

**УДОСКОНАЛЕННЯ ЗАЛІЗНИЧНИХ ПЕРЕВЕЗЕНЬ ЗЕРНОВИХ
ВАНТАЖІВ В УКРАЇНІ НА ОСНОВІ ПРИНЦИПІВ ЛОГІСТИКИ
СПІЛЬНОГО КОРИСТУВАННЯ**

**IMPROVEMENT OF RAILWAY TRANSPORTATION OF GRAIN
CARGOES IN UKRAINE BASED ON THE PRINCIPLES OF SHARED
LOGISTICS**

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Grain logistics in Ukraine plays a crucial role in global food supply and ensuring world food security. Ukraine, which is considered one of the largest producers and exporters of grain crops, has a huge potential to ensure stable supplies of grain to the world market [1]. According to data from the World Trade Organization (2022) Ukraine is the main world exporter of wheat and provides 9% of the world market. It also accounts for 42% of the world sunflower oil market and 16% of world corn production. Countries in Africa and the Middle East are the most dependent regions, as they import more than 50 percent of their grain needs from Ukraine. Under such conditions, grain logistics in Ukraine becomes even more important in the context of a full-scale Russian war against Ukraine. Taking into account armed Russian aggression, the improvement of grain logistics becomes a necessity to ensure the uninterrupted functioning of food supplies and food security of the world. In the conditions of massive missile attacks on the railway infrastructure and limited capacity of the network, it is important to use flexible transportation technologies that will allow speeding up the transportation of grain cargoes in difficult operational conditions.

One of the ways to provide the grain cargo transportation system of Ukraine with significant flexibility of operations and the speed of movement of shipments is the hybridization of the existing "hub-and-spoke" transportation model with "point-to-point", which can be based on transportation technologies that allow combining groups of wagons to form block trains destined for the unloading station at the first stages of transportation process. This will allow speeding up movement and reducing the costs transporting wagon and group shipments by eliminating irrational

transformations that occur on the route following the option of sending these wagons as a Single Wagon load (SWL) shipment [2, 3]. One of the well-known transportation technologies is the formation of staged routes based on the principle of ridesharing. This model of transportation corresponds to the principles of the sharing economy [4]. In order to achieve a network effect, which is important for building any ride-sharing service, it is proposed to consider the creation of a digital aggregator platform that will allow combining wagon shipments into a staged route by increasing the load of grain batches to 15-25 wagons from different senders who want to send the grain to nearby stations during coincident calendar periods for the possibility of booking a seat in a staged route (a train of 45-55 wagons). The analysis of transportation services based on the principles of ridesharing proved its effectiveness in the fields of motor transport and aviation. In order to study the possibility of using the ride-sharing service for a group of shippers for the organization of staged routes trains (SRT) on the railway network of Ukraine, a study was conducted on the impact of changes in transportation patterns of grain cargoes on the macro indicators of the railway system [5].

In the study, the impact of utilizing a ridesharing service on the functioning of the railway system was investigated based on game theory. It is proposed to formalize the formation of a stage train and its movement during peak load periods in the form of coalitions in cooperative congestion games. It is proposed to investigate how a coalition of shippers' combinations changes the quality of solutions obtained in competitive games [6]. It is worth studying the impact of the change in the transportation model on the railway system, calculating the price of anarchy in order to estimate the cost of the lack of coordination in the railway system when transporting grain cargoes with the quality of centrally optimal planning.

A comparative analysis of the price of anarchy values for the "low season" and "high season" of grain transportation showed an insignificant effect of the change in the transportation model on the efficiency of the railway system. The application of the transportation model with the formation of staged route trains based on the principles of ridesharing leads to greater changes in the railway system efficiency in the "high season" of transportation. Such results can be explained by the weaker interdependence of train flows at the landfill, which is a bottleneck on the railway network. In the conditions of stable train movement in the "free flow" mode, the shippers' utility function before the formation of coalitions is significantly reduced as the dispatch according to the selfish scenario does not lead to an increased delay in the duration of the movement, which does not cause the complication of the transportation process. However, if we compare the costs of the average wagon-hours per shipment in the model of transportation with SRT - 394.89 wagon-hours with the similar costs under the current model SWL - 857.75, then the profitability is 2.17 times higher for staged routes. This proves the effectiveness of the hybrid transportation model even in the absence of high demand for transportation and the instability of train traffic. Based on the solution of the bimatrix game in pure strategies, it has been demonstrated that the winning strategy is the application of a digital aggregator platform for coordinating coalitions, aligning transport plans with

the carrier, thereby reducing inefficient railcar downtimes and enhancing the reliability of transportation.

For the practical implementation of the obtained results within the scope of the study, requirements for the digital aggregator platform have been developed to facilitate swift planning of mixed transport of grain cargoes.

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- [1] Center for Transport Strategies. Cargo flows of Ukrainian ports. Main trends. https://cfts.org.ua/infographics/gruzopotoki_portov_ukrainy__2021
- [2] European Commission. (2015). Study on Single Wagonload Traffic in Europe – challenges, prospects and policy options. Final report. <https://transport.ec.europa.eu/system/files/2017-02/2015-07-swl-final-report.pdf>
- [3] JSC Ukrzaliznytsia. (2021). The procedure for directing wagon flows and organizing them into freight trains for 2021-2022 (train formation plan). https://www.uz.gov.ua/cargo_transportation/general_information/formuvannia/
- [4] DHL. (2017). Sharing economy logistics. Rethinking logistics with access over ownership. <https://www.dhl.com/discover/content/dam/dhl/downloads/interim/preview/updates/dhl-trend-report-sharing-economy-preview.pdf>
- [5] A. Prokhorchenko, M. Kravchenko and A. Prokopov, "Improvement of railway logistics of grain cargo on the basis principles of ridesharing / Thesis of XIII international scientific and practical conference «Globalization of scientific and educational space. Innovations of transport. Problems, experience, prospects.»,"(Vlora may 21-26, 2021). Thesis. – Vlora. 2021. P. 63.
- [6] Kravchenko, M., Prokhorchenko, A., & Zolotarov, S. (2023). Mathematical model of a railroad grain cargo ridesharing service in the form of coalitions in congestion games. Eastern-European Journal of Enterprise Technologies, 5(3 (125), 35–48. <https://doi.org/10.15587/1729-4061.2023>