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**СЕКЦІЯ
ЗАХИСТ НАВКОЛИШНЬОГО СЕРЕДОВИЩА ТА РОЗВИТОК
СУЧАСНИХ ЗЕЛЕНИХ ТЕХНОЛОГІЙ.
СУЧАСНІ ТРЕНДИ РОЗВИТКУ МЕДИЦИНИ В УКРАЇНІ.**

**THEORETICAL FOUNDATIONS OF GREEN LOGISTICS AND ITS
ENVIRONMENTAL IMPACT**

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Logistics is a system that manages the movement, storage, and handling of goods throughout the entire supply chain. In modern conditions, it is not only an operational activity but also a strategic factor that directly influences business efficiency, competitiveness, and customer satisfaction. Over the past decades, logistics has evolved from simple transportation management to a complex system that integrates production, distribution, and information flows.

At the same time, the traditional approach to logistics focused mainly on minimizing costs and maximizing speed. Environmental consequences were often ignored because they were not directly included in company expenses. However, growing environmental problems, especially climate change, forced businesses and governments to reconsider this approach.

As a result, the concept of green logistics appeared. It can be defined as the management of logistics activities in a way that minimizes their negative impact on the environment. This includes reducing emissions, saving energy, optimizing resources, and decreasing waste. An important feature of green logistics is the balance between economic efficiency and environmental responsibility. Sustainable logistics is closely

connected with the idea of sustainable development, which combines economic, environmental, and social aspects. This approach allows companies not only to reduce harm to the environment but also to improve their long-term performance [1].

Logistics activities have a significant impact on the environment, and this impact is growing due to globalization and increasing demand for goods. One of the main sources of environmental damage is freight transport. It generates air pollution, noise, and greenhouse gas emissions. According to the provided material, logistics activities account for a considerable share of global energy consumption and CO₂ emissions.

Road transport plays the biggest role in environmental pollution, as trucks and vans are responsible for the majority of emissions in the logistics sector. In addition to carbon dioxide, logistics produces other harmful substances such as methane and nitrogen oxides, which contribute to climate change. Another important aspect is warehousing. Modern warehouses consume large amounts of energy for lighting, heating, cooling, and automation systems. The expansion of distribution centers increases resource consumption and land use.

Moreover, logistics affects the environment not only locally but also globally. Earlier, attention was mainly focused on local problems such as noise and air pollution. Today, the main concern is global climate change, which is strongly connected with logistics activities.

The development of green logistics is influenced by several important factors. One of the main drivers is environmental regulation. Governments introduce strict standards for emissions, fuel efficiency, and environmental reporting. These measures force companies to adopt cleaner technologies and reduce their environmental impact.

Another important factor is corporate social responsibility. Companies are increasingly aware that their reputation depends on environmental performance. As a result, many organizations include green logistics in their overall sustainability strategies. This includes reducing emissions, improving energy efficiency, and using environmentally friendly materials [1, 2].

Technological progress also plays a crucial role. Digital technologies, automation, and artificial intelligence make it possible to optimize logistics processes

and reduce unnecessary operations. In addition, innovations such as electric vehicles and alternative fuels help decrease dependence on fossil energy sources. Globalization is another factor that influences green logistics. On one hand, it increases the scale of logistics operations and environmental impact. On the other hand, it encourages companies to adopt international standards and implement sustainable practices across global supply chains.

One of the most important directions of green logistics is the transformation of transport systems. Traditional transport modes, especially road and air transport, produce high levels of emissions. Therefore, companies are trying to shift to more environmentally friendly alternatives such as rail and water transport, which have lower carbon intensity.

Another important step is the use of electric vehicles and alternative fuels. Electric trucks, hybrid systems, and biofuels significantly reduce greenhouse gas emissions. Although these technologies are still developing, they already show strong potential for improving environmental sustainability. Reducing the carbon footprint has become a key objective for many companies. This involves measuring emissions at different stages of the supply chain and implementing strategies to reduce them. Carbon auditing allows companies to identify inefficient processes and optimize their operations. Optimization is one of the most effective ways to reduce environmental impact without significant financial losses. Route optimization helps minimize fuel consumption by reducing unnecessary trips and choosing the most efficient paths. Modern software systems and artificial intelligence make this process more accurate and effective [1, 2].

Another important aspect is improving vehicle utilization. Many trucks operate with incomplete loads, which increases the number of trips and emissions. By optimizing loading processes, companies can transport more goods with fewer vehicles, reducing environmental pressure.

Digital technologies also play a significant role. Real-time data, smart systems, and automation allow better coordination of logistics operations. This leads to improved efficiency, reduced delays, and lower emissions.

Warehousing is an essential part of logistics, and its environmental impact cannot be ignored. Modern warehouses are becoming more energy-efficient through the use of advanced technologies. For example, LED lighting, automated systems, and energy management tools significantly reduce energy consumption.

The use of renewable energy sources, such as solar panels, is another important trend. This allows warehouses to reduce dependence on traditional energy sources and lower their carbon footprint.

Automation and smart technologies improve efficiency and reduce waste. Smart warehouses use digital systems to manage inventory and optimize operations. This not only increases productivity but also contributes to environmental sustainability.

Despite its advantages, green logistics faces several serious challenges. One of the main problems is the high cost of implementation. New technologies, such as electric vehicles and renewable energy systems, require significant investment, which can be difficult for many companies. Another challenge is the lack of infrastructure. For example, the development of electric transport depends on the availability of charging stations and supporting systems. Without proper infrastructure, the transition to green logistics becomes slower. There is also a conflict between sustainability and customer expectations. Modern consumers demand fast and cheap delivery, which often increases emissions. This creates a difficult balance between efficiency and environmental responsibility [1].

The future of green logistics is closely connected with innovation. Technologies such as drones, autonomous vehicles, and smart logistics systems are expected to transform the industry. These solutions can improve efficiency and reduce environmental impact. Reverse logistics is becoming increasingly important. It focuses on returning products for recycling, reuse, or proper disposal. This approach reduces waste and supports the circular economy. In the long term, green logistics will become a standard rather than an option. Companies that adopt sustainable practices will have a competitive advantage, while those that ignore environmental issues may face serious risks. The development of sustainable logistics models will continue, combining economic efficiency with environmental responsibility. This will allow the logistics

industry to meet growing demand while reducing its impact on the planet.

In the course of this term paper, the concept of green logistics and its role in improving the environmental sustainability of logistics systems have been considered. It has been shown that logistics, while being essential for economic development, creates a significant environmental impact, mainly through transport emissions, high energy consumption, and intensive use of natural resources.

Special attention has been given to the fact that freight transport is one of the largest contributors to greenhouse gas emissions. At the same time, warehousing and material handling processes also affect the environment due to their high energy demand and resource intensity. As a result, the transformation of traditional logistics into more sustainable systems becomes increasingly necessary.

The analysis has shown that green logistics involves integrating environmental considerations into all logistics activities. The use of alternative transport modes, energy-efficient technologies, route optimization, and digital solutions allows companies to reduce their environmental impact. In addition, many of these measures also improve operational efficiency and reduce costs, which makes green logistics economically beneficial.

However, several challenges remain. High implementation costs, insufficient infrastructure, and the growing demand for fast delivery make the transition to green logistics more difficult. These factors slow down the widespread adoption of sustainable solutions in the logistics sector.

At the same time, the future of green logistics appears promising. Technological innovation, stricter environmental regulations, and increased corporate responsibility are driving further development in this field. Solutions such as alternative fuels, automation, and reverse logistics are expected to play a key role in reducing environmental impact.

As a result, green logistics can be seen not only as an environmental necessity but also as a strategic direction for modern business development. Its implementation contributes to reducing environmental damage while maintaining efficiency and meeting the needs of a rapidly evolving global economy.

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SUSTAINABILITY IN LOGISTICS: THE GREEN TRANSFORMATION OF GLOBAL SUPPLY CHAINS

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Logistics is the engine of the global economy, but it is also a significant contributor to the environmental crisis that threatens it. The transportation sector accounts for approximately 24% of global CO₂ emissions, with freight transport representing a substantial and growing share (International Energy Agency, 2023). Warehousing, packaging, and reverse logistics add further environmental burdens through energy consumption, material waste, and land use. As climate change accelerates and regulatory scrutiny intensifies, sustainability has moved from a peripheral corporate social responsibility concern to a central strategic imperative for the logistics industry.

The transformation required is profound. It extends beyond incremental efficiency improvements to encompass alternative fuels, electrification, circular economy models, and fundamental redesign of supply chain networks. This article examines the environmental impacts of logistics, the drivers pushing sustainability to the forefront, the strategies available to reduce emissions and waste, and the challenges that must be overcome on the path to a genuinely sustainable logistics sector.

The Environmental Footprint of Logistics

Carbon Emissions and Climate Impact Freight transport is a major and growing source of greenhouse gas emissions. Road freight alone accounts for approximately 6% of global CO₂ emissions, with heavy-duty trucks—which represent only 4% of the global vehicle fleet—responsible for roughly 40% of road transport emissions