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Olena V. Borysiak, Doctor of Economic Sciences, Deputy Director, Education and Research Institute of Innovation, Nature Management and Infrastructure, West Ukrainian National University. Ternopil, Ukraine.
ORCID 0000-0003-4818-8068, Scopus 57219602195

Prerequisites for Developing an Information Support System for Freight Transportation of Agricultural Waste

Abstract: Developing the agricultural sector is essential for ensuring food security. The modernisation of freight logistics by applying innovative measures to the organisation of such transportation is of particular importance. The study aims to analyse and systematise the prerequisites for developing an information support system for transporting agricultural waste. The article considers the requirements for developing an information support system for freight transportation of agricultural waste. The specifics of agricultural waste transportation in terms of determining their safety level are highlighted. The ways to improve the efficiency of freight transportation are considered. Information and communication measures have been formed to enhance the efficiency of freight transportation of agricultural waste, including thoughtful freight planning and digital solutions to improve the efficiency of the vehicle fleet. Prospects for further research include studying the issue of the safety of freight transportation of agricultural waste.

Keywords: information technologies, freight logistics, transport safety, agricultural enterprises, agricultural products, vegetable oil production waste, smart freight planning, circular economy, digitalisation, automobile transport.

Introduction

Environmental responsibility in the context of agricultural development is based on the rational use of natural resources. This process includes the supply of raw materials and the production and marketing of finished agricultural products. Of particular importance in this process is the storage, transportation, and disposal of agricultural waste.

Today, information technology is used to optimise any business process. The effective use of information support by agricultural enterprises directly depends on the level of assessment of the organisational and economic conditions for its use. Because of this, an analysis of the prerequisites for developing an information support system for freight transportation of agricultural waste is an urgent issue.

The study aims to analyse and systematise the prerequisites for developing an information support system for transporting agricultural waste.

Aspects of improving freight transportation efficiency and using innovative approaches to forming supply chains based on digitalisation are the scientific community's subject of discussion and research. In particular, A. Kuzmenko, E. Komarov, I. Zhyr, I. Lesnikova, N. Khalipova and O. Shapovalov (*2023*), A. Fonseca, R. Oliveira and R. Lima (*2013*), and others analyse the optimisation of routes for the freight transportation of agricultural products by automobile transport. The use of GIS technologies for optimisation of reverse logistics routes is studied by O. Bakulich (*2022*), V. Dembitsky (*2022*), Lisandra Quintana, Marcos A. Coronado, José R. Ayala, Daniela G. Montes and Laura J. Pérez (*2023*), Taknaz Alsadat Banihashemi, Jiangang Fei and Peggy Shu-Ling Chen (*2019*), etc.

The analysis of the scientific achievements of domestic and foreign scientists shows the relevance of freight transportation in general and automobile transport in particular. Most studies focus on analysing the conditions and developing recommendations for optimising logistics flows, modelling supply chains, and improving the supply chain management system. At the same time, the study of the prerequisites for integrating information technology into the transportation system of dangerous goods in the agricultural sector remains an open issue.

Methods

The methodological basis of the study is the following general and special methods:

- analysis, comparison, and synthesis to consider ways to improve the efficiency of freight transportation;
- induction and deduction to identify the specifics of transporting agricultural waste in terms of determining the level of their safety;
- dialectical cognition to study information and communication measures to improve the efficiency of freight transportation of agricultural waste, including smart cargo planning and digital solutions to improve the efficiency of vehicle fleets.

Results

Automobile transport is considered to be the most convenient type of transport for short-distance freight transportation. In terms of production in the agricultural sector, it is of particular importance to ensure a waste-free production process, which also includes issues related to minimising the negative impact on the environment during freight transportation and disposal of agricultural waste. In general, the following types of waste are distinguished: industrial waste, hazardous waste, medical waste, household waste, agricultural waste (containers for pesticides, agrochemicals, herbicides; pesticides and agrochemicals; herbicides; poisoned and spoiled grain; seeds; cake; vegetable oil; elevator waste; animal feed) (*Edible…, 2024*), etc.

In particular, vegetable oil production waste is classified as agricultural waste. According to the National Waste List, approved by the Resolution of the Cabinet of Ministers of Ukraine No. 1102 dated October 20, 2023, waste classifiers "20 01 25 – Edible Oils and Fats" and "20 01 26—Oil and Fats" other than those specified in code "20 01 25" are distinguished. The type of waste as edible oils and fats also includes vegetable oil waste, which, according to the classification, is classified as vegetable oil production waste in Section 14, "Secondary Raw Materials; Municipal and Other Waste: Group 14.2 Other Waste and Secondary Raw Materials".

In Appendix 3, "vegetable oil waste is included in the waste classification by hazard. In particular, vegetable oil production waste has such a dangerous property as ecotoxicity. Such waste is toxic to water and soil resources" (*On Approval of the Waste…, 2023*) and requires special conditions for transportation and utilisation. This necessitates compliance with environmental standards and, as a result, an increase in the efficiency of freight transportation of vegetable oil production waste. "Among the requirements is that vegetable oil waste is not worth releasing into the environment." (*On Approval of the Classification…, 2014*)

"Synchronisation of Ukraine's transport logistics system with the European transport logistics system is to optimise the transport system by addressing issues related to the modernisation of roads, creating a network of multimodal transport and logistics centres, increasing containerised cargo transportation, renewing the vehicle fleet, increasing the use of environmentally friendly and energy-efficient transport, equipping vehicles with software that minimises downtime, reduces congestion and reduces the number of vehicles per route." (*Sustainable…, 2024*)

Among the ways to solve the issue of modernising the transport logistics of freight transportation are "drawing up a route that involves collecting freight from several points; using modern vehicles; transition to the transportation of groupage freight; optimisation of loading and unloading processes." (*Boychenko, 2018*) Among the ways to improve the efficiency of freight transportation is multimodal transportation, which is "performed by two or more modes of transport, but by a single operator. Multimodal transportation includes intermodal transportation, a distinctive feature of which is the absence of a single operator responsible for transporting goods." (*Chaika-Petegirich, 2020*)

In the context of ensuring the climate neutrality of freight transportation, in particular by automobile transport, another effective method of freight transportation (especially in international transportation) used in the European Union is the interaction of automobile transport with railway transport through counter-railway connections.

Improving the efficiency of freight transportation of agricultural waste necessitates an integrated approach to analysing organisational and economic factors. An open issue is ensuring the interaction of automobile transport with vehicles by type on the route. Among such problems are "cargo safety, unloading, and work with terminal operators." (*Bolzhelarsky et al., 2022*)

Considering the issue of increasing the efficiency of freight transportation of vegetable oil production waste, among the organisational components, and the choice of vehicle and vehicle interaction, the direct method of forming a logistics route (ring, pendulum, delivery and collection) is essential. For long-distance transport of goods by road, "pendulum routes are used. The use of these routes is due to the need to simultaneously send goods to customers located in different cities of the country. The main disadvantage of this type of route is empty runs during the return journey, which significantly increase the cost of the transportation process." (*Chaika-Petegirich, 2020*) As a result, it is economically feasible to use the pendulum route, provided that the freight is loaded on the way back.

Because of this, it is proposed, as an alternative to the pendulum route, to use a "distribution and collection route, which allows achieving an economic effect by reducing the number of rolling stock units and reducing the total mileage per trip in both directions of the transport

company's trucks. The use of a distribution and collection route is characterised by the fact that other freight is loaded simultaneously at the same points when unloading freight. It is a combination of the two above routes." (*Litvinona & Baranovskyi, 2020*)

The tasks related to developing the road network in terms of harmonising conditions for international transport, namely "harmonisation with European standards of road transport," (*National Transport Strategy…, 2018*) are of great importance for agricultural enterprises.

In this context, to improve the efficiency of freight transport in Ukraine, it is of particular importance to apply the global practice of transition to multimodal transport as a component of sustainable mobility. The European Union has developed White Papers (the first in 1996, the second in 2001, and the third in 2011) to formulate a standard transport policy.

Because of this, one of the ways to improve the efficiency of freight transportation of agricultural waste is to use multimodal transportation, which involves container transport. The organisational and economic prerequisites for the feasibility of using such transport by the company are based on the analysis of the provisions of the National Transport Strategy of Ukraine for the period up to 2030, which identifies the expansion of the multimodal transport network as one of the priority areas for reforming the transport sector of Ukraine.

"The interaction of vehicles (automobile and railway) determines the possibility of forming optimal supply chains in domestic and international traffic. Formation of supply chains based on the interaction of automobile and railway transport minimises transport costs and creates conditions for further development of supply chains and transport technology systems." (*Shramenko et al., 2021*) As a result, the global trend in freight transportation is to increase the role of multimodal freight transportation, considering organisational and economic factors to improve the efficiency of freight transportation of agricultural waste. The characteristic features of multimodal freight transportation that are worth considering by an enterprise are "the use of two or more vehicles, a unified tariff rate, and the presence of a single operator responsible for the entire process of transportation to the final destination." (*Pron, 2021*)

On this path, "the formation of an innovative transport policy by considering modern requirements for the transport of goods is promising" (*Pron, 2021*). Another challenge is "limited resources of transport modes and transport safety" (*Pysarchuk & Konrad, 2020*). Because of this, the urgent tasks for agricultural enterprises are to ensure the most favourable conditions for introducing multimodal freight transportation by considering the factors of influence of martial law in Ukraine and the need for decarbonisation of transport.

In turn, implementing sustainable development principles and transitioning to carbon neutrality requires innovative approaches to producing and supplying agricultural raw materials and direct production, storage, transportation, and marketing of farm products. Such approaches should be based on circular resource use and digitalisation principles. Scientists (*Optimizing cargo delivery…, 2024*) highlight the importance of using GIS technologies to form reverse routes. The table presents information and communication measures to improve the freight transportation process of agricultural waste (*Table 1*).

In the context of considering the issue of organising the working conditions of a logistician at an agricultural enterprise, it is valuable to consider the possibilities of using TIP Insight Digital Services, which increases "the competitiveness of transport companies through online monitoring, which will provide improved decision-making and connected work, namely:

- FleetRadar is TIP's interactive self-service fleet management platform for all our customers;
- FleetConnected is a telematics system for live visibility and connectivity;
- FleetAdmin is TIP's customer registration software;
- TIP Vehicle Inspection is a mobile application for damage management." (*TIP…, 2024*)

To prevent climate change, more and more logistics companies worldwide are implementing environmental solutions to preserve biodiversity and prevent climate change. To improve the efficiency of freight transportation of agricultural waste, it is valuable to consider the international experience in improving logistics services in the context of the transition to climate neutrality.

Among the measures to reduce carbon emissions, the Chinese logistics company SF focuses on reducing energy consumption in transport through intelligent planning of transport routes, promoting electronic delivery confirmation (POD), photo uploading and paperless document management, increasing the construction of photovoltaic equipment in green industrial parks and increasing the share of clean energy use, diversifying green transport, and establishing the "SF carbon-neutral forest", for offset carbon emissions and the use of green packaging.

"As a pioneer of environmental and low-carbon transformation in the industry, SF has established a digital intelligent carbon management platform, which consists of carbon accounting, carbon targets, asset management and other parts covering packaging, transportation, transit, delivery and other processes, with a total of more than 120 indicators in more than 60 typical scenarios. The platform can calculate the end-to-end carbon footprint of businesses in real-time, enabling real-time monitoring of carbon targets. The four main functional sections of "identifying emission sources, setting emission factors, quantifying greenhouse gas emissions, and reducing emissions" are complete, reasonable, and accurate. Thus, it can perfectly meet SF's greenhouse gas inventory needs." (*2022 S.F., 2023*)

Conclusion

Today, the use of services and goods is viewed through the prism of the speed of their delivery directly to the end consumer, namely, effective supply chain management. In this regard, the assessment of cargo safety, selection of vehicles, ensuring interaction between them and determining the most efficient route for the transportation of agricultural raw materials and finished agricultural products, as well as agricultural waste, are particularly important for the agriculture sector.

Automobile transport is the most common type of vehicle used to transport various goods. In the production logistics of the agricultural sector, special attention is paid to transport support for the uninterrupted supply of raw materials, delivery of finished products to the end consumer, and the transportation of agricultural waste. An urgent issue is improving the efficiency of freight transport of agrarian waste by road based on information technology. This involves applying an integrated approach to forming a logistics system, including an analysis of the characteristics of the cargo, including determining the level of its safety for transportation, selecting the most economically and environmentally feasible types of vehicles, ensuring a harmonious interaction between them to reduce downtime during unloading and loading operations, and directly forming the optimal logistics route, considering road conditions.

Thus, transporting agricultural waste requires consideration of a set of conditions for its safety. Information support for freight transportation of agrarian waste is significant for the prompt collection, analysis, systematisation of factors and effective decision-making. This necessitates further research to focus on the issue of the safety of freight transportation of agricultural waste in general and automobile transport in particular as the most common way of transporting goods within Ukraine during military operations.

Conflict of Interest

The author declares that there is no conflict of interest.

Reference:

2022 S.F. Holding Sustainability Report. (2023). *S.F. Express*. https://www.sf-express.com/uploads/2022_0f4ba3b56a.pdf

Bakulich, O. (2022). *Study of environmental safety of traffic flows. Scientific and technical research in transport: A collective monograph* (pp. 45–76). [Academy of Technical Sciences of Ukraine]. Ivano-Frankivsk: Publisher "Kushnir H.M.". (In Ukr.). https://ukrtsa.org.ua/wp-content/uploads/2024/04/transport1-45-76.pdf

Bolzhelarsky, J., Grevtsov, S., & Sannitsky, N. (2022). Combined transport in the logistics system of the European Union and Ukraine. *Railway Supply*. https://www.railway.supply/uk/kombinovani-perevezennya-ta-%D1%97h-miscze-u-transportnij-logistichnij-sistemi-%D1%94vrosoyuzu-ta-ukra%D1%97ni/

Boychenko, M. V. (2018). Problems of transport logistics of freight transport in Ukraine. *Bulletin of Economic Science of Ukraine*, *2*, 22–26. (In Ukr.). http://www.venu-journal.org/download/2018/2/04-Boichenko.pdf

Chaika-Petegirich, L. B. (2020). Multimodal and intermodal freight transport in the system of international transport logistics. *Scientific Bulletin of Uzhhorod National University. Series: International Economic Relations and the World Economy*, *33*, 2. (In Ukr.). https://doi.org/10.32782/2413-9971/2020-33-41

Dembitskyi, V. (2022). *Study of energy performance of vehicles with electric drive. Scientific and technical research in transport: A collective monograph* (pp. 77–114). [Academy of Technical Sciences of Ukraine]. Ivano-Frankivsk: Publisher "Kushnir H.M.". (In Ukr.). https://ukrtsa.org.ua/wp-content/uploads/2024/04/transport1-77-114.pdf

Edible oils and fats. (2024). *Ecological Investments*. https://ecological.investments/xarchovi-oliyu-ta-zhiri.html

Fonseca, A. G., Oliveira, R. L., & Lima, R. S. (2013). Structuring reverse logistics for waste cooking oil with geographic information systems. *CUPUM 2013: Conference papers*. https://cupum2013.geo.uu.nl/download/usb/contents/pdf/shortpapers/153_Fonseca.pdf

Lesnikova, I., Khalipova, N., Kuzmenko, A., Zhyr, S., & Shapovalov, O. (2023). Optimisation of transport and technological scheme of transportation of agricultural products in special conditions of Ukraine. *Systems and Technologies. 65*(1), 111–123. (In Ukr.). https://doi.org/10.32782/2521-6643-2023.1-65.14

Lisandra Quintana, Marcos A. Coronado, José R. Ayala, Daniela G. Montes, & Laura J. Pérez. (2023). Waste vegetable oil collection: a comprehensive logistics system for sustainable and efficient resource recovery. *Journal of Material Cycles and Waste Management, 26*(12). https://doi.org/10.1007/s10163-023-01832-3

Litvinona, Y. V., & Baranovskyi, O. D. (2020). Search and substantiation of ways to improve the efficiency of transportation of containerised piece cargo. *Science and Transport Progress*, *5*(89), 22–31. (In Ukr.). https://doi.org/10.15802/stp2020/217765

On Approval of the Classification of Types of Cargo. (2014). Order of the State Statistics Service of Ukraine No. 25, dated February 04, 2014. (In Ukr.). https://zakon.rada.gov.ua/rada/show/v0025832-14#Text

On Approval of the Waste Classification Procedure and the National Waste List. (2023). Resolution of the Cabinet of Ministers of Ukraine No. 1102, dated October 20, 2023. (In Ukr.). https://ips.ligazakon.net/document/KP231102?an=1

Optimizing cargo delivery: Practical tips for safe and efficient transportation. (2024). *Tip Group*. https://www.tip-group.com/en/knowledge/optimizing-cargo-delivery-practical-tips-safe-and-efficient-transportation

Pron, S. V. (2021). Study of global trends in multimodal transport. *Market Infrastructure*, *54*, 20–24. (In Ukr.). http://www.market-infr.od.ua/journals/2021/54_2021/6.pdf

Pysarchuk, O. O., & Konrad, T. I. (2020). The technology of automated traffic control in a multimodal transport network. *Electronics, Telecommunications and Radio Engineering*, *48*(4), 451–459. https://doi.org/10.18372/2310-5461.48.15128

Shramenko, N., Shramenko, V., & Solarov, O. (2021). Analysis of the freight transportation market of Ukraine. *Modern Technologies in Mechanical Engineering and Transport*, *1*, 30–35. (In Ukr.). http://nbuv.gov.ua/UJRN/ctmbt_2021_1_7

Sustainable Logistics Strategy for Ukraine until 2030. (2024). Ministry of Ukraine's Infrastructure. (In Ukrainian). https://mtu.gov.ua/files/Logistics.pdf

Taknaz Alsadat Banihashemi, Jiangang Fei, & Peggy Shu-Ling Chen. (2019). Exploring the relationship between reverse logistics and sustainability performance. *Modern Supply Chain Research and Applications, 1*(1). https://www.emerald.com/insight/content/doi/10.1108/mscra-03-2019-0009/full/html

TIP Insight Digital Services. (2024). *Tip Group*. https://www.tip-group.com/en/digital-services

National Transport Strategy of Ukraine for the Period up to 2030. (2018). Order of the Cabinet of Ministers of Ukraine No. 430-p, dated May 30, 2018. (In Ukr.). https://zakon.rada.gov.ua/laws/show/430-2018-%D1%80#Text

Appendix

Table 1. Information and communication measures to improve the efficiency of freight transportation of agricultural waste

Event Name	Characteristics of the Event
Smart freight planning	Before any freight is shipped, plans must be made. A review of the destination and route of the shipment helps companies assess potential difficulties that may arise during transport. This includes possible road closures, traffic jams, or bad weather. By planning ahead, e.g., adjusting delivery times, using alternative routes or taking extra security measures, businesses can be well prepared for disruptions and ensure on-time delivery.
Digital solutions to improve vehicle fleet efficiency	Digital solutions can help ensure smooth deliveries and inform companies about their loads. Trailer telematics uses technology and software linked wirelessly to sensors on trailers to generate data that allows fleet managers to maximise ROI and uptime and minimise the total cost of trailer ownership. Trailer telematics data gives operators more information so they can make better decisions. It also provides greater real-time transparency into all aspects of the trailer, from the condition of its mechanical components and the need for preventive maintenance to its journey and the freight it carries as it moves through the supply chain to final delivery.

Source: based on (*Optimizing…, 2024*).