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INFRASTRUCTURAL PROBLEMS OF IMPORT DELIVERY OF PETROLEUM PRODUCTS IN WAR CONDITIONS

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Summary

Introduction. *The article explores key aspects of ensuring energy security in Ukraine under martial law, with a specific focus on the supply of diesel fuel, a strategic resource essential for the functioning of the economy and the defense sector. The urgency of addressing energy security issues stems from disruptions in traditional supply routes caused by the outbreak of full-scale military actions, which have necessitated rapid adaptation of Ukraine's transportation and logistics infrastructure.* ***Purpose.*** *The purpose of the study is to analyze the current challenges of supplying petroleum products to Ukraine, to assess the impact of new customs legislative initiatives, and to substantiate effective transportation and logistics solutions to maintain stable diesel imports during martial law.* ***Results.*** *The research highlights significant changes in the geography of petroleum product supplies after the start of hostilities, including the reorientation towards alternative supply chains and partnerships. The article examines new legislative changes regulating customs clearance for petroleum products, emphasizing their importance in accelerating border procedures and enhancing energy security. The advantages of using flexitanks as an alternative to traditional transportation methods are substantiated, including reduced logistics costs, increased flexibility, and improved operational convenience within the modified infrastructure conditions. Practical proposals for the optimization of petroleum product imports using modern logistical solutions are presented.* ***Conclusions.*** *Ensuring stable diesel supply under martial law requires a flexible, diversified logistics strategy and the rapid adaptation of infrastructure. The new legislative measures and alternative transportation technologies such as flexitanks significantly strengthen Ukraine's energy resilience during crises. The proposed logistics models provide practical tools for enhancing national energy security under conditions of prolonged instability.*

Key words: *energy security, diesel fuel, transportation and logistics infrastructure, petroleum products, customs procedures, flexitanks, alternative transportation, martial law, crisis logistics, Ukraine.*

ІНФРАСТРУКТУРНІ ПРОБЛЕМИ ІМПОРТНИХ ПОСТАВОК НАФТОПРОДУКТІВ В УМОВАХ ВІЙНИ

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Анотація

Вступ. *У статті розглянуто ключові аспекти забезпечення енергетичної безпеки України в умовах воєнного стану, особливий акцент зроблено на постачанні дизельного палива як стратегічного ресурсу, необхідного для стабільного функціонування економіки та сектору оборони. Актуальність дослідження зумовлена порушенням традиційних логістичних маршрутів внаслідок повномасштабних бойових дій, що вимагає оперативної адаптації транспортно-логістичної інфраструктури України.* ***Мета.*** *Метою дослідження є аналіз актуальних викликів у сфері постачання нафтопродуктів до України, оцінка впливу нових законодавчих ініціатив щодо митного оформлення та обґрунтування ефективних транспортно-логістичних рішень для забезпечення стабільного імпорту дизельного палива в умовах воєнного стану.* ***Результати.*** *У дослідженні висвітлено суттєві зміни в географії постачання нафтопродуктів після початку бойових дій, зокрема переорієнтацію на альтернативні логістичні ланцюги та міжнародну співпрацю. Проаналізовано нові законодавчі зміни щодо митних процедур оформлення нафтопродуктів та акцентовано їхню роль у прискоренні перетину кордону й підвищенні енергетичної безпеки. Обґрунтовано доцільність використання флексітанків як альтернативного методу транспортування, що забезпечує зниження логістичних витрат, підвищення гнучкості та зручності експлуатації в нових інфраструктурних умовах. Запропоновано практичні рішення для оптимізації імпорту нафтопродуктів із використанням сучасних логістичних технологій.* ***Висновки.*** *Для забезпечення стабільного постачання дизельного палива у воєнних умовах необхідні впровадження гнучкої, диверсифікованої логістичної стратегії та швидка адаптація інфраструктури. Запроваджені законодавчі зміни й використання альтернативних технологій транспортування, зокрема флексітанків, значно підсилюють енергетичну стійкість України в умовах кризи. Запропоновані логістичні моделі надають практичні інструменти для підвищення національної енергетичної безпеки в період тривалої нестабільності.*

Ключові слова: *енергетична безпека, дизельне паливо, транспортно-логістична інфраструктура, нафтопродукти, митні процедури, флексітанки, альтернативне транспортування, воєнний стан, кризова логістика, Україна.*

Introduction. The challenges of ensuring Ukraine's economy and social sector with energy resources of sufficient quantity and quality represent one of the most critical issues for the country. Under conditions of martial law, the uninterrupted supply of diesel fuel to Ukraine is a vital factor for maintaining defense capabilities, the operation of critical infrastructure, and overall economic stability. The peculiarities of the of Ukrainian imports structure brings up the idea that it is necessary to reduce transportation costs when delivering fuel and energy products, which are the basis of the country's economic and energy security. In relation to them, the solutions are needed aimed at increasing the efficiency of transportation and foreign trade operations by applying more advanced methods of transportation.

Formulation of the problem. In the current conditions prevailing in the country, there is a need for a complete restructuring of previously arranged transport routes, strategies for customs brokerage management in import processes thorough justification and optimization.

Recent research and publications analysis. Most modern publications mainly highlight the economic and logistical problems of imported petroleum products transportation to Ukraine. For example, in paper [1] the challenges of the global petroleum products market and their impact on national security are considered. The publications [2-3] are devoted to the analysis of the main trends in the light petroleum products market in Ukraine. The papers [5-9] highlight the aspects of modeling supply chain costs for the delivery of foreign trade cargo in modern conditions. But unfortunately, few publications are devoted to the issue of finding new transport and technological solutions for providing Ukraine with petroleum products.

Target setting. The purpose of this article is to analyze the specific features of customs clearance procedures for diesel fuel imports, assess the effectiveness of the current measures aimed at simplifying customs procedures, and identify ways for their further improvement, as well as address infrastructure challenges related to the import delivery of petroleum products under martial law conditions.

Presentation of the main research material. An important role in the efficient organization of the cargo delivery process is played by the formation of a priority version of the infrastructure framework of cargo delivery schemes, considering customs-related factors which are necessary for a thorough study of the process. First, it should be noted that this study is based on the concept of "infrastructure framework of cargo delivery scheme", which was proposed by the authors in the previous study [10]. That is, the definition of the "infrastructure framework of the cargo delivery scheme" was taken as a basis, as a graphic representation of possible variants of transport and technological schemes for cargo delivery, which are formed according to the selected optimization criterion.

It can be argued that the configuration of the infrastructure framework of the delivery scheme depends to a greater extent on the geographical structure and volumes of cargo flows. Let us analyze these factors using the example of the import cargo flow of diesel fuel to Ukraine.

Since the beginning of the full-scale invasion, the Ukrainian fuel market has undergone such a structural geographical and transport-logistics transformation that no other country in the world has experienced. From March to July 2022, imports

moved from the eastern and northern to the western and southern borders. The Russian Federation and Belarus were replaced by Poland, Romania, Bulgaria, Turkey, Lithuania and their ports [4]. Thus, in recent years, fuel imports to Ukraine have been mainly along two approximately equivalent routes – Polish and Romanian. This refers to the point of crossing the Ukrainian border, rather than the origin of the fuel.

It is obvious that the Ukrainian oil products market is now fully oriented towards the European border. As a result, not only a geographical transformation has taken place on the Ukrainian market, but also a customs, transport and logistics one.

As is known, the most economical type of transportation for petroleum products transportation in large quantities is pipeline transport, in second place in terms of economies by scale comes sea transport, followed by rail. Before the war, large quantities of diesel fuel entered Ukraine mainly: via pipelines and by rail from the East. Then it was stored in large volumes at oil depots located throughout the country, then transported by road (gasoline trucks) to gas stations within the country. In other words, road transport was applied only for retail trade [2-4].

Since oil depots became one of the main targets of aggression, one of the main transport and logistics problems arose, namely the impossibility of accumulating a large cargo of diesel fuel at oil depots. Therefore, the geography of supplies has changed, the size of cargo lots has changed – all this has significantly affected transport logistics. More than 40% of imports began to arrive by road transport, while by 2022 this type of transportation did not exist at all in imports. In turn, the share of railways has decreased to 40-45% [3-4].

The market for light petroleum products is actively transforming. The speed of development of alternative supply channels directly depends on the right transport and technological solutions.

The problems immediately arose with the existing rolling stock: both in railway and road transport. The Ukrainian farmers proposed one of the possible solutions to this problem back in 2002. The farmers ship fairly large batches of grain and vegetable oils in twenty-foot equivalent units (TEU) for export by truck and rail. On the other hand, on the return journey, the containers usually travel empty. It is quite possible to apply special reusable flexi-tanks on the return journey to transport diesel fuel to Ukraine [11].

In the early 1990s, they were replaced by those made of thermoplastics, which resulted in a drop in prices. However, there was no significant expansion of the market until 2001, when the supply volume was about 5,000 units per year.

Also, in the early 1960s, the US military began to use flexi-tanks for the storage and transportation of diesel fuel. The transportation organization model is as follows. A flexi-tank is a soft container that can be placed on various means of transportation, it can be either a metal twenty-foot container, or a strong truck body, or a platform. It can hold a significant volume of liquid, while when folded it usually takes up to 2% of the volume it can hold. For example, one TEU can hold a flexi-tank with a volume of up to 20 m^3 of diesel fuel, and when folded it is only about 0.3 m^3 and can be transported for use on the way back. Flexi-tank (or flexible-tank) on the Ukrainian market is represented, as a rule, by imported disposable products, the price of which varies within USD 500.00. The disposable flexi-tanks are made of polyethylene or polyamide and are intended for single use for the transportation of safe bulk cargoes (Fig. 1).

Fig. 1. Traditional flexi-tank design
1 – partition with concave beams, 2 – multilayer material, 3-inch flange, 3 – 3-inch loading valve, 4 – Automatic Exhaust valve, 5 – paper roll, 6 –20ft container

Unlike a traditional flexi tank, reusable special flexi-tanks should be used for the storage and transportation of dangerous goods, which include diesel fuel. There are a few companies on the world market that specialize in the production of reusable flexi-tanks. The price of the flexi-tank in this case will be higher, but the cost of operating flexi-tanks will ultimately be lower due to repeated use. A distinctive feature of such products is that flexi-tanks are made of a special polymer material, adapted for repeated use and resistant to almost any liquids; in particular (and this is one of the main features) – these are containers and reservoirs for the storage and transportation of oil and liquid petroleum products.

The world practice has proven that flexi-tanks are a more economical solution than tank-containers, barrels, IBCs (intermediate bulk containers) or cisterns (Table 1). As is evident from Table 1, loading 1 m^3 of a flexi-tank requires less time than loading the same volume, for example, in cisterns, and therefore less time is required for the operation of the transfer pump and operators, respectively, electricity costs and operator wages are reduced. Using flexi-tanks reduces transportation and equipment rental costs, there is no need to pay for the return of the tank container or cistern, there is no need to clean the flexi-tank after unloading.

Table 1

Comparison of loading times for flexi-tank, IBC (per 1 TEU), barrels (per 1 TEU), tank container and cisterns

№	Parameter	Flexi-tank	IBC	Barrels	Tank container	Cistern
1	Number of cargo spaces per standard ISO container, units	1	18 *	80	–	–
2	Total capacity, m^3	24	~18.0	~16.0	~24.0	~60.0 *
3	Loading time, minutes	~30	~120	≥120	~30	~120*
4	Loading time per 1 m^3, minutes	~1.25	~6.7	~7.5	~1.25	~2.0
5	Capacity per 1 cargo space, m^3	~24.0	1.0	0.20	~24.0	~60.0

** Typical loading – 18 IBCs of 1000 liters; a maximum of 20 units can fit.*
** Estimated capacity of a railway cistern; a tanker truck typically has a capacity of ~30 m^3.*
** For a large cistern with a capacity of 70 m^3, 2 hours is the assumed filling time; smaller volumes may load faster.*

Source: developed by the authors based on [12-16].

It should be noted that flexi-tanks also have disadvantages: pumps are required for loading, flexi-tanks cannot be used in refrigerated containers. But despite this, flexi-tanks are a profitable alternative to barrels, IBCs, tank containers, and cisterns, especially in conditions of shortage of the latter. The widespread application of these technologies reduces the time and costs for cargo owners.

Of course, for such transportation, appropriate safety conditions must be met:

– drivers must undergo appropriate training and obtain a certificate,

– vehicle must be equipped with fire extinguishing equipment and other equipment in accordance with the requirements,

– periodic inspection of the integrity and degree of wear of flexi-tanks,

– use of duplicate layers to avoid fuel spillage beyond the container, vehicle body, etc.

In addition, it is necessary to consider the regulatory influence of the state on the importation and delivery of petroleum products under current conditions. This is particularly relevant to the detection of smuggling and counterfeit goods, which can not only cause economic losses but also pose threats to national security. The problems that arose at the beginning of the war during customs clearance of goods were related to the insufficient amount of time allocated for thorough document verification. Since customs clearance of cargo is limited to only four hours, customs officers faced difficulties in detecting falsifications, especially in cases where there were no obvious signs of forgery. During the customs clearance process, the customs authorities conducted document verification, including through requests to competent authorities of foreign states. In 2022–2023, numerous requests were sent to foreign authorities regarding the authenticity of documents and the country of origin of petroleum products.

Energy security is one of the key components of the national security of the state. The Law of Ukraine No. 3484-IX "On Minimum Stocks of Oil and Petroleum Products," which entered into force on December 24, 2024, is an important step towards implementing European standards in energy policy. Its adoption responds to the need to ensure the stability of Ukraine's energy sector and compliance with the requirements of the European Union [17]. The law mandates the creation and maintenance of strategic reserves of oil and petroleum products, which reduces risks associated with supply disruptions. This aligns with Directive 2009/119/EC, which requires EU member states to maintain minimum oil stocks equivalent to at least 90 days of average daily net imports [18].

One of the key aspects of the law's implementation is the introduction of an electronic reporting system that provides real-time monitoring of reserves. Similar systems operate in EU countries, including Germany and France, where they allow for effective control over strategic reserves and rapid response to crisis situations [19].

For the implementation of the law's provisions, the Cabinet of Ministers of Ukraine adopted Resolution No. 1455 dated December 20, 2024. This resolution establishes mechanisms for the creation, management, and operation of the minimum oil stock system. It regulates inventory accounting, procedures for their use, and the framework for interaction between state authorities and market participants. An important factor in the effective functioning of the system is the ability of the State Customs Service to ensure uninterrupted customs clearance of oil and petroleum products. In this context, the interaction of customs information systems with the electronic reporting system via an API interface plays a key role, minimizing the risk of delays in energy supply.

Further development of the system provides for its integration with international standards and the improvement of stock management mechanisms, taking into account best global practices.

The restoration of state market surveillance of non-food products in Ukraine, which began on January 1, 2025, represents an important stage in regulating the import of petroleum products. The key requirements for the unimpeded import of fuel include compliance with the Technical Regulation, the availability of a declaration of conformity, and a quality certificate marked with a conformity symbol. The study of this issue is of great importance for assessing the impact of new regulations on the petroleum products market, customs procedures, and the economy as a whole. The introduction of new requirements may lead to delays in customs clearance of petroleum products due to the need for additional inspections. According to Part 1 of Article 38 of the Law of Ukraine No. 2735-VI [20], selective sampling mechanisms may be applied, which will affect the speed of customs processing. On the one hand, this contributes to improving fuel quality and consumer safety; on the other hand, it creates potential barriers for importers due to the need to comply with the new requirements.

An important aspect is the efficiency of customs procedures and the adaptation of businesses to updated regulations, which requires further monitoring and analysis.

Nevertheless, such a solution will significantly reduce the cost of transportation, road congestion and shortage of diesel fuel supplies to Ukraine. The main advantage of such technology is the ability to transport diesel fuel directly from the points of departure without reloading, i.e. in a multimodal forwarding. But currently in Ukraine and the European Union this type of transportation is not sufficiently regulated and, accordingly, is not widely considered permitted, because diesel fuel is classified as dangerous goods (with a low degree of danger), the transportation of which has separate regulations.

At the same time, the transportation of diesel fuel in flexi-tanks is permitted in Australia and the countries of the Southern African Development Community (SADC) under special permits for the mining industry and agriculture both in standard containers and in grain truck bodies with a double (duplicating) layer for such flexi-tanks. Diesel fuel storage in flexi tanks is also quite common in Canada in the agricultural and mining industries.

Several companies with significant experience and relevant certificates for their products are involved in the production and supply of special flexi-tanks for transportation and storage of diesel fuel – FTS Flexi-tanks systems (Republic of South Africa), Musthane (France), Wiefferink (Netherlands) and others. That is, there is some experience in their effective production and application.

To solve the task of forming a priority version of the infrastructure framework of diesel fuel delivery schemes, various methods can be applied: both non-formalized and formalized and weakly formalized. In the previous study, we proposed an algorithm for modeling the infrastructure framework of cargo delivery schemes, which involves the application of a certain sequence of a complex of various methods [10]. The proposed algorithm involves the following sequence of stages:

1. At the stage of setting the research problem, i.e. formation of the possible options for the infrastructure framework of cargo delivery schemes, it is proposed to apply non-formalized methods (e.g. the morphological method or the collective idea generation method), as well as formalized methods (e.g. statistical analysis methods). It is at this

stage that the need to use specialized flexi-tanks for transporting diesel fuel is proven and possible options for the infrastructure framework of the scheme for delivering imported diesel fuel to Ukraine are formed.

2. At the stage of optimization, i.e. choosing a priority version for the infrastructure framework of cargo delivery schemes, it is advisable to apply formalized methods, which primarily include operations research methods (mathematical programming methods: linear, integer and dynamic programming), as well as weakly formalized methods (e.g. network planning methods and graph theory elements).

3. At the stage of analysis of the optimal variant of the infrastructure framework of cargo delivery schemes, the application of empirical methods is proposed, namely, a practical assessment of the adequacy of the obtained result.

The proposed algorithm can also be applied in this case to form the infrastructure framework of the diesel fuel delivery scheme.

Conclusions. Modern conditions require effective transport and technological solutions to substantiate the variants of schemes for the petroleum products delivery to Ukraine, in particular diesel fuel. The possibility and advantages of applying specialized reusable flexi-tanks for transporting diesel fuel in containers are proven. An algorithm for forming the infrastructure framework of diesel fuel delivery schemes is proposed, which involves the use of a complex of various methods. The impact of recent regulatory changes on the import and customs clearance process of petroleum products has been studied. In particular, the legislative amendments introduced special control procedures for the import of fuel. These measures enhance oversight of imports and prevent the entry of sanctioned or low-quality fuel into the market, while also requiring importers to adapt to stricter rules and prepare additional documentation.

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