Green logistics – a prerequisite for sustainable management in enterprises

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Abstract **The report examines the essence and characteristics of the concept of "green logistics" and the possibilities for its application. As a result, a conceptual model for the application of green logistics in the logistics system of the supply chain is proposed. Goals, directions and key performance indicators (KPIs) are proposed, with which business organizations can report the application of the principles of "green logistics" in Bulgaria. Examples of logistics operators applying the principles of "green logistics" are presented. Problems regarding the application of "green logistics" in Bulgaria are identified.**

Keywords **— green logistic, sustainable development, sustainable management**

I. INTRODUCTION

[1]In recent years, there has been a change in the decisions taken by management teams and employees in business organizations aimed at protecting the cleanliness of the environment. Logistics as a main or ancillary activity in the business of organizations is related to the transportation of raw materials, goods and various cargoes. Analysis shows that "Modern logistics contributes to the release of 5.5% of the total amount of carbon emissions" [1]. Many companies around the world are starting business initiatives and introducing good practices in their activities related to reducing carbon dioxide emissions, recycling of materials and products, etc.

The aim of the study is to analyze, as a result of a literature review, the main aspects related to the concept of "green logistics" as prerequisites for sustainable business management.

Main tasks of the study:

1. To clarify the main aspects of the concepts of "green logistics" and "sustainable development";
2. To clarify and indicate, based on a literature study, the main directions for the application of the concept of green logistics around the world.
3. To identify directions for the application of green logistics in business in Bulgaria.

II. GREEN LOGISTICS

The definition of “green logistics” refers to “a set of processes and projects that a company develops with the aim of reducing the environmental impact and carbon footprint of their supply chain.

Specifically, the importance of green logistics is closely related to: optimal supply of production, packaging, delivery, reverse logistics, etc. [2].

Green logistics “aims to protect the environment and conserve resources by creating a state of balance between the environment and economic activities,” in contrast to traditional logistics, which “the goal of logistics is to move products and information from one point to another in the best possible way” [3].

Logistics encompasses procurement, inventory management, distribution, warehousing, transportation, packaging, and risk management. Green logistics (or “sustainable logistics”) is “a business practice to reduce the environmental impact of these processes” [4].

The author of a study on risk management in the logistics activities of enterprises believes that "good organization of logistics systems can develop the potential for rationalization, which can give stable competitive advantages to the enterprise" [5].

The authors of a study related to "creating conditions for the implementation of digital dimensions in logistics activities" believe that "the great diversity and significant number of links in the logistics chain require more effective ways of communication and information interaction between them" [6].

III. DIRECTIONS FOR IMPLEMENTING THE GREEN LOGISTICS CONCEPT

DHL identifies several main areas for the practical application of green logistics in its business [4]:

- **Lower emissions**

Green logistics “emphasizes the use of alternative fuels, electric vehicles, and optimized transportation routes to reduce greenhouse gas emissions.”

The company promotes energy efficiency throughout its logistics network (such as implementing energy management systems (EMS) in warehouses).

Source: DHL

Fig. 1. Alternative fuel vehicles in the DHL logistics network

As a result of the measures taken, the business will reduce

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its overall carbon footprint.

- **Improving reputation**

DHL management believes that "Sustainability is a key influence on consumer purchasing decisions. Current and future customers expect green logistics practices from businesses." In DHL's 2023 Global Online Shopper Survey, "over 70% of respondents indicated that sustainability is important to them when shopping online, while almost half would be willing to wait longer for their goods if it would help the environment." It concludes that "Businesses need to consider a comprehensive and in-depth green logistics strategy".

- **Cost reduction**

Green logistics focuses on fuel efficiency and waste reduction. The author cites a McKinsey & Co report1 which found that "reducing material waste through zero and low waste policies can help businesses improve their operating profits by up to 60%".

- **Circular economy**

The circular economy model "promotes the idea of sharing, repairing, refurbishing and recycling products and materials for as long as possible to reduce waste." DHL's implementation of a reverse logistics strategy "will help businesses transition to a circular economy model and achieve their sustainability goals, and give customers more choice in managing their returns".

- **Adoption of environmentally friendly transport**

The logistics and transport sector "contributes to just over a third of global carbon dioxide (CO2) emissions. By optimizing space and packaging their products in the right size boxes and cartons - allowing them to group packages into fewer vehicles".

- **Route planning software integration**

The technology achieves "optimal delivery routes based on real-time traffic analysis. Multiple deliveries are made in the fastest and most efficient order".

- **Green logistics partner**

It involves carrying out "logistics processes with the help of a third-party partner company that meets green credentials." DHL Express, the global leader in logistics, has launched GoGreen Plus, a solution that "helps businesses reduce the carbon footprint of their shipments through the use of sustainable aviation fuel."

- **Delivery on demand**

DHL analysis found that "failed delivery attempts increase vehicle emissions and business costs." With the introduction of "on-demand delivery," customers choose "exactly when and where their products are delivered (to a neighbor, to a parcel locker, or to an alternative address like their workplace). First-time delivery speeds are improved and customers benefit from a more convenient service."

The authors of a study on the relationship between green logistics and the circular economy conclude that: "ecological logistics will determine the efficiency of the economic cycle in the circular economy" and "important green logistics activities in the implementation of the circular economy concept by companies include the following environmentally friendly:

- green packaging,
- green transportation,
- storage,
- processing flow" [7].

Source: DHL

Fig. 2. „Delivery on demand" service in the DHL logistics network

The authors of a scientific study on "the contribution of green logistics and sustainable purchasing to green supply chain management" conclude that "the supply chain is focused on environmental efficiency. Green supply chain management seeks to eliminate waste, reduce costs, and maximize profits by mitigating environmental damage caused throughout the production chain" [8].

IV. DIRECTIONS FOR THE APPLICATION OF GREEN LOGISTICS IN BUSINESS IN BULGARIA

As a result of the research conducted on scientific publications in the field of green logistics, a conceptual model is proposed for the application of the principles of "green logistics" in Bulgaria. The model covers two groups of enterprises, according to the logistics supply chains:

- Enterprises from the macro-logistics system – the purpose of which is to provide logistics services for business clients (transportation of goods, warehousing of goods, trade organizations, etc.) or services supporting the logistics activities of their business clients (insurance of goods, services related to the preparation and submission of customs documents, information services, consulting services);
- Enterprises from the micro-logistics system that produce products or provide technology-based services to their clients. Objectives: to supply their business activities (production of products, provision of services, commercial activities) with the necessary raw materials, materials, and components, etc.; to carry out their business activities; to sell the finished products/services.

As a result of the study, Table I and Table II propose specific business activities and key performance indicators aimed at setting strategic environmentally friendly business goals and implementing "green logistics" in supply chains for enterprises in the macro and micro logistics system.

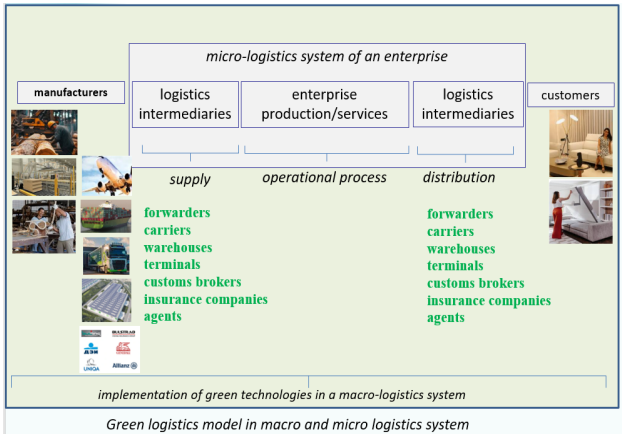


Fig. 3. Model of "green logistics" in a macro and micro logistics system

TABLE I
ACTIVITIES FOR IMPLEMENTING GREEN LOGISTICS IN ENTERPRISES FROM THE MACROLOGISTIC SUPPLY SYSTEM

Activities for implementing green logistics	**KPIs for reporting results from green logistics implementation**
Goal: reduce greenhouse gas emissions	
• use of electric vehicles • use of alternative fuels (biofuels) for vehicles • optimization of transport routes	• ton/year of fuels used • money/year spent on fuel/energy/consumables (electric batteries, etc.) • money saved through green technologies and/or optimized transport routes
Goal: use of energy from renewable sources	
• use of renewable energy sources (solar energy, wind energy, hydropower) • средства use of alternative fuels (ethanol, biodiesel, hydrogen, gas – propane/methane) for vehicles	• amount of energy used per month/quarter/year • tons of fuels used per month/quarter/year • funds spent per month/quarter/year
Goal: up-to-date information provision of logistics processes	
• real-time traffic information in and outside populated areas • real-time information for access and/or use of services from intermodal terminals/ports/airports/railway stations/car terminals/border crossings • real-time information for the current location of a vehicles in the global transportation system • information on introduced administrative restrictions or obligations of local authorities when transporting various types of cargo, processing documents, etc.	• absence/presence of traffic jams • number of vehicles waiting in traffic jams • time for receiving and processing cargo at intermodal terminals/ports/stations/car yards • money saved from optimized transport routes as a result of avoiding weather phenomena, traffic jams, administrative restrictions of local authorities

TABLE II
ACTIVITIES FOR IMPLEMENTING GREEN LOGISTICS IN ENTERPRISES FROM THE MICROLOGISTICS SUPPLY SYSTEM OF ENTERPRISES

Activities for implementing green logistics	**Activities for implementing green logistics**
Goal: use of green/eco technologies in the logistics processes of enterprises *- warehouse for: resources (raw materials) and finished products*	
• use of energy from warehouse equipment (electric forklifts, forklifts, conveyors, transmanipulators, cranes, etc.) through renewable energy sources to implement automated/semi-automated supply and distribution processes • use of warehouse equipment powered by alternative fuel or electricity • use of recycled packaging (transport packaging, packaging to preserve the commercial appearance and qualities of materials/products)	• amount of energy used kW/h for technological warehouse processes • time to implement a technological process using energy from renewable sources • kilometers/miles traveled by a vehicle in a warehouse based on alternative fuel/electricity from renewable sources • operating hours per day/year of working warehouse equipment alternative energy sources • funds spent on recycled packaging • % recycled packaging
Goal: use of green/eco technologies in the logistics processes of enterprises *- production / technological operational processes (production logistics)*	
• use of energy from production equipment obtained through renewable energy sources in operational processes • use of transport equipment powered by alternative fuel or electricity when delivering material resources/preparations/components, etc. to workplaces • Use of recycled packaging (transport packaging,	• amount of energy used kW/h for technological warehouse processes • time to implement a technological process using energy from renewable sources • kilometers/miles traveled by a vehicle in a warehouse based on alternative fuel/electricity from

	packaging to preserve the commercial appearance and qualities of materials/products)	renewable sources • kilometers/miles traveled by a vehicle in a warehouse based on alternative fuel/electricity from renewable sources • funds spent on recycled packaging • % recycled packaging

V.IMPLEMENTATION OF GREEN LOGISTICS IN BULGARIA

An analysis of the activities of logistics operators on the Bulgarian market found that the application of the concept of "green logistics" is entering the business practices of logistics companies in Bulgaria, such as Green Point Logistics, Delamod Bulgaria, DHL Group, Next Logistics, Active Logistics, etc [9,10, 11, 4, 12, 13]

- **Green Point Logistics**

Green Point Logistics is a company focused on providing urban courier services (in cities such as: Sofia, Plovdiv, Veliko Tarnovo, Burgas and other cities) [9, 10].

Source: Green Point Logistics

Fig. 4. Green Point Logistics vehicles and a logistics base of a partner company

In recent years, the company has been implementing the philosophy and following principles of "green logistics" in its business practice. [9, 10]:

- „transition to fully electric cars - range - 130 km for urban logistics;
- good route estimation on a single charge;
- use of solar energy through a photovoltaic plant installed on the roof of a company building. The energy generated by the sun is successfully stored for a month, so that when the minibuses return from their trips, they can be fully charged in about 40 minutes;
- In the long term, the company plans to build solar sheds, with the first one to be installed in the parking lot at its logistics base“.

- **Delamod Bulgaria**

Delamode Bulgaria is a forwarding company, which is a division of Delamode Group [11].

The main services offered on the Bulgarian market are [11]:

- „Land groupage transport in Europe,
- Transportation of goods with partial and complete filling of the vehicle's cargo area (for destinations in Bulgaria and Europe),
- Internal distribution,
- Sea and air transport,
- Warehousing and logistics,
- Customs representation,
- Ferry reservations“.

Source: Delamod Bulgaria

Fig. 5. Delamod logistics base in Bulgaria

The management team of Delamod Bulgaria believes that "optimization is a key factor in achieving environmental friendliness in the provision of logistics services" [11].

In the company, implementation of the principles of "green logistics is carried out on several levels" [11]:

- „optimization of goods and cargo;
- route optimization;
- introduction of environmentally friendly packaging;
- creation of a corporate network for logistics services;
- partnership within Europe with other logistics companies with an ecological focus of their activities,
- optimization of logistics processes through specialized software“.

- **Route optimization**

A business practice has been introduced to "determine the shortest routes to minimize fuel consumption and environmental pollution".

- **Controlling logistics activities**

Controlling logistics activities "is carried out regularly to ensure continuous improvement in the quality of the activities carried out and their environmental efficiency".

- **Measurement of the amount of fuel used and other indicators**

The company regularly measures the following indicators:

- „fuel consumed;
- average lifespan of vehicle tires;
- use of cargo space in vehicles;
- the percentage of kilometers traveled by each vehicle without a load;
- the amount of packaging waste“.

VI. PROBLEMS IN ENTERING GREEN LOGISTICS IN BULGARIA

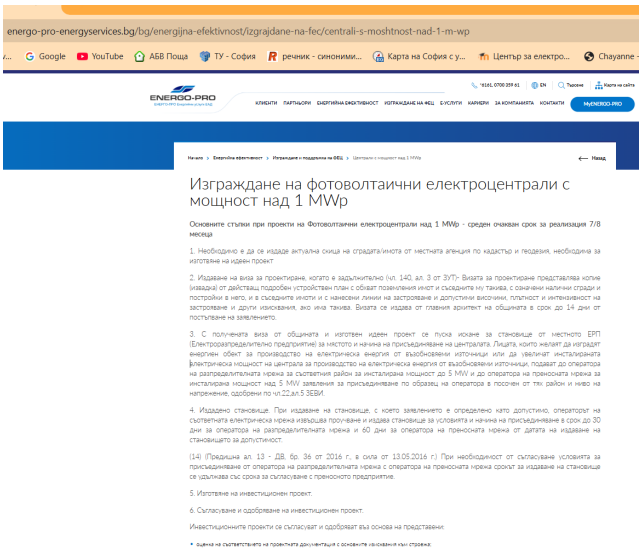
As a result of the study, some problems were identified that hinder the mass introduction of "green logistics" in Bulgaria, such as::

- **lack of infrastructure** - insufficient number of public charging stations built by the state or local authorities to supply vehicles with electricity;

limitation of vehicle routes, mainly for shorter distances;

- **it takes more technological time to charge the battery of an electric vehicle** compared to traditional gasoline vehicles. In a "mid-range electric vehicle, the battery is around 45 - 50 kWh, and premium models 70 and 100 kWh. In the most common cases, charging at a fast station takes between 15 and 30 minutes." [14].
- **insufficient production capacity and distribution of alternative fuels** (ethanol, biodiesel, hydrogen, etc.);
- **relatively short life of vehicle batteries**, after which there are no sufficiently effective and cheap methods for recycling them - "the problem is in the batteries, their replacement is estimated at almost twice the price of a new car" [15];
- **relatively long and cumbersome administrative procedures for the construction of photovoltaic power plants** and the placement of such elements on buildings and their connection to the network of local electricity distribution companies in the country;
- **relatively expensive investment for building photovoltaic power plants** with higher capacity for small and medium-sized enterprises.

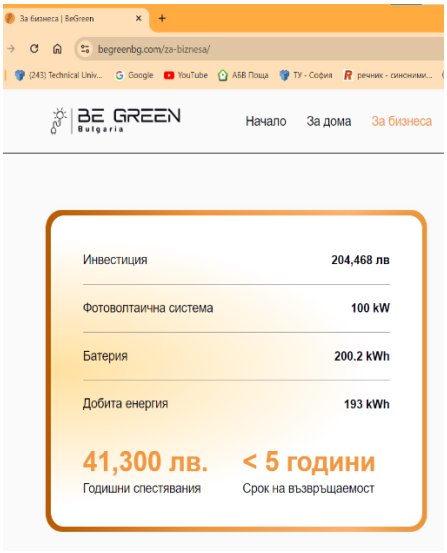
Figure 6 visualizes the requirements of ENERGO-PRO for business enterprises that aim to build photovoltaic power plants with a capacity of over 1MWp and connect them to the grid of the energy supply operator [16]. Preparing the documentation and obtaining the relevant permits in Bulgaria takes from several months to years, in accordance with the complexity of the investment project for the construction of photovoltaic power plants.



Source: ЕНЕРГО-ПРО

Fig. 6. ENERGO-PRO requirements for the construction of photovoltaic systems with a capacity of over 1 MWp

Figure 7 visualizes data from an electronic calculator that presents the approximate cost of the investment for design, construction and payback period that a business organization needs to invest to build a 100kW photovoltaic system, using the services of the company BEGreen [17]. For small businesses, the required investment requires more detailed planning and assessment of its payback, as it covers a relatively high value for the capabilities of a number of businesses.



Source: Be Green

Fig. 7. Be Green's electronic calculator for visualizing the necessary investment in building a photovoltaic system for a business organization

VII. CONCLUSION

The scientific study includes a literature review of publications in the field of "green logistics" and its application in the world. Based on the studied publications, the essence of the concept is examined and directions for application of the concept of "green logistics" are systematized. As a result of the studies, a conceptual model for the application of "green logistics" in enterprises of the macro and micro logistics system of the supply chain is proposed. Strategic goals, directions and key performance indicators (KPIs) are proposed, with which business organizations can report the application of the principles of "green logistics" in their activities. Examples of logistics operators in Bulgaria and directions in which they apply the basic principles of the concept of "green logistics" are given. Main problems that slow down the widespread application of "green logistics" in Bulgaria are identified.

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