Bottleneck effect of maritime logistics of exports from Ukraine

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Introduction

The imperatives of Elijah Goldratt's theory of system constraints are a tool for identifying the bottleneck effect of maritime logistics of exports from Ukraine in the conditions of today's war.

The closure of land border transportation for agricultural exports of Ukraine through the neighboring countries of Poland and Hungary based on the policy of their internal protectionism led to the overloading of existing logistics routes according to the schemes of transportation by sea vessel to the ports of Romania (Constanta) and Moldova (Giurgiulesti): "road transport-sea port-vessel", "river port-transshipment on a raid-vessel", "river port-railway-sea port-vessel" and caused crisis indicators of such indicators of the efficiency of supply chains as: avoiding queues and stagnation, increasing throughput; full power and minimize waiting.

Despite the described bottle-neck effect for maritime logistics of exports from Ukraine, the diffusion of this effect is evident only in the case of the formation of the Value Stream Creation Map, which demonstrates the stages of increasing the cost of exports from Ukraine based on restrictions imposed on logistics routes, and inflationary processes based on the increase in the price of goods from other countries that replace Ukrainian exports.

Purpose

prove the existence of a bottleneck effect of maritime logistics of exports from Ukraine in the conditions of the current war based on the imperatives of Eli Goldratt's theory of constraints and a negative diffuse effect

Tasks:

1. Consider the principles of Goldratt's theory of limitations and identify common methodological principles with the design of maritime export logistics systems;
2. Form restrictions of the maritime export logistics system in wartime conditions;
3. Identify the key limitation of the appearance of the bottleneck effect of maritime logistics of Ukraine's exports in modern conditions;
4. Determine the consequences of the manifestation of this effect.

The research is conducted within the framework of
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Methodology

Methods used: literature analysis, statistical data, visualizations and analytical mapping.

The research used: statistical materials of the *Administration of Seaports of Ukraine* with an emphasis on 2021 (the beginning of the war) - 2023 (the realities of today) to reflect the volume of exports and the number of ports involved; *Marinetraffic* information resource to visualize and map the bottleneck effect caused by the blockade of seaports and wartime logistical traffic jams.
Tabular layouts, schematic mapping of the interaction of elements and organizational processes were used to present the data.

Table 1. The volume of cargo turnover of exports to the ports of Ukraine before the war and during the war, million tons

Port Pivdenny	Port Mykolaiv	Port Chornomorsk	Port Odesa	Port Mariupol	Port Olvia	Port Berdyansk	Port Kherson	Port Izmail	Port Reny	Port Ust-Dunaiskyi
Before the war, 2021										
53,5	29,8	25,6	22,5	6,8	5,1	1,6	0,5	3,9	1,4	0,006
During the war, 2023										
X	X	X	X	X	X	X	X	Total 4,0		
Blocked										

Sourse: https://www.uspa.gov.ua/

Map 1. Vessels in and near the port of Izmail, 12.07.23
Sourse: Marinetraffic

Map 2. Vessels in and near the port of Reny, 12.07.23
Sourse: Marinetraffic

Map 3. Vessels in and near the port of Ust-Dunaiskyi, 12.07.23
Sourse: Marinetraffic

Results

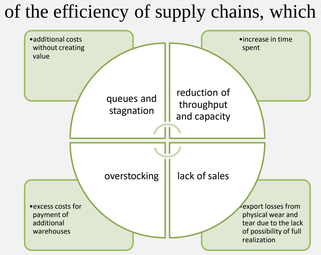
1. The following common principles of Goldrath's theory of limitations with the methodological principles of designing maritime export logistics systems have been identified, namely:

- lack of efficiency in the case of ensuring full power operation in the presence of a weak point in the chain;
- concentration on significant organizational constraints; the need to adapt to changes in the logistics environment and constant improvement and improvement of processes (especially in the challenges of war);
- rejection of suboptimal solutions and achievement of maximum optimization;
- systematic tracking and analysis of deficiencies based on mathematical modeling and information support;
- overcoming inertia and overcoming resistance to change.

2) Restrictions of the maritime export logistics system in wartime conditions have been formed, which includes the following parameters: disruption of supply chains; transition to multimodal transportation, which increases the cost of logistics services and delivery time; rapid increase in fuel prices; staff shortage and loss of seafarers due to lack of work in blocked ports; logistical traffic jams in the supply of commercial goods due to the priority of the movement of humanitarian and military cargo; low level of flexibility of large business in adapting to changes; foreign companies do not import into Ukraine, but only deliver cargo to the border; an increase in the length of the route due to the appearance of dangerous areas (mining of territories, military operations); frequent cases of cargo theft; lack of air logistics; occupation of the Azov Sea and blockade of the Black Sea; congestion of rail and road transport; additional need for specialists; the complexity of coordination to optimize fuel consumption and rational use of water transport; insufficient capacities of river logistics; the difficulty of tracking the dynamics of stock movement, fuel consumption, the reputation of carriers and the organization of loading and unloading operations; there are permit systems that make transportation difficult.

3) Based on the Value Stream Mapping method, it was established that the blockade of the sea and the transition to land transportation for exports from Ukraine across the borders of neighboring countries led to the overloading of existing logistics routes according to transportation schemes to sea ports. The reorientation of logistics routes primarily affects the state interests of transit neighboring countries and is manifested through the crisis of product competition based on price/quality criteria and manifestations of open protests by national product manufacturers.

4) The consequences of the bottleneck effect of marine logistics of Ukraine's exports have been determined, namely the crisis of the efficiency of supply chains, which is manifested in the following:



It is proven that the diffusion of this effect occurs, which causes an increase in the cost of exports from Ukraine, and an increase in the price of goods from other countries that replace Ukrainian exports, which worsens the welfare of consumers, due to the price inaccessibility of products.

Main conclusions

1. The effect of a bottleneck in maritime logistics of exports from Ukraine is the difficulty of meeting sales needs when ports are operating at full capacity and switching to multimodal transportation in wartime conditions..
2. The strengthening of this effect occurs due to the blockade of the transportation of exports from Ukraine by land to the sea through the borders of neighboring countries, which leads to overloading of existing logistics routes according to transportation schemes to sea ports. This is demonstrated by statistical data and mapping visualization. The consequences of the effect are manifested in the crisis of the efficiency of supply chains: queues and stagnation, reduced throughput and capacity, increased waiting.
3. The crisis in the efficiency of maritime supply chains causes an increase in the cost of exports from Ukraine, and an increase in the price of goods from other countries that replace Ukrainian exports, which describes the diffuse effect of inflation and crisis manifestations in the economies of countries dependent on exports from Ukraine.