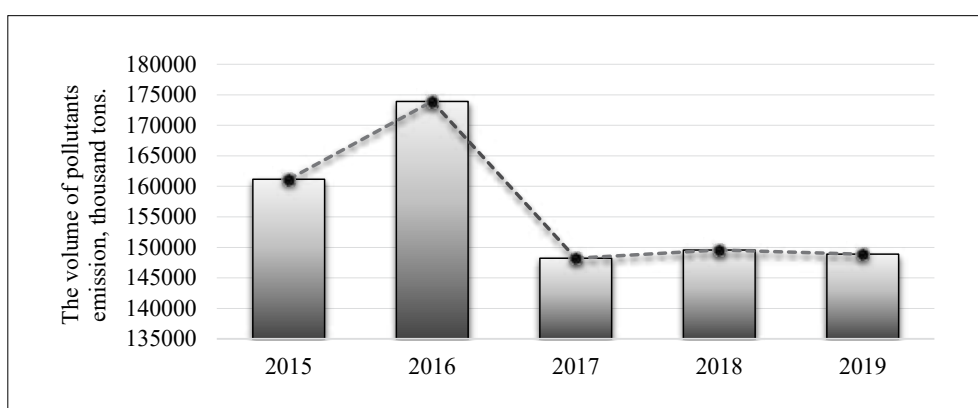


Fig. 4. Dynamics of pollutant emissions from mobile sources in Ukraine for 2015 – 2019, thousand tons

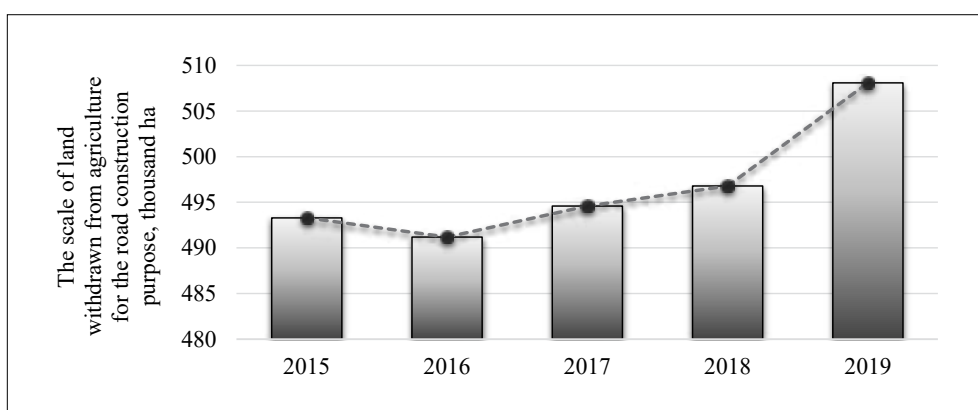


Fig. 5. Dynamics of land withdrawal from productive turnover under roads in Ukraine for 2015 – 2019, thousand hectares

increased depreciation, etc.) in recent years. The degree of depreciation of fixed assets of transport is presented on Fig. 7 [11].

An analysis of the scientific literature [12; 13; 14] made it possible to systematize the factors of

sustainable development of transport and logistics systems (Fig. 8):

Accordingly, based on the structural-functional approach, the main functions of the logistics systems elements are:

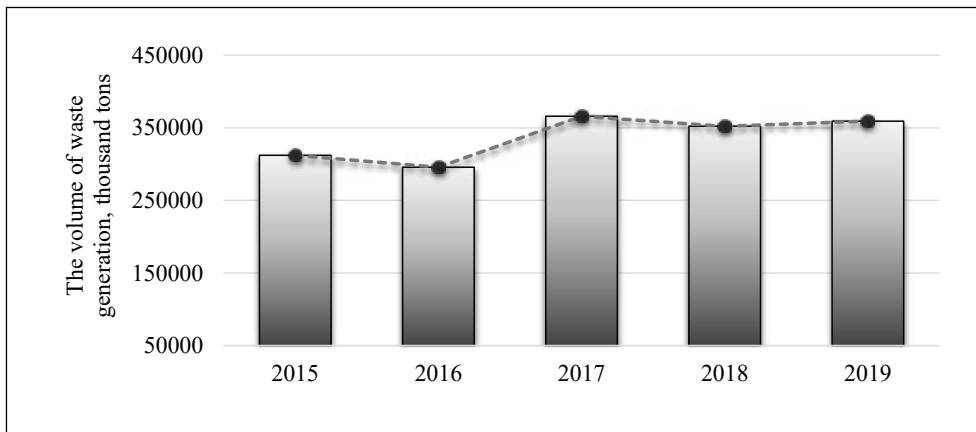


Fig. 6. Dynamics of waste generation in Ukraine for 2015 – 2019, thousand tons

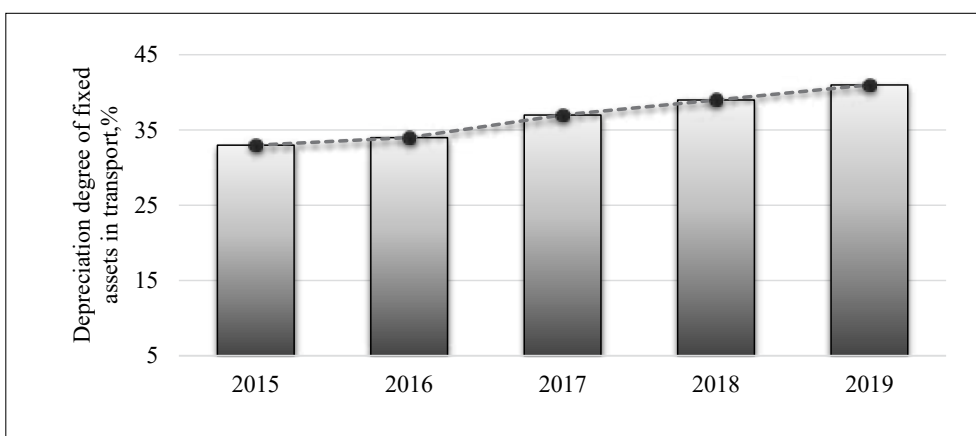


Fig. 7. Dynamics of the transport fixed assets depreciation degree in Ukraine for 2015 – 2019, %

- input element – receipt of material flow and service flow into the logistics system;
- processing element – a change in the quality properties of the material stream, its conversion from raw materials to finished products;
- storage element – regulation of the flows speed as a result of their inhibition, accumulation and storage;
- transport element – headway of material flow in the logistics system;
- output element – disposal of material flow and service flow from the logistics system;
- control element – coordination of all elements of the logistics system for processing and headway of material and service flow by changing the properties of information and financial flows.

The advantage of the structural-functional approach to the systematization of various factors is the possibility of grouping them according to two main characteristics: by belonging to a logistic element that implements one of the basic logistic functions; and by the influence of the factor on logistic flows (material, information, financial and etc.).

Using the proposed system of factors that influence the sustainable development for both individual

elements of the transport and logistics system, and the system as a whole will make it possible to conduct a comprehensive assessment of supply chains for compliance with the principles of sustainable development, make progress and apply tools and methods that contribute to the achievement of sustainable goals development.

Conclusions. The world community connects by the solution of the global climate change problems, improving the quality of life and reducing the human impact on the environment with the concept of sustainable development, which is based on the idea of achieving a reasonable balance between economic, social and environmental development, as well as the needs of society. The increase in traffic and cargo turnover, the intensive use of transport makes the urgent task of the sustainable development of transport and logistics systems and identify factors that affect the stability of these systems.

The system of factors of sustainable development of supply chains proposed by the authors is the basis for the development of criteria and indicators for evaluating transport and logistics activities. Taking into account the identified factors in the design and

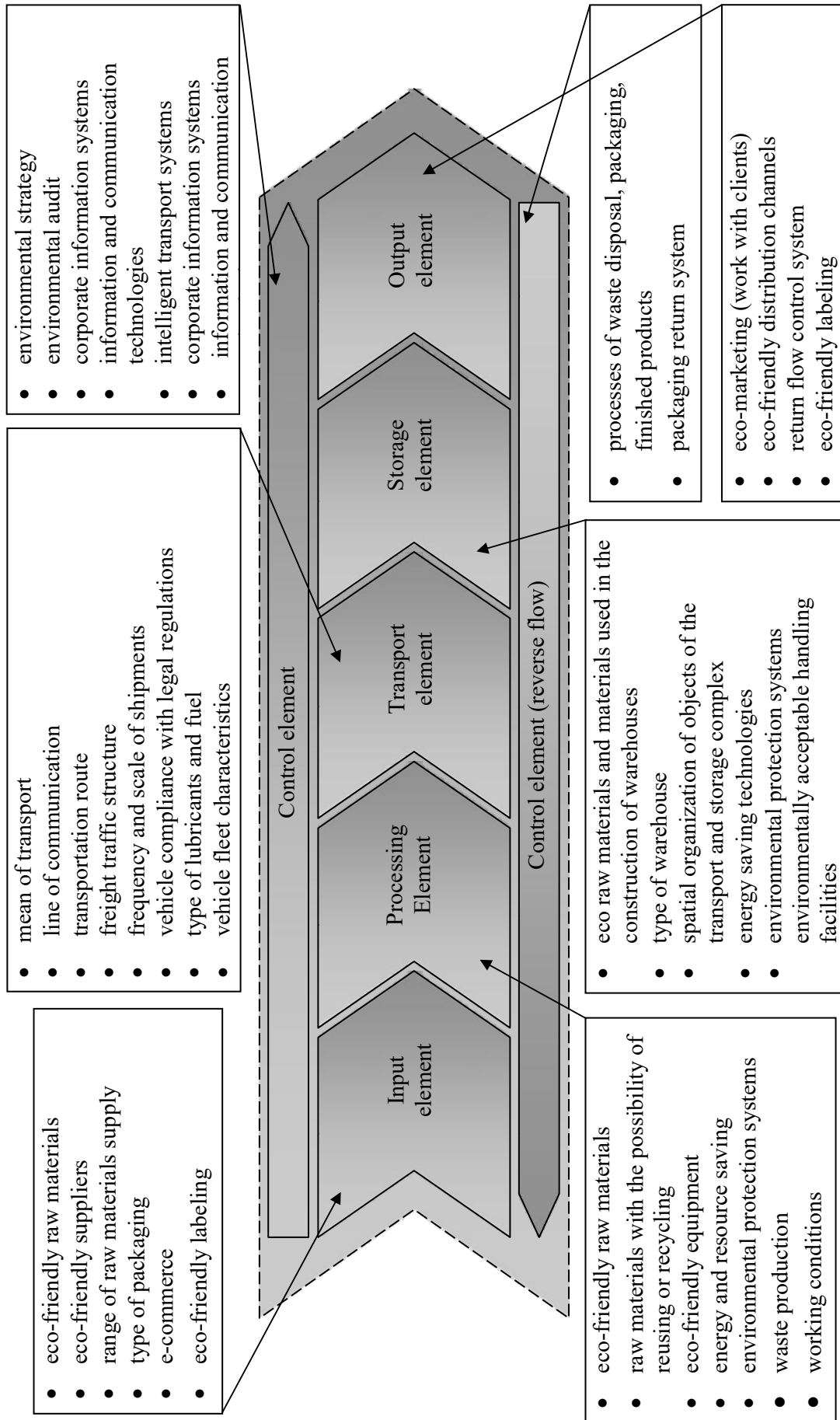


Fig. 8. Sustainable development factors scheme of the transport and logistics system

operation of transport and logistics systems will allow us to assess supply chains for compliance with the principles of sustainable development, develop measures to improve the efficiency of the functioning of logistics systems, reduce harmful effects on the environment and achieve sustainable development goals.

REFERENCES:

- Vakulenko V. M. (2017) "Zelena" ekonomika v mekhanizmi derzhavnogo upravlinnja stalym rozvytkom rehioniv Ukrainy ["Green" economy in the public administration mechanism of sustainable development of regions of Ukraine]. *Public governance*, vol. 1, pp. 63 – 74. Available at: <https://cyberleninka.ru/article/n/green-economy-in-the-public-administration-mechanism-of-sustainable-development-of-regions-of-ukraine/viewer> (accessed 12 March 2020).
- Transformacija nashogho svitu: Porjadok dennij stalogho rozvytku do 2030 roku [Transforming our world: the 2030 Agenda for Sustainable Development]. Available at: <http://www.un.org/ga/search/viewdoc.asp?symbol=A/RES/70/1&Lang=R> (accessed 12 March 2020).
- Karpenko O. A., Horbenko O. V., Vovk Yu., Tson O. P. (2017) Doslidzhennja struktury ta tendencij rozvytku loghystychnogho rynku v Ukraini [Research of the structure and trends in the development of the logistics market in Ukraine]. *Journal of Sustainable Development of Transport and Logistics*, vol. 2, pp. 57 – 66. Available at: https://www.researchgate.net/publication/322034954_Research_of_the_structure_and_trends_in_the_development_of_the_logistics_market_in_Ukraine (accessed 12 March 2020).
- Litman T. (2016) Dobre vymirjanyj: Rozrobka pokaznykiv dlja stalogho ta zruchnogho planuvannja transportu [Well Measured: Developing Indicators for Sustainable and Livable Transport Planning]. Victoria: Transport Policy Institute. (in Canada) (accessed 12 March 2020).
- Rakhmangulov A., Sladkowski A., Osintsev N., Muravev D. (2017) Zelena loghistryka: element koncepciji stalogho rozvytku [Green Logistics: Element of the Sustainable Development Concept]. *Nase More*, vol. 64, no. 3, pp. 120-126. Available at: https://www.researchgate.net/publication/320898692_Green_Logistics_Element_of_the_Sustainable_Development_Concept_Part_1 (accessed 12 March 2020).
- Sands P., Peel J., Fabra A., MacKenzie, R. (2018) Prynцыpy mizhnarodnogho ekologhichnogho prava [Principles of International Environmental Law]. Cambridge: Cambridge University Press. (in England) (accessed 12 March 2020).
- Svitovyj svitoghljad. OECD / IEA, Mizhnarodne energhetychne aghentstvo [World energy outlook. OECD/IEA, International Energy Agency]. Available at: <https://webstore.iea.org/download/summary/190?fileName=Russian-WEO-2018-ES.pdf> (accessed 12 March 2020).
- Oficijnyj sajt statystyky Ministerstva energhetyky ta okhorony navkolyshnjogho pryrodnogho seredovyshha Ukrainy [Official site of statistics of the Ministry of Energy and Environmental Protection of Ukraine]. Available at: http://mpe.kmu.gov.ua/minugol/control/publish/newscategory?cat_id=35081 (accessed 12 March 2020).
- Statystychnе vydannja. Dovkillja Ukrainy [Statistical publication. Environment of Ukraine]. Available at: http://www.ukrstat.gov.ua/druk/publicat/kat_u/2019/zb/11/Zb_dovk_2018.pdf (accessed 12 March 2020).
- Podannja zavtra. Na shljakhu do stjikoji loghistryky, jak innovaciji ta ekologhichnyj popyt biznesu spryjajutj rozvytku vughlecevoji ghaluzi [Delivering Tomorrow. Towards Sustainable Logistics How Business Innovation and Green Demand Drive a Carbon-Efficient Industry]. Available at: http://www.dhl-usa.com/content/dam/downloads/g0/logistics/green_logistics_sustainable_logistics_study_en.pdf (accessed 12 March 2020).
- Derzhavna sluzhba statystyky Ukrainy (2018) *Transport i zv'jazok Ukrainy* [Transport and Communication of Ukraine], Kyiv: <http://www.ukrstat.gov.ua/druk/publicat/Arhivu/08/Archtrzb.htm> (accessed 12 March 2020).
- Martins V. B., Oswaldo L. G., Anholon R. and Filho V. L. (2019) Stali praktyky v loghistrychnykh systemakh: oghljad kompanij Brazyliji [Steady Practices in Logistics Systems: An Overview of Brazilian Companies]. *Stability*, vol. 11, pp. 1-12. Available at: https://www.researchgate.net/publication/334806738_Sustainable_Practices_in_Logistics_Systems_An_Overview_of_Companies_in_Brazil (accessed 12 March 2020).
- Kumar A. (2015) Zelena loghistryka dlja stalogho rozvytku: analitychnyj oghljad. [Green logistics for sustainable development: an analytical review]. *IOSRD International Journal of Business*, vol. 1, Is. 1, pp. 7-13. Available at: https://www.researchgate.net/publication/330422673_Green_Logistics_for_sustainable_development_an_analytical_review (accessed 12 March 2020).
- Vandycke N. Zabezpechennja neobkhidnogho nam transportu [Envisioning the Transport We Need]. *Transport & ICT. Connections*, vol. 18. Available at: <https://openknowledge.worldbank.org/bitstream/handle/10986/24999/Envisioning0th0ustainable0transport.pdf?sequence=1> (accessed 12 March 2020).

БІБЛІОГРАФІЧНИЙ СПИСОК:

- Вакулєнко В. М. «Зелєна» економїка в механїзмі державного управлїння сталим розвитком рєгїонів України. *Публїчне урядування*. 2017. № 1. С. 63 – 74 (дата звернення: 12.03.2020).
- Трансформація нашого свїту: Порядок денний сталого розвитку до 2030 року. URL: <https://sustainabledevelopment.un.org/post2015/transformingourworld/publication> (дата звернення: 12.03.2020).
- Карпенко О. А., Горбенко О. В., Вовк Ю. Я., Цьонь О. П. Дослїдження структури та тенденцїй розвитку логїстичного ринку в Україні. *Журнал сталого розвитку транспорту та логїстики*. 2017. Вип 2. С. 57 – 66 (дата звернення: 12.03.2020).
- Лїтман Т. Добре вимїряний: Розробка показників для сталого та зручного планування транспорту. / Т. Лїтман. Вікторїя, 2016. С. 107 (дата звернення: 12.03.2020).
- Рахмангулов А., Сладковський А., Осїнцев Н., Муравїов Д. Зелєна логїстика: елемент концепцїї сталого розвитку. *Нашє Море*. 2017. № 64 (3). С. 120-126. (дата звернення: 12.03.2020).

6. Сендс Ф., Піл Ж., Фабр А., Макензі Р. Принципи міжнародного екологічного права. / Ф. Сендс, Ж. Піл, А. Фабр, Р. Макензі. Кембридж: Кембриджський університетський прес, 2018. С. 1-2 (дата звернення: 12.03.2020).

7. Світовий світогляд. ОЕСР / МЕА, Міжнародне енергетичне агентство, 2018. URL: <https://webstore.iea.org/download/summary/190?fileName=Russian-WEO-2018-ES.pdf>. (дата звернення: 12.03.2020).

8. Офіційний сайт статистики Міністерства енергетики та охорони навколишнього природного середовища України. http://mpe.kmu.gov.ua/minugol/control/publish/newscategory?cat_id=35081 (дата звернення: 12.03.2020).

9. Статистичне видання. Довкілля України. Київ, 2019. URL: http://www.ukrstat.gov.ua/druk/publicat/kat_u/2019/zb/11/Zb_dovk_2018.pdf (дата звернення: 12.03.2020).

10. Подання завтра. На шляху до стійкої логістики, як інновації та екологічний попит біз-

несу сприяють розвитку вуглецевої галузі. URL: http://www.dhl-usa.com/content/dam/downloads/g0/logistics/green_logistics_sustainable_logistics_study_en.pdf (дата звернення: 12.03.2020).

11. Статистичний збірник. Транспорт і зв'язок України. Київ, 2018. URL: http://www.ukrstat.gov.ua/druk/publicat/kat_u/2019/zb/08/zb_tr2018pdf.pdf (дата звернення: 12.03.2020).

12. Мартінс В. Б., Освальдо Л. Г., Анхолон Р. та Філхо В. Л. Сталі практики в логістичних системах: огляд компаній Бразилії. *Стійкість* 2019. № 11. С. 1-12.

13. Кумар А. Зелена логістика для сталого розвитку: аналітичний огляд. *МОНДР Міжнародний журнал бізнесу*. 2015. Вип. 1. Ч. 1. С. 7-13 (дата звернення: 12.03.2020).

14. Вандицке Н. Забезпечення необхідного нам транспорту. *Транспорт та ІКТ. З'єднання*. 2015. № 18 (дата звернення: 12.03.2020).