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### **The Role of Logistics in Promoting a Green Economy**

**Abstract. Introduction.** In modern times, in order to achieve the goals set by enterprises, the relevance of green agriculture and green logistics is very high in terms of achieving customer satisfaction, producing competitive products, providing services, and ensuring social and ecological balance. The research work emphasizes how important green logistics is in terms of environmental protection, the health of living beings, the reduction of financial costs of enterprises, minimization of harmful gas emissions into the air, etc. It also highlights that transition to green logistics leads to sustainable development.

**Purpose.** The main purpose of writing this research paper is to investigate the role of logistics in the modern era, especially as many countries and enterprises are transitioning to a green economy. From this point of view, to find out the solutions to the problem posed in the research work, scientific publications from different years were examined and efforts were made to find a resolution. Adittionally, the main purpose of the topic was examined by analyzing the positive changes in various countries related to green logistics implementation, the existing challenges in this field, and statistical data on the Logistics Performance Index (LPI) of countries over the years.

**Results.** Since the above-mentioned issues are among the main topics many enterprises focus on in modern times, it is very important to conduct research. In the article, using comparative analysis, a systematic approach, statistical and monographic methods, it was found that companies can help restore ecological and economic balances by applying green logistics applications in a developing green economy.

**Conclusions.** As shown above, using green logistics applications allows companies to protect the environment, prevent excess gas emissions, reduce financial costs and carry out activities without harming people's social condition. As a result, it will enables companies to achieve their goals more efficiently and effectively.

**Keywords:** logistics; green logistics; sustainable; performance index; GLPI; emissions.

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### **Роль логістики у просуванні зеленої економіки**

**Анотація.** В даний час для досягнення цілей, поставлених підприємствами, актуальність зеленого сільського господарства та зеленої логістики дуже висока з точки зору досягнення задоволеності клієнтів, виробництва конкурентоспроможної продукції та надання послуг, а також забезпечення соціального та екологічного балансу. У дослідженні підкреслюється важливість зеленої логістики для захисту навколишнього середовища, здоров'я живих істот, зменшення фінансових витрат підприємств та мінімізації викидів шкідливих газів; це також підкреслює, що перехід до зеленої логістики веде до сталого розвитку.

Основною метою цієї наукової роботи є дослідження ролі логістики в сучасну епоху, коли багато країн і підприємств переходять до зеленої економіки. З цієї точки зору, для з'ясування шляхів розв'язання проблеми, поставленої в дослідницькій роботі, досліджувалися наукові праці, опубліковані в різні роки, і намагалися знайти вирішення проблеми. Водночас у науковому дослідженні відображено інформацію про роботи, які проводяться низкою підприємств світу з розвитку зеленої логістики та їх результати. Також були наведені статистичні аналізи позитивних змін країн світу у цій сфері, пов'язаних із реалізацією робіт, пов'язаних із зеленою логістикою, існуючі проблеми у цій сфері, а також індекс логістичної ефективності (LPI) країн світу за роками.

Проведення цього дослідження є важливим, оскільки питання, згадані вище, є одними з основних тем, на яких зосереджуються багато підприємств у сучасний час. У статті за допомогою порівняльного аналізу, системного підходу, статистичних та монографічних методів з'ясувалося, що компанії, які використовують додатки зеленої

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*логістики у сфері логістики в період розвитку зеленої економіки, можуть покращити екологічні, економічні тощо забезпечить відновлення балансів.*

*Використання додатків зеленої логістики дозволить компаніям захистити навколишнє середовище, запобігти надмірним викидам газів, скоротити фінансові витрати та здійснювати діяльність, не завдаючи шкоди соціальному становищу людей, і в кінцевому результаті компанії будуть більш ефективно і результативно досягати своїх цілей.*

**Ключові слова:** логістика; зелена логістика; стійкий розвиток; індекс ефективності; GLPI; викиди.

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**Formulation of the problem.** Half a century ago, experts predicted that the depletion of natural resources and the decrease in food security would lead to increased state attention to the issues of sustainable development of the socio-economic system, particularly in terms of territorial division.

As a result of the correct and rational solution of the mentioned issues, the needs of the population and future generations will be met, while preserving natural resource potential [8].

In today's rapidly changing competitive environment, as in other sectors, the activities of the logistics sector have begun to change rapidly in order to adapt to the economic and competitive conditions.

Logistics management can be defined as the stages of all processes through which products and services pass from production to consumption. Logistics traditionally refers to the planning, execution, and control of the movement and placement of people and/or goods within an economic system to achieve certain goals [5]. During various stages of logistics activities including storage, transportation, stocking and packaging, situations that affect the environment can also arise. Green procurement, green packaging, green distribution, green reverse logistics, and green production are among the measures implemented within the framework of green logistics [1].

**Analysis of recent research and publications.** It should be noted that propaganda campaigns and courses should be organized among the population and business entities related to logistics, especially green logistics. Vietnam Logistics Business Association (VLA) Deputy Secretary General Ngo Khac Le noted that awareness and understanding of green logistics requirements remain limited, especially among small and medium enterprises (SMEs), and it was required to adapt green logistics solutions and approaches to each business. [6] It can be concluded that it is necessary to strengthen awareness-raising activities in the direction of green economy and green logistics.

Sustainable development should involve a shift to a higher quality in economic growth, an inclusive society and environmental protection. This means working together to build a future that is inclusive, sustainable and reliable future without causing problems for future generations [3].

Green businesses are those that adopt green management principles, policies, and practices that improve the quality of life for customers, employees, the communities in which they operate, and the

environment. To address the effects of climate change and other environmental issues, enterprises must adopt green approach and standards in their operational management and product output [4].

Businesses focus on goals of recycling and reducing consumption when implementing green logistics. The structure of the green logistics system includes green product design, green procurement, green production, green marketing, green warehousing, green packaging and reverse logistics.

Green logistics is a comprehensive term, so it is also referred to as Green Supply Chain Management and logistics green practices [13].

Green logistics is the main development trend of modern logistics. Green logistics is the fundamental and essential component of the circular economy development system. Green logistics is a concept that connects resources with products, products with customers [15].

Green manufacturing involves designing products that use less energy and materials while also emphasizing recycling and reuse. It minimizes the costs in production, assembly and disassembly, simplifies processes, promotes material reuse and speeds up recycling. Topics covered in green design include environmental risk management, product safety, occupational health and safety, pollution prevention and waste management.

The following will help businesses transition to green design: - reducing production and improving waste management costs; - building trust by responding to customers' interests; - cutting waste and saving on raw materials, ensuring environmental efficiency; - complying with legal norms and standards; - attracting investors by enhancing the success and environmental performance of the enterprise; - ensuring readiness for environmental risks and new changes.

Nowadays, more and more companies are implementing conscious purchasing policies to be more sustainable in terms of energy use. The issue of sustainable procurement is also increasingly in the focus of attention of the parties involved [18]. Green procurement is the procurement of reusable and environmentally friendly products and services that follow the principles of a sustainable and responsible purpose and meet social standards in procurement.

Reverse logistics is all activities related to collection of used, expired products, reuse, recycling and destruction of these products: direct reuse; repair;

product renewal; reproduction; partial use of the product; overproduction [12].

**Formulation of research goals.** Green Logistics of “DHL Express”: DHL offers a comprehensive and unrivaled range of logistics services from domestic and international package delivery, e-commerce, road, air and sea freight to supply chain management. With approximately 350,000 employees in more than 220 countries worldwide, DHL enables global trade flows by connecting people and companies quickly and securely. The company's activities in the framework of green logistics are as follows: - the company's “Go Green” strategy has reduced carbon footprint by 30% in 2020; - the effects of harmful carbon dioxide on the environment during the transportation and storage of products with optimized transport routes and alternative means of transport have been reduced; - carbon reports are prepared to show customers' levels of gas emissions. Although the environment in the logistics sector is most affected by carbon gases such as methane and nitrogen oxides, other greenhouse gas emissions are also reported; - customers are shown ways to reduce greenhouse gases with the green optimization service; - major studies are being carried out for obtaining ISO 14001 certificate for all facilities.

Alternative means of transportation that are important for ensuring the transition to green logistics are:

- Electric bus. It is an environmentally friendly transport method created for urban public transport. These zero-CO<sub>2</sub>-emission buses are more convenient and easy to use for sunny cities thanks to solar panels installed on them. Buses are divided into three segments by type: battery electric buses are the market leader with more than 90% share, hybrid electric buses and plug-in hybrid electric buses. Batteries account for 40% of the cost, and with the cost of Lithium-ion battery packs expected to drop by 52% between 2018 and 2030, these buses are expected to reduce costs. This in turn will lead to market growth. The market, valued at US\$29 billion in 2021, is expected to reach US\$105 billion by 2028;

- APAC is the leading region in this field in 2021 with a market value of 26 billion dollars. China alone has 24 million of this market value and controls 80% of the market. The country has made progress in the production of the new energy bus (NEB), which is mainly battery-powered. Despite being in second place, Europe is growing faster. France, Great Britain, Poland, Scandinavian countries, the Netherlands and Germany together account for more than half of the total number of electric buses in Europe today. It is predicted that 16,710 electric buses will be put into operation by 2025. About 25 of the registered buses in 2021 were zero-

emission buses. New Zealand, Denmark, and the Netherlands have targeted 100% zero-emission bus purchases by 2025, and Costa Rica has targeted 100% electrification of its bus fleet by 2050.

North America lags behind APAC and Europe in the transition to electric buses. With 2.6% of the total market share, it has 756 million USD. The buses are also used in the cities of Izmir and Malatya in Türkiye, and according to the data obtained as a result of 2 months of use, 75% of energy has been saved.

The agricultural sector is an important factor in the development of rural areas. The impact of its technological development on the sustainable development of these areas is not insignificant [17].

The relevance of the criteria for the sustainable development of agricultural technologies was assessed mainly from the economic and economic-technological point of view. Such cases may still occur from the standpoint of a specific manufacturer [2]. The environmental impact of these technologies have never been the focus of attention at the level of individual producers [14]. Logistics villages were created to avoid congestion caused by heavy vehicles in the US, and to prevent pollution caused by freight transport in Europe. As a result of the study conducted in 2013, it was concluded that there are 3 elements of the logistic village. These are physical goods, service goods and activity related items. A lot of infrastructure needs to be developed for developing countries to compete with technologically advanced countries. In green logistics applications, competition requires government incentives and increased awareness. This makes the implementation of green logistics accessible to developing countries. Despite the minor setbacks the industry is experiencing, the years ahead look promising for green logistics. As can be seen from the analysis, many countries and companies have adopted the use of efficient vehicles and equipment to reduce maintenance costs, fuel consumption, and the level of waste produced. As information and communication technologies advance, it is predicted that most countries will implement green logistics [7].

**Outline of the main research material.** The main advantages during the construction of a logistics village are performance criteria related to infrastructure quality, logistics service quality, timing, transportation capabilities, cost and logistics tracking, controllability. These advantages are qualities that are recognized in the logistics performance index and are also taken into account by business partners in commercial relations. It is possible to say that logistics villages, when properly set up together with customs services (Fig. 1), will have a significant impact on improving logistics performance.

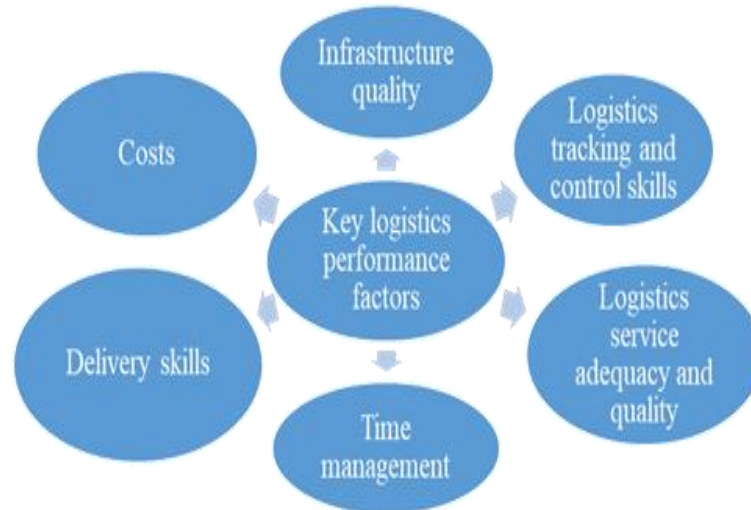


Figure 1 – Basic logistics performance factors

Source: [10]

According to the eighth “The Logistics Performance Index 2023” report presented by the World Bank, which evaluates the logistics performance of 139 countries, Germany handed over the first place to Singapore with 4.3 points and ranked fourth with 4.1 points. The top 10 countries in the ranking are Singapore, Finland, Denmark, Germany, the Netherlands, Switzerland, Austria, Belgium, Canada and Hong Kong, respectively. Libya ranked last with 1.8 points. Various economic processes occurring in the modern world, as well as the great disaster of the COVID-19 pandemic, have damaged all

areas of the economy and the economy on a global scale [11]. Despite the disruption caused by the COVID-19 pandemic, the 2023 LPI scores based on the global supply chain are almost similar to the 2018 values. The report is based on qualitative assessments collected through a questionnaire from 652 logistics specialists selected by a special sampling method from international logistics companies in 115 countries of the world in September-November 2022. Using a “Big Data” approach, key performance indicators for container, air and parcel transportation were obtained.

Table 1 Logistics Performance Index of countries by years

2016 LPI			2018 LPI			2023 LPI		
Row	Country	Index	Row	Country	Index	Row	Country	Index
1	Germany	4,23	1	Germany	4,20	1	Singapore	4,3
2	Luxembourg	4,22	2	Sweden	4,05	2	Finland	4,2
3	Sweden	4,20	3	Belgium	4,04	3	Denmark	4,1
4	Netherlands	4,19	4	Austria	4,03	4	Germany	4,1
5	Singapore	4,14	5	Japan	4,03	5	Netherlands	4,1
6	Belgium	4,11	6	Netherlands	4,02	6	Switzerland	4,1
7	Austria	4,10	7	Singapore	4,00	7	Austria	4,0
8	United Kingdom	4,07	8	Denmark	3,99	8	Belgium	4,0
9	Hong Kong	4,07	9	United Kingdom	3,99	9	Canada	4,0
10	USA	3,99	10	Finland	3,97	10	Hong Kong	4,0
34	Turkey	3,42	47	Turkey	3,15	38	Turkey	3,4
160	Syria	1,60	160	Afghanistan	1,95	138	Lithuania	1,8

Source: [9]

The Green Logistics Performance Index combines both the Logistics Performance Index (LPI) and the Environmental Performance Index (EPI). This index justifies the demand for an index that can measure

environmental aspects to help develop both logistics and green logistics.

A few years ago, there was no definition of the term green logistics. The word “green” referred to something

that was ecological or sustainable in logistics and management. This approach changed after people realized that this word also means efficiency. Better route planning, using better quality fuel or improving supply coordination not only help the environment, but also reduce costs. If any company performs its environmental activities effectively, its overall performance is also improved and more competitive. This term, which is important in the 21st century, plays a significant role in forming the image of a company that cares about the environment.

Not all components of both indices are correlated. For example, the customs score in the LPI does not affect the environment and the environmental index (EPI) in general. The two main things that affect environmental performance index (EPI) are infrastructure and time. When infrastructure is developed by a country, it can increase transportation activities and the pollution it creates. If time is mismanaged, it can prevent these products from being transported on time and lead to fewer trucks available for transportation. From an environmental performance index perspective, the most important contributors to outdoor air pollution are sulfur dioxide emissions from trucks, nitrogen oxide emissions, non-methane volatile organic compound emissions, and industrial greenhouse gas emissions. The Green Logistics Performance Index (GLPI) proposed by scholars, described in this paper and presented as a hybrid index, considers not only the environment but also logistics performance to create eco-efficiency. Eco-efficiency was first introduced by the World Business Council for Sustainable Development, but it was not clear enough. In 2005, scientists gave it a clearer definition. In 2000, this concept was expressed mathematically:

$$\text{eco - efficiency} = \frac{\text{product or service value}}{\text{environmental influence}}$$

The Green Logistics Performance Index was introduced to measure the logistics performance of any country, taking into account all logistics activities in the environment. Thus, this index can be expressed mathematically as the same environmental efficiency:

$$GLPI = \frac{\text{Logistics Performance}}{\text{Environmental Impacts}}$$

If LPI and EPI are to be used, this formula may be:

$$GLPI = \frac{\text{sum of selected LPI data (output)}}{\text{sum of selected EPI data (input)}}$$

To get the numerator we add the value from the two divisions in the LPI. The first value represents the

infrastructure score and the second value represents the time score. Then, to find the denominator, we need to sum up the 5-score values of the EPI: 1. Outdoor air pollution (PM10) – this value is an indicator of pollution formed during transportation services; 2. Non-methane volatile organic compound emissions; 3. Nitrogen oxide emissions; 4. Industrial greenhouse gas emissions; 5. Sulfur dioxide emissions (SO<sub>2</sub>) - this value is also an indicator of pollution formed during transportation services [16].

**Conclusions.** Based on the analyzed indicators from different years, it can be said that countries and enterprises operating within their territory are increasingly using green logistics applications during cargo transportation year by year. This trend supports the development of the green economy, environmental protection, the health of people and other living beings, as well as socio-economic development. It is extremely important that logistics activities are carried out in an environmentally friendly manner. The use of less and ecologically clean raw materials in packaging and the investigation of alternative transportation methods are typical examples of steps to be taken in this direction. Companies take various measures to reduce the harmful effects of transportation on the environment. First of all, it is necessary to focus on problems such as fuel consumption, excessive noise, and traffic congestion. When purchasing environmentally friendly company equipment, preference should be given to vehicles that use unleaded gasoline, and rail transport should be used for long-distance transportation operations. If it is necessary to transport by road, the transportation of the products should be organized with machines equipped with technology that ensures the disposal of used fuel in a way that does not pollute the environment, green motor vehicles should be preferred.

The main benefits of green logistics for firms are as follows:

- by adding originality to the service production system and operational procedures, it allows to manage environmental impacts, existing or new legislation and learn to cope with changes;
- increases the quality and efficiency of service and product supply;
- the needs of the green economy force to make innovative decisions. These factors always push businesses further in terms of reducing operating costs;
- when products that meet the requirements of the environment, are developed, the services and products provided make a difference;
- increases consumer awareness in the areas of sustainability and social responsibility.

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