



## Green logistics - modern transportation process technology

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### Abstract

Green logistics is the part of the activities of an enterprise aimed at measuring and minimizing the impact of logistics activities on the environment. Such actions are dictated by the possibility of achieving a competitive advantage in the market, because clients require it. Transport is a particularly important area with a huge impact on the environment, because it is identified as the fastest growing source of greenhouse gas emissions. Green transport is low-emission and ecological travelling mode. The goals of green transport are not only to reduce greenhouse gas emissions, air pollution, noise and space use, but also to reduce poverty and promote economic growth. Transport is considered green when it supports environmental sustainability, but also supports the other two pillars of sustainable development, i.e. economic and social. This paper discusses the application of the concept of "green" logistics and "green" technologies in transport in the transportation process. The modern requirements for transport in the field of environmental safety and compliance with environmental requirements both on the part of customers and on the part of states are considered.

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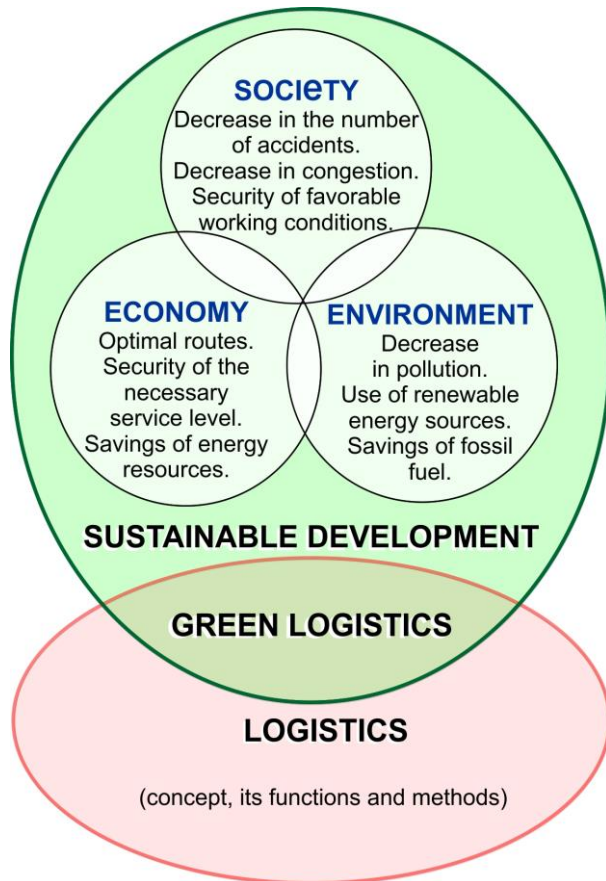
## 1. Introduction

In modern society, with a constant increase in cargo turnover, both within countries and between countries, environmental safety issues are becoming very relevant. According to modern research, transport systems account for 25% of CO<sub>2</sub> emissions and 23% of total energy consumption, which implies high financial costs, vulnerability due to higher fuel prices, environmental damage due to the use of non-renewable fossil fuels (95%) (Shabani and Shahnazi, 2019; Vasile et al., 2012; Ulewicz et al., 2021).

All over the world, the principle called "polluter pays" is increasingly used, which is reflected in the legislation of European countries. In accordance with the new environmental policy of European Union, the culprit must pay for the emissions. This has led to numerous legal requirements and restrictions due to environmental priorities, and to public pressure on business, from which they began to demand a more green behavior and increased attention to environmental values in all areas of corporate activity. Both individual and corporate customers began to pay increasing attention to the environmental quality of the goods and services consumed. As a result, the concepts of green transport and green logistics have acquired real market value.

Green logistics is not only a scientific theory, a concept of doing business, but also the next stage in the development of the concept of logistics (Fig. 1). It is necessary to take into account the fact that logistics is a developing and dynamic concept, therefore the use of green logistics methods is a significant competitive advantage for a transport company (Jazairy et al., 2021). Green logistics brings positive results not only to enterprise, but also to the state and society. Often green logistics is reduced solely to environmental protection, but it is worth noting that in a broad sense, it should have a social focus.

Green logistics aims to solve the problem of reducing the impact of road transport emissions on air pollution. It is known that the amount, composition and degree of harmfulness of exhaust gases depends on the design of the engine, the type and quality of fuel, the technical condition and mode of operation of the vehicle which was described in papers (Kovács, 2020; Szymanski et al. 2018; Ingaldi and Klimecka-Tatar, 2020; Tutak et al., 2020). Only one adjustment of automobile engines can reduce the toxicity of exhaust gases by several times (Mazur and Nowakowska-Grunt, J 2017). Green logistics may be an element of the enterprise's competitiveness, which may prove the strategic position of enterprises (Klimecka-Tatar and Ingaldi, 2020; Karcz and Ślusarczyk, 2021).



**Fig. 1.** Concept of green logistics  
(own study based on Vasiliauskas et al., 2013)

The main aim of the paper was to discuss the basic assumptions and practical implications of green logistics, with an emphasis on the transportation. In order to achieve this aim, at the beginning, the issue of green logistics was briefly characterized in the light of the Sustainable Development Goals (SDGs). The impact of traditional transport on the natural environment was also presented. This allowed to indicate the importance of the research topic, but also to show the positive impact of green logistics on this environment. It should be emphasized that this study is based on the collected facts and not on the conducted research. It is therefore a case study based on European and Russian experience. This article may therefore be an element that is to trigger a discussion on green logistics, in particular green transport and the need of its use.

The authors wanted to look at the concept of green transport and some of the solutions that were created under this concept. They state that green transport is a concept often described in literature, but its promotion is not yet at the appropriate level, and the society still needs education in this subject. Hence, the need to develop this work.

## 2. Green logistics vs. SDGs

The natural environment is an important part of our lives, because its protection can ensure economic and social development for the benefit of different generations (Tomsana et al., 2020). In recent years, there has been increasing concern

about the environmental impact of human activities. Therefore, stakeholders are increasingly putting pressure on companies to assume responsibility for any negative effects that their business activities may have (Seroka-Stolka, 2015).

That is why the whole world has paid attention to sustainable development in recent years (Olawumi and Chan, 2018), and its role in our everyday life is still growing (Bombiak and Marciniuk-Kluska, 2018; Lazar et al., 2021).

The concept of sustainable development has been incorporated into policy as the world has finally understood the effects of climate change and the effects of rapid urbanization and a modern lifestyle. Sustainable development is perceived as a contemporary paradigm that allows to meet these challenges and creates an opportunity to create new mechanisms for building the desired future (Bilińska-Reformat et al., 2019; Bajdor, 2012).

The Sustainable Development Goals (SDGs) can be defined as a universal call to action to eradicate poverty, protect the planet and ensure peace and prosperity for all (Sustainable Development Goals; Kostetska et al. 2020). It is a set of goals, created as international agreements, which were created to save our planet. These goals were formally adopted by the Heads of State and Government of 193 countries, meeting at the 70th General Assembly of United Nations (UN) in September 2015. They are in force from 2016 to 2030 (Morton et al., 2017). Their program is based on the principles of sustainable development. It is a human, planet and welfare action plan that aims to eradicate poverty and hunger worldwide; fighting inequalities within and between countries; building a peaceful, just and society; the protection of human rights and the promotion of gender equality and the empowerment of women and girls; and ensuring the sustainable protection of the planet and its natural resources (Boto-Álvarez and García-Fernández, 2020). The SDGs offer important new opportunities to address the linkages between environment and poverty in a more holistic and integrated way. Some scientists e.g. Wackernagel et al. (2017), argue that the SDGs are by far the most important global effort for global sustainable development.

Among all sustainable goals, special attention should be paid to 2 of them, i.e.: 7. Ensure access to affordable, reliable, sustainable and modern energy for all (energy also used as vehicle fuel) and 11. Make cities and human settlements inclusive, safe, resilient and sustainable (including ensuring the availability of sustainable transport).

The implementation of solutions aimed at achieving SDGs in individual European Union countries is facilitated by a properly developed strategic approach to the implementation of the 2030 Agenda for Sustainable Development, including the Sustainable Development Goals. However, it is not so unambiguous for Russia, hence the need for studies on the need to implement such solutions, but also education for the SDGs. This is especially important when it comes to international cooperation and international transport, especially for transnational companies. So in order to cooperate with the countries of the European Union, Russia must also take into account the regulations and requirements in force in its territory.

One of the key areas where current views on sustainability need to be revised is energy. Growing social awareness in the field of environmental protection forces changes in this industry (Tutak et al. 2020). It should be added that all types of industry and the lives of ordinary people are based on the use of energy, and the lack of it can have very bad results, this also applies to energy used as fuel. Hence, the importance of the chosen topic of the paper. Green Logistics need to be improved, which can help you achieve the sustainable development goals.

### 3. Influence of transport on the environment

In the paper, it was considered the cargo turnover, taking into account the percentage of different types of transport. Thus, the percentage of freight turnover of certain types of transport in the total freight turnover was: railway transport 45.3%, pipeline transport 47.7%, road transport 4.9%, water transport 2.0%, air transport 0.1% (Gerami, 2014). From the point of view of the legislation and natural environment, the pollutant is not CO<sub>2</sub> itself, but the total amount of emitted harmful substances, such as NO and CO<sub>2</sub>.

When comparing the amount of emissions into the atmosphere, road transport is undoubtedly in the lead, its emissions in total exceed the emissions of the industrial enterprises by 6 times, and railway transport by orders of magnitude. What is more, today the trend is such that an increasing number of shippers prefer the delivery of goods by road, because it is more profitable to carry cargo in a car for a distance of less than 2.5 thousand km. Nevertheless, the situation on Russian highways, the overall congestion of key highways, congestion at border crossings, requires the transfer of part of the traffic to the railroad.

According to statistics (Gerami, 2014), there is a constant growth in freight turnover. There is a noticeable increase in the number of freight shipments using rail transport. Along with the growth of freight traffic, Russian Railways is effectively using the concept of green logistics to attract new customers and is engaged in environmental protection activities within the framework of the Environmental Strategy of Russian Railways for the period up to 2017 and the prospect until 2030, which includes measures the following areas: protection of atmospheric air, noise protection, use and protection of water resources, waste management, technical re-equipment (Rodrigue et al., 2001).

To solve the problem of increasing the competitiveness of railway transport, industry representatives are developing new transport and logistics products that meet the challenges of the European market, which is actively introducing green technologies into its business processes. The promising direction of organizing the movement of freight trains according to a fixed schedule contributes to attracting customers to railway transport. This practice, supported by leading railway operators, guarantees the timely delivery of goods, eliminating possible downtime. The company actively advertises its transportation, convincing customers that by choosing rail transport, they thereby protect nature and contribute to the reduction of CO<sub>2</sub> emissions into the atmosphere.

If we consider the transportation of goods by road, then without any doubt, it causes the greatest harm to the environment, which is associated with the deterioration of the vehicle fleet (trucks with a service life of less than 5 years - 16.3%, from 5 to 10 years - 19.6%, more 10 years - 64.1%) (Kizim and Kabertai, 2012) and the use of fuel that complies with the Euro-3 standard (in Europe, this standard was in force in 1999, since 2013 the Euro-6 standard has been in effect).

### 4. Practical implications of the green logistics

In modern conditions, it is becoming increasingly important to apply the concept of the Green logistics in practice, especially for the main subjects of world economic relations in the exchange of goods - transnational companies (TNCs). For transnational companies in the context of increasing trade and globalization, the development of the concept of green logistics, as well as the widespread tightening of environmental requirements both in the European Union and in Russia, becomes the need to rationalize and improve all operations to reduce environmental pollution (Kizim and Kabertai, 2012).

Considering the international experience in the field of green logistics, one can cite the experience of the following significant companies:

- Express delivery companies - DHL launched the GoGreen service, the essence of which is that DHL calculates the amount of CO<sub>2</sub> emissions during the transportation of each cargo from the moment it is received until the time of delivery to the recipient. The customer can pay 3% more than the standard rates. DHL invests the collected money in climate protection programs around the world. UPS operates hybrid vehicles that consume 35% less gallons of fuel per year than combustion-engine vehicles. Then CO<sub>2</sub> emissions can decrease by 42% (Aleksandrova, 2011).
- The Japanese shipping company K Line installed a computer system on individual ships, which, based on constant monitoring of weather and hydrographic conditions, optimizes engine operation, which, in turn, leads to a 1% decrease in harmful emissions into the atmosphere (Grad-View, 2010).
- The German carrier Deutsche Bahn Schenker Rail was the first in the European railway industry to offer a method of transporting goods that completely excludes carbon dioxide emissions (Kirillov, 2011).
- Green Cargo company use of locomotives with low energy consumption (Springer, 2009).
- In the logistics centre "Toyota" in the Belgian city of Eyebrugge, two wind turbines were built in early 2013. While solar panels were installed at Toyota plants in the UK and France to generate electricity (Toyota's green logistics, 2011).

When considering global projects (Nord Stream), due to the developed concept of green logistics, according to the environmental management department of Nord Stream AG, Nord Stream has become the safest and most environmentally friendly way of transporting gas in the world. according to experts, the reduction of CO<sub>2</sub> emissions into the atmosphere

within 50 years of the gas pipeline operation will amount to 200 million tons (Aleksandrova, 2011).

All over the world, numerous regulations are being actively implemented aimed at limiting CO<sub>2</sub> emissions from transport, all these acts, according to the study of Dr. Christoph Earhart, distinguish three categories (Earhart, 2012):

- Traditional - all restrictive measures that limit various activities or prohibit the production / use of certain products (emission and fuel efficiency standards). Top runner method focuses on the most efficient models available and sets their characteristics as the future minimum of the standard. Restricting access to vehicles implies the complete closure of certain geographical areas for certain categories of vehicles, while in low-emission zones their own criteria are set, which must be met in order to be able to enter the zone. Both of these requirements are implemented locally to avoid emissions in concentrated urban areas and to encourage the use of low-emission transport alternatives by reducing emissions from road traffic.
- Economic - instruments that are not prohibitive in the sphere of influence on the environment, but instead seek to establish the right incentives. Stakeholders are encouraged to reduce emissions through monetary incentives, they ensure that producers and consumers take into account the goal of carbon containment in all of their decisions (emission trading programs that set emission caps while issuing an appropriate number of pollution permits). Industrial companies can respond by either reducing their own emissions or buying redundant permits from companies that have successfully reduced their emissions. Carbon taxes are taxes levied on the burning of fossil fuels; they should discourage the use of carbon-intensive fuels. However, their implementation reduces the volatility of all associated prices, but cannot guarantee a certain amount of carbon emission reductions. Promotion of low-carbon technologies through financial support rewards contributions for reducing emissions and stimulates investment in the development of coal efficiency.
- Infrastructure tools and market liberalization - efficient storage, use and administration of transport and logistics infrastructure significantly affects the efficiency of transport. It includes sufficient investment in the physical infrastructure of transport and logistics. Market barriers limiting transport capacity from full use in various segments of transport should be overcome. Laws hindering carriers to operate freely in other countries should be abolished. Lack or insufficient liberalization or enforcement of liberalization actions, and lack of cross-border interoperable infrastructures should be covered. Suboptimal infrastructure management need to be optimized.

The use of such tools is an important factor in promoting the green logistics concept. This is true not only for financial incentives that reward carbon reduction measures or financing innovative solutions for transport enterprises, but also for carbon pricing schemes, as they are a critical tool for representing the impact of carbon emissions in business decisions. Strengthening compliance with carbon standards and promot-

ing carbon transparency will be key drivers in the development of green logistics in transport and the enterprise. In addition to the above, in order to attract additional users of transport and logistics services, transport companies should have clear standards for compensations associated with the emission of carbon dioxide transport, as well as assessments of independent organizations, but this is impossible without the active participation and support of the state.

According to statistics from independent experts The Green Trends Survey, most end users are starting to pay attention to carbon awareness measures, in particular CO<sub>2</sub> labels. Accordingly, end users and businesses alike expect future regulation to take place more nationally than internationally, as international regulation complicates companies' operations due to overlapping regulations.

The development of appropriate logistic solutions to the problem of environmentally sound disposal of various types of waste, including their transportation, gave rise to a direction that was called return logistics and over time has significantly expanded from its original purpose, including all activities but rationalization of the process of the return movement of goods in the supply chain from the characteristic point of their final consumption in order to obtain added value or to destroy them. For all companies, the priority is to make a profit and most of the developing areas in the company are areas that are aimed at maximizing profits and ensuring economic growth, which in turn refers to the problems associated with transport logistics, and this is where a conflict of interest arises in the company - making a profit and environmental safety costs.

Currently, the following modern approaches in logistics exist and are being applied (Gerami, 2014):

- The transition to road and air transport - is aimed at ensuring timely delivery and flexibility of transport services, therefore, when transporting, enterprises are forced to use the least environmentally friendly modes of transport to achieve these goals.
- The application of the "hub-spoke" concept in transport leads to the concentration of logistics activities in the largest ports, logistics parks and distribution centres. By reducing total costs, it simultaneously creates extremely high local environmental loads.
- The tendency to reduce warehouse stocks is increasingly being implemented within the framework of the floating stock concept, which leads to an increase in the volume of goods "on wheels" and an increase in the volume of transportation, primarily by road.
- Development of electronic commerce - contributes to the growth of the market for express delivery services based on the use of exclusively air and road transport, which in turn is environmentally unfriendly.

Currently, individual and corporate customers have begun to pay increasing attention to the environmental quality of the goods and services they consume. As a result, the concepts of green transport and green logistics have acquired real market value. In modern conditions, the principles of green logistics are implemented on the basis of two parallel approaches: state and market.

The transition to sustainable development in public transport management provides for the following main directions (Gerami, 2014):

- Tightening of technical standards, the introduction of more and more safe and environmentally friendly vehicles and fuels. An example is the system of "Euro" standards developed by the ECE OOP to regulate the environmental parameters of vehicles. The requirements of this system are constantly increasing.
- All-round stimulation of transportation switching from the ecologically most problematic mode of transport, i.e. road, to other modes of transport. This direction is manifested, in particular, in all-round support at the state and international level for the development of intermodal transport.
- Application of the "polluter pays" principle in the system of transport taxes and fees. For example, within the framework of the application of this principle, trucking companies must fully compensate (through increased taxes on fuel or special environmental charges) the damage caused to the environment, which is currently compensated mainly by budgets of various levels. From a sustainable development perspective, fiscal reimbursement creates unjustified market advantages for an environmentally unfriendly mode of transport.

The state approach is fully implemented in the current "White Paper" of the European transport policy. Adopted in 2011 "White Book-2011", towards a common European transport space - through the creation of a competitive and resource-efficient transport system is another conceptual document on the basis of which the EU determines the policy for the development of European transport for the coming decades. The White Book sets a two-fold goal, i.e. to complete the creation of a common European transport space and to drastically reduce the negative environmental effects of transport, having achieved a 60% reduction in greenhouse gas emissions by 2050. The document identifies ten main tasks (White paper on Transport, 2011):

1. Halve the use of petroleum-fuelled cars in cities by 2030; completely eliminate it by 2050, practically free urban freight logistics from CO<sub>2</sub> emissions by 2030.
2. Ensure the use of environmentally friendly aviation fuels in the amount of 40% of their total consumption by 2050. Also, by 2050, reduce the CO<sub>2</sub> toxicity of marine fuels by 40-50%.
3. Ensure by 2030 the switch of 30% (and by 2050 - 50%) of road transport over a distance of more than 300 km to rail and water transport through the creation of efficient and green transport corridors.
4. Complete by 2050 the creation of a European high-speed rail network. Triple their length by 2030. To ensure by 2050 the transportation of the bulk of passengers traveling over medium distances by rail.
5. Ensure by 2030 the creation of a mainly multimodal transport network of the EU, completing its creation by 2050 with the necessary information support.
6. By 2050, ensure the connection of all base airports with the railway network, mainly high-speed. Also ensure the

connection of the main seaports with the freight rail network and, where possible, with inland waterways.

7. Introduce by 2020 a modernized air traffic control infrastructure and complete the creation of a single European airspace. Introduce similar traffic control systems for land and water transport. Implement the European global satellite navigation system Galileo.
8. By 2020, create the basis for the formation of a unified European multimodal information and management system and a system of mutual settlements.
9. By 2050, reduce mortality from road traffic accidents to almost zero. By 2020, halve the number of road accidents. Ensure the world leadership of the EU in the field of transport safety and transport security in all modes of transport.
10. Ensure full application of user-pays and polluter-pays principles to avoid imbalances and subsidize environmentally damaging transport activities. Provide sufficient income for future investments in the transportation system.

The priorities for environmental friendliness and energy efficiency of transport are central to the document. The White Paper contains 40 specific initiatives that need to be implemented in EU transport to remove a range of barriers to increased transport mobility of people and the growth of the European economy. At the same time, Europe's dependence on fuel oil should be radically reduced, and hydrocarbon transport emissions into the atmosphere should decrease by 50% by 2050 (Gerami, 2014).

These approaches are becoming relevant and even vital, since every year in the world automotive equipment used in logistics activities emit 350 million tons of carbon monoxide, more than 50 million tons of various hydrocarbons, 150 million tons of sulfur oxide into the atmosphere. Carbon dioxide accumulates in the atmosphere, and the amount of oxygen decreases. Emissions go to plants, soil, are inhaled by people, end up in human organisms, in food consumed. Vehicles operating on the territory of the Russian Federation annually burn 110-115 million tons of fuel and 1.2-1.5 million tons of lubricant, including when operating vehicles, the environment is polluted by crankcase gases, battery acid, lubricating and cooling liquids, other operating materials.

In such conditions, it becomes necessary to use green technologies in logistics. Green technologies are now in their early stages of development, just like information technology was. It is expected that the development of green technologies in scale, the power of influence on the change in the structure of the economy and the forthcoming changes will be comparable to information innovations that have actively entered our lives. Hence, along with green technologies, such concepts as green investments, green schools, green cities, and a green economy are actively entering life.

Green logistics, if viewed as part of the green economy, has its own right to exist. Of great interest for the deployment of a new scientific direction, green logistics, are the views of A.A. Bogdanov, who was close to the problem of rational organization of social life and maintaining a consistently high tone of material production in conjunction with the law of self-organization of natural systems (Kizim and Kabertai, 2012).

In recent years, the share of road transport in the provision of logistics services has increased significantly. The number of road transport in Russia is growing from year to year. Compared to 1991, its number has almost tripled. Cars in Russia annually emit into the atmosphere more than 10.3 million tons of carbon monoxide, 1.8 million tons of nitrogen oxides, 344 thousand tons of sulfur oxide, 58 thousand tons of soot and other harmful components. Specific emissions of harmful substances into the environment during the operation of all vehicles in Russia exceed the corresponding indicators of developed countries by more than 2 times.

## 5. Discussion

The concepts of green transport and green logistics are not new. They were described by many authors, their research concerned various elements concerning these two terms.

The advantages of green transport were pointed out by Vasile et al. in their work (2021). They described green transport in the context of the need to reduce CO<sub>2</sub> emissions and take into account the wide use of alternative energy sources (e.g. biofuels, biogas). They underlined the need to invest in the design of vehicles and transport infrastructure that can withstand the adverse effects of climate change.

According to Li (2016) green transport is a type of intensive, efficient and ecological travel mode with low emissions, low energy consumption and low pollution. In the paper, it was stated that currently the research and practice of the green transport system is only at the initial stage and requires an in-depth analysis and identification of the construction of a green transport system in international cities.

Mazurova et al. (2021) presented interesting results of the survey on green transport conducted among the inhabitants of Slovakia. They found that respondents were most satisfied with commuting by bike or on foot and most dissatisfied with commuting by public transport, indicating that they feel the need to implement sustainable and "green" transport infrastructure in their country. It can therefore be concluded that the concept of green transport is not only related to industry and freight transport, but also social issues.

Lu et al. (2016), in their research on green transport, drew attention to the environmental logistics performance index (ELPI) measured by logistics performance index (LPI), CO<sub>2</sub> emissions and oil consumption from the transport sector, using a range-adjusted measure (RAM) of the data envelopment analysis (DEA). This indicator reflects the compromise between logistics efficiency and environmental protection in transport.

Ogryzek et al. (2020) presented principles and guidelines for sustainable transport that can lead cities towards a more efficient transport network. They relied on good practice in neutral urban areas such as London and Copenhagen.

On the other hand, Bajdor (2012) pointed out that "green logistics" should not only focus on activities aimed at minimizing the harmful impact on the environment, but introduce tools and behaviors that will contribute to the improvement of the social community and its rapid economic development.

Regardless of the scope of research described in the literature, all scientists emphasize the need to introduce green transport and educate the society in this direction. Such action is related not only to the assumptions of sustainable development and the achievement of the goals developed under this concept, but can also have a positive impact on the natural environment, and thus people's lives.

## 6. Summary and conclusion

There are many more methods and techniques used in the framework of the concept of green logistics, in addition, new technologies and practices are constantly being developed. It is safe to say that the concept of green logistics is partly the engine of technological progress, since there is a difficult task of reducing the damage to the environment in parallel with the optimization of logistics costs.

For the introduction of green technologies, it is necessary to organize the interaction of all participants in the process: government departments of the federal and regional levels, and business (an integrated approach). The use of an integrated approach in the implementation of green technologies in transport is significant costs for all participants in this project. Therefore, it is necessary to create such conditions so that, in addition to costs, the use of green technologies would become profitable for market participants, and the state should take the first step in this direction, since the point effect of only one of their participants will be ineffective.

The development of green technologies is not only the creation of environmentally friendly modes of transport and fuel, but also the construction of appropriate infrastructure and training of specialists who, in turn, will be able to use green technologies. Therefore, the introduction of new products must necessarily be accompanied by both economic incentive measures and government support. By using the concept of green logistics, the company will ultimately achieve not only cost optimization, improved service quality, improved labor quality and productivity, but also recognition from customers and suppliers.

## Reference

- 2011. Toyota's green logistics. (in Russian), Available on: <http://www.st-logistics.net/press/4080.html>, (accessed on February 3, 2021).
- 2011. White paper on Transport. Roadmap to a Single Transport Area – Towards a Competitive and Resource-Efficient Transport System: European Commissions. Directorate General for Mobility and Transport, 32p.
- Aleksandrova, K., 2011. Green logistics saved 60 million euros, (in Russian), Available on: [http://www.lenoblin-form.ru/apps/news/2011/11/08/zelenaya-logistika-pozvolila-sekonomit-okolo-mln-e/?cat\\_ids=3](http://www.lenoblin-form.ru/apps/news/2011/11/08/zelenaya-logistika-pozvolila-sekonomit-okolo-mln-e/?cat_ids=3), (accessed on January 10, 2021).
- Bajdor, P., 2012. Comparison between sustainable development concept and green logistics - the literature review. Polish Journal of Management Studies, 5(1), 236-244.
- Bajdor, P., 2012. Comparison between sustainable development concept and green logistics – the literature review. Polish Journal of Management Studies, 5(1), 223-231.
- Bilińska-Reformat, K., Kucharska, B., Twardzik, M., Dolega, L., 2019. Sustainable development concept and creation of innovative business models by retail chains. International Journal of Retail & Distribution Management, 47(1), 2-18.

- Bombiak, E., Marciniuk-Kluska, A., 2018. Green human resource management as a tool for the sustainable development of enterprises: Polish young company experience. *Sustainability*, 10(6), 1739.
- Boto-Álvarez, A., García-Fernández, R., 2020. Implementation of the 2030 Agenda Sustainable Development Goals in Spain. *Sustainability*, 12(6), 2546.
- Ehrhart, C.E., 2012. Delivering Tomorrow: Towards Sustainable Logistics. Available on: <http://www.delivering-tomorrow.com>, (accessed on January 10 2021).
- Gerami, V.D., 2014. Management of transport systems. Transport support of logistics: textbook and workshop for academic bachelor's degree. In: V.D., Gerami, A.V., Kolik, M., Yurayt Publishing House, Russia, 510 p. (in Russian).
- GradView, 2010. Environmental Awareness Movement Inspires Green MBA Courses. Available on: <http://www.gradview.com/news/article/environmental-awareness-movement-inspires-green-mba-courses-499> (accessed on January 15 2021).
- Ingaldi M., Klimecka-Tatar D., 2020. People's Attitude to Energy from Hydrogen - from the Point of View of Modern Energy Technologies and Social Responsibility. *Energies*, 13(24), 6495, DOI: 10.3390/en13246495.
- Jazairy, A., von Haartman, R., Bjorklund, M., 2021. Unravelling collaboration mechanisms for green logistics: the perspectives of shippers and logistics service providers. *International Journal of Physical Distribution & Logistics Management*, early access, DOI: 10.1108/IJPDLM-09-2019-0274.
- Karcz, J., Ślusarczyk, B., 2021. Criteria of quality requirements deciding on choice of the logistic operator from a perspective of his customer and the end recipient of goods. *Production Engineering Archives*, 27(1), 58-68.
- Kirilov, I., 2011. Ecology by order. *Kommersant*. Company's secret, 3(307), (in Russian), Available on: <http://www.kommersant.ru/doc/1592409>, (accessed on January 10 2021).
- Kizim, A.A., Kabertai, D.A., 2012. Trends in the development of modern logistics in the TNC system: a look into the future. The mechanism of economic and legal support of national security: experience, problems, prospects. (collective monograph): Publishing House of the Research Institute of Economics of the Southern Federal District of the Russian Federation, Krasnodar, Russia, 62p. (in Russian).
- Klimecka-Tatar, D., Ingaldi, M., 2020. Assessment of the technological position of a selected enterprise in the metallurgical industry. *Materials Research Proceedings*, 17, 72-78.
- Kostetska, K., Khumarova, N., Yuumanska, Y., Shmygol N., Koval, V., 2020. Institutional qualities of inclusive environmental management in sustainable economic development. *Management Systems in Production Engineering*, 28(1), 15-22.
- Kovács G., 2020. Combination of Lean value-oriented conception and facility layout design for even more significant efficiency improvement and cost reduction. *International Journal of Production Research*, 58(10), 2916-2936, DOI: 10.1080/00207543.2020.1712490.
- Lazar, S., Klimecka-Tatar, D., Obrech, M., 2021. Sustainability Orientation and Focus in Logistics and Supply Chains. *Sustainability*, 13(6), 3280.
- Li, H.R., 2016. Study on Green Transportation System of International Metropolises. *Procedia Engineering*, 137, 762-771, DOI: 10.1016/j.proeng.2016.01.314.
- Lu, M.X., Xie, R.H., Chen, P.R., Zou, Y.F., Tang, J., 2019. Green Transportation and Logistics Performance: An Improved Composite Index. *Sustainability*, 11(10), 2976; DOI:10.3390/su11102976.
- Mazur, M., Nowakowska-Grunt, J., 2017. Logistic in production system. *Carpathian Logistics Congress (CLC) 2016*. NOV 28-30, 2016, Tanger Ltd., 353-358.
- Mazurova, B., Kollar, J., Nedelova, G., 2021. Travel Mode of Commuting in Context of Subjective Well-Being—Experience from Slovakia. *Sustainability*, 13(6), 3030. DOI: 10.3390/su13063030.
- Morton, S., Pencheon, D., Squires, N., 2017. Sustainable Development Goals (SDGs), and their implementation: A national global framework for health, development and equity needs a systems approach at every level. *British Medical Bulletin*, 124, 81–90.
- Ogryzek, M., Adamska-Kmieć, D., Klimach, A., 2020. Sustainable Transport: An Efficient Transportation Network—Case Study. *Sustainability*, 12(9), 8274; DOI: 10.3390/su12198274.
- Olawumi, T.O., Chan, D.W., 2018. A scientometric review of global research on sustainability and sustainable development. *Journal of Cleaner Production*, 183, 231–250.
- Rodrigue, J.-P., Slack, B., Comtois, C., 2001. Green logistics (the paradoxes of). In *The handbook of logistics and supply chain management (Handbooks in transport №2)*, Pergamon/Elsevier, London, UK, 339-350.
- Seroka-Stolka, O., 2014. The development of green logistics for implementation sustainable development strategy in companies. *Procedia - Social and Behavioral Sciences*, 151, 302-309.
- Shabani, Z.D., Shahrazi, R., 2019. Energy consumption, carbon dioxide emissions, information and communications technology, and gross domestic product in Iranian economic sectors: A panel causality analysis. *Energy*, 169, 1064-1078.
- Springer, Y., 2009. Green light for green logistics. Available on: <http://ru.sap.info/green-light-green-logistics/15650>, (accessed on January 17 2021).
- Sustainable Development Goals, Available on: <http://www.undp.org/content/undp/en/home/sustainable-development-goals.html>, (accessed on February 12 2021).
- Szymanski, P., Zolnieruk, M., Oleszczyk, P., Gisterek, I., Kajdanowicz, T., 2018. Spatio-Temporal Profiling of Public Transport Delays Based on Large-Scale Vehicle Positioning Data From GPS in Wrocław. *IEEE Transactions on Intelligent Transportation Systems*, 19(11), 3652–3661.
- Tomsana, A., Itoba-Tombo, E.F., Human, I.S., 2020. An analysis of environmental obligations and liabilities of an electricity distribution company to improve sustainable development. *SN Applied Sciences*, 2, 1648.
- Tutak, M., Brodny, J., Siwiec, D., Ulewicz, R., Bindzar, P., 2020. Studying the Level of Sustainable Energy Development of the European Union Countries and Their Similarity Based on the Economic and Demographic Potential. *Energies*, 13(24), 6643. DOI: 10.3390/en13246643
- Ulewicz, R., Siwiec, D., Pacana, A., Tutak, M., Brodny, J., 2021. Multi-Criteria Method for the Selection of Renewable Energy Sources in the Polish Industrial Sector. *Energies* 14, 2386. DOI: 10.3390/en14092386.
- Vasile, E., Balan, M., Grabara, I., Balan, S., 2012. Measures to reduce transportation greenhouse gas emissions in Romania. *Polish Journal of Management Studies*, (6), 215-223.
- Vasiliauskas, A.V., Zinkevičiūtė, V., Šimonytė, E., 2013. Implementation of the concept of green logistics referring to it applications for road freight transport enterprises. *Business: Theory and Practice*, 14(1), 43–50.
- Wackernagel, M., Hanscom, L., Lin, D., 2017. Making the Sustainable Development Goals Consistent with Sustainability. *Frontiers in Energy Research*, 5(18), DOI: 10.3389/fenrg.2017.00018.

## 绿色物流-现代运输过程技术

### 關鍵詞

绿色物流  
技术  
绿色交通  
可持续发展  
可持续发展目标

### 摘要

绿色物流是企业活动的一部分，旨在衡量和最小化物流活动对环境的影响。这些行动取决于在市场上获得竞争优势的可能性，因为客户需要它。交通是一个特别重要的领域，对环境有着巨大的影响，因为它被认为是增长最快的温室气体排放源。绿色交通是一种低排放、生态的出行方式。绿色交通的目标不仅是减少温室气体排放、空气污染、噪音和空间使用，而且是减少贫困和促进经济增长。当交通支持环境可持续性，但也支持可持续发展的另外两个支柱，即经济和社会时，交通被认为是绿色的。本文讨论了“绿色”物流概念和“绿色”技术在运输过程中的应用。考虑了环境安全领域的现代运输要求以及客户和国家方面对环境要求的遵守。