Economic assessment of the cost of reducing the delivery time for cargo owners when sending goods through the international transport corridor “North-South”

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Abstract. Purpose: substantiation of the author's methodology for assessing the economic effect of saving time in supply chains, analysis based on the proposed methodology for saving time of commodity producers when sending goods from St. Petersburg (North-Western Federal District of Russia) to India, the cargo is sent along the eastern branch of the international transport corridor “North-South” to compared with the option of delivery via the “deep sea” technology via the Mediterranean Sea and the Suez Canal. Methods: economic modeling, statistical parameterization, analysis and optimization of supply chains. As a result of the conducted research: the parameters of cargo shipments from the North-Western Economic District, the region of the St. Petersburg agglomeration to India for five different delivery options are systematized; the author's methodology for assessing the economic effect of saving time is disclosed, on the basis of which the effects of saving time for goods sent to India from St. Petersburg are determined, when switching from the “deep sea” supply option to the “North-South” multimodal eastern route option. Conclusion: as a result of the study, high-yield cargoes were identified, in particular, pulp, paper, metal structures, the dispatch of which from Russia to India via the international transport corridor is economically attractive, since the effect of saving time overrides the higher cost of delivery.

1 Introduction

The economic assessment of the cost of time, saving time is an important area of research in transport logistics. The economic category of time, unlike many other traditional scientific categories, is still insufficiently studied. Attempts to estimate the time savings have been made repeatedly. At the same time, there is still no generally accepted methodology to assess the economic effect of saving time while reducing the delivery time with an alternative proposed route, delivery channel.
Within the framework of the material prepared in the article, the author makes an attempt to present his vision regarding the methodological foundations of saving time through an assessment of the cost of reducing the financial cycle of cargo owners.

The purpose of the article is to substantiate the author's methodology for assessing the economic effect of saving time in supply chains, an analysis based on the proposed methodology for saving time of commodity producers when sending goods from St. Petersburg (North-Western Federal District) to India when delivered via the eastern branch of the international transport corridor “North-South” in comparison with the option of delivery using the “deep sea” technology through the Mediterranean Sea and the Suez Canal.

2 Materials and methods

The research is based on statistical data of the Eurasian Economic Union, container freight indexes of China Containerized Freight Index [11], statistical data of Rosstat, various analytical agencies (in particular, InfraONE), data of Russian railways, railways of Iran, Turkmenistan, Kazakhstan.

The scientific methodology, the use of which helped the author to come to his own methodology for assessing the economic effects of saving time, is presented in the works of: L.M. Chechenova [1], M. Drozdova, O. Pokrovskaya, A. Safronova [2], I.V. Fedoseev, M.N. Yudenko, A.A. Salov, K.A. Grigoriev, K.A. [3], I. Gulyi, V. Shavurskaya [4], L.F. Kazanskaya [5], K.E. Kovaleva, Yu.E. Galkina [6], N.A. Zhuravleva [7, 9], E.M. Volkova [8].

3 Evaluation of options for the supply of goods from St. Petersburg to India

Currently, goods from St. Petersburg to India can be shipped via 5 different delivery routes: via Novorossiysk, the Black Sea, the Mediterranean Sea and the Suez Canal; via the Baltic Sea, the Mediterranean Sea and the Suez Canal (it is the main one), along the routes of the international transport Corridor (ITC) “North-South” western route via Astara; ITC “North-South” trans-Caspian route via Amirabad; ITC “North-South” eastern route via Serakhs. The main delivery option via the Suez Canal is shown in Figure 1.

Fig. 1. The traditional route of delivery from St. Petersburg to India via the Suez Canal. Source: made by authors.
Figure 2 clearly shows three alternative routes for the supply of goods from St. Petersburg to India via the “North-South” international multimodal corridor.

Fig. 2. Cargo delivery routes along the international transport corridor “North-South” from the North-West of Russia (St. Petersburg) to the ports of India. Source: made by authors.

Table 1 shows the delivery parameters (distance, average time, cost per unit of a 40-foot container) of delivery according to the 5 indicated alternative options.

Table 1. Comparative analysis of the routes of ITC “North-South” and alternative routes (direction: St. Petersburg - Nova Sheva) (data as of March 2023)

<table>
<thead>
<tr>
<th>Route</th>
<th>Distance, km</th>
<th>Delivery time, days</th>
<th>Cost, USD per 40DC (40-foot equivalent - FEU)</th>
<th>Cost, USD per 1 metric ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>International Transport corridor «North-South», western route via Astara</td>
<td>7500</td>
<td>30</td>
<td>8300</td>
<td>415</td>
</tr>
<tr>
<td>International Transport Corridor «North-South», Trans-Caspian route via Amirabad</td>
<td>7300</td>
<td>32</td>
<td>8500</td>
<td>425</td>
</tr>
<tr>
<td>International Transport corridor «North-South», eastern route via Serakhs</td>
<td>9055</td>
<td>20</td>
<td>8353</td>
<td>418</td>
</tr>
<tr>
<td>Route through Novorossiysk</td>
<td>10700</td>
<td>28</td>
<td>5800</td>
<td>290</td>
</tr>
<tr>
<td>Route through the Baltic Sea, the Mediterranean Sea and the Suez Canal</td>
<td>14000</td>
<td>40</td>
<td>2500</td>
<td>125</td>
</tr>
</tbody>
</table>

Source: [11].

According to Table 1, we see the disadvantages and advantages of deliveries by routes. The advantages of deliveries via the Suez Canal are associated with the low cost of transportation.

The disadvantage of cargo shipments via the North-South ITC in comparison with the delivery options via the Suez Canal is currently the higher cost of transportation, which, according to the delivery option via Serakhs, is about $8.5 thousand per 40-foot container. But, at the same time, ITC “North-South” has an advantage: the reduction in delivery time, which,
in particular, along the eastern branch of the route, is 20 days. The eastern branch of the corridor has the greatest potential for cargo traffic growth. At the same time, the increase in cargo traffic by 2030 is expected to be tenfold due to the great interest of the participating countries of the North-South ITC and the EAEU in the development of supplies through the specified multimodal corridor.

The cargo owner, the shipper, when making a decision on deliveries under the North-South ITC, must understand its economic benefit (economic effect) caused by time savings. Since, in terms of the cost of transportation, delivery via the North-South ITC is not a benefit in terms of the cost of transportation in comparison with the delivery of the deep sea.

4 Methodology of economic evaluation of time savings in supply chains

We will evaluate the economic advantages of deliveries via the North-South ITC routes in comparison with the options for deliveries via Novorossiysk; the route through the Baltic, Mediterranean Seas and the Suez Canal (through a monetary estimate of the cost of saving time based on a reduction in financial and operational cycles).

We will perform all calculations for the option of shipments via the North-South ITC via the waste branch (where the delivery time is the shortest among all three routes of the ITC) in comparison with deliveries through the waters of Europe, the Mediterranean Sea, the Suez Canal and further to the ports of India.

Using the example of typical container shipments of products (the most widespread commodity groups) from St. Petersburg to India, we will assess the savings effect for Russian cargo owners, shippers-exporters based on a typical container shipment from St. Petersburg to India.

The reduction in delivery time compared to the route via the Suez Canal is at least 20 days (when shipping via the Serahs).

The estimate of the time saving effect (E) in US dollars for one 40-foot container equivalent (FEU) is calculated according to formula 1:

\[ E = \frac{20}{365} \times R_{BR} \times 100 + \frac{C_{cargo}}{t_{fc}} \times 20 \times R_{S}/100, \]  

where 20 (days) – saving time in days; \( R_{BR} \) – the key rate of the Bank of Russia (%); \( C_{cargo} \) (US dollars) – the average cost of export cargo from the stations of the Oktyabrskaya Railway (cargo: a specific option) in a container (FEU), US dollars; \( t_{fc} \) – the duration of the financial cycle production of a specific product; \( R_{S} \) – profitability of sales of a specific production on average for companies (in the region).

The value of the \( C_{cargo} \) is determined by the website of the Economic Commission for Europe (section statistics – statistics of foreign trade [3]).

Further, to determine the \( C_{cargo} \), it is necessary to multiply the average price of the exported goods by the average weight of the cargo in a 40-foot container (we accept 25 tons) (formula 2):

\[ C_{cargo} = P_{goods} \times Q_{cont}, \]  

where \( P_{goods} \) is the price of the goods [10], \( Q_{cont} \) is the weight of the cargo (goods) in the container.

The value of the Central Bank of Russia will be determined by the dynamics of the amount of the key rate of the Bank of Russia is (currently it is 7.5% per year, despite the fact that in September temporarily 15% per year).

The duration of the financial cycle of production and sale of goods \( t_{fc} \) (in days) is determined by the formula 3:
\[ t_c = \frac{365}{(SR/AE)} + \frac{365}{(SR/S)} - \frac{365}{(SR/AP)}, \]  
\[ \text{where SR is revenue (net) from the sale of goods, products, works, services (excluding value-added tax, excise taxes and other similar mandatory payments); S is inventory; AP is accounts payable; AR is debited debt.} \]

We will generate all the indicators through the Internet resource of statistical information EMISS fedstat.ru [12]. In the search, we select the appropriate indicators (type of activity: the corresponding type of activity in accordance with the table; territory: the Russian Federation or the North-Western Federal District as the region of activity of the Oktyabrskaya Railway, on a larger part of the territory; year 2022, the period January-December).

The profitability of sales of a particular production on average for companies (in the region) RS (in %) is determined by the formula 4:

\[ RS = \frac{P}{SR} * 100, \]

where P is profit (loss) from sales; SR is revenue (net) from the sale of goods, products, works, services (minus value added tax, excise taxes and other similar mandatory payments).

Table 2 shows the parameters of the author's assessment of the time-saving effect for the most common goods delivered from Russia to India (according to data for 2021).

**Table 2.** Estimated parameters for estimating the cost of saving time for various cargoes delivered from St. Petersburg to India in 40-foot containers according to the North-South ITC in comparison with the deep sea option

<table>
<thead>
<tr>
<th>Product group</th>
<th>Product price, USD</th>
<th>The cost of cargo in a container, USD per 1 FEU</th>
<th>Return on sales, %</th>
<th>Duration of the financial cycle, days</th>
<th>Time savings, USD per 1 FEU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newspaper paper in rolls or sheets</td>
<td>404.0</td>
<td>10099</td>
<td>21.2</td>
<td>48</td>
<td>934</td>
</tr>
<tr>
<td>Metal structures made of ferrous metals</td>
<td>39912.1</td>
<td>997802</td>
<td>8.0</td>
<td>61</td>
<td>30219</td>
</tr>
<tr>
<td>Wood pulp, sodium or sulfate</td>
<td>659.8</td>
<td>16496</td>
<td>24.5</td>
<td>32</td>
<td>2616</td>
</tr>
<tr>
<td>Longitudinally sawn timber</td>
<td>456.8</td>
<td>11420</td>
<td>3.8</td>
<td>35</td>
<td>292</td>
</tr>
<tr>
<td>Lye (from the production of wood pulp)</td>
<td>455.4</td>
<td>11384</td>
<td>24.5</td>
<td>32</td>
<td>1805</td>
</tr>
<tr>
<td>Plywood glued</td>
<td>861.9</td>
<td>21546</td>
<td>13.0</td>
<td>38</td>
<td>1572</td>
</tr>
<tr>
<td>Initiators, accelerators and catalysts of chemical reactions</td>
<td>2097.1</td>
<td>52427</td>
<td>21.0</td>
<td>28</td>
<td>8147</td>
</tr>
<tr>
<td>Kraft paper and kraft cardboard are unmeeled</td>
<td>758.2</td>
<td>18955</td>
<td>21.2</td>
<td>48</td>
<td>1753</td>
</tr>
<tr>
<td>Lumber</td>
<td>1023.9</td>
<td>25598</td>
<td>3.8</td>
<td>35</td>
<td>654</td>
</tr>
<tr>
<td>Seeds of anise, star anise, fennel, coriander, cumin, juniper berries</td>
<td>738.5</td>
<td>18462</td>
<td>19.4</td>
<td>306</td>
<td>310</td>
</tr>
<tr>
<td>Parts of rolling stock</td>
<td>1195.5</td>
<td>29886</td>
<td>7.2</td>
<td>95</td>
<td>576</td>
</tr>
<tr>
<td>Soft roofing materials</td>
<td>407.1</td>
<td>10178</td>
<td>26.9</td>
<td>113</td>
<td>528</td>
</tr>
<tr>
<td>Wood semi-cellulose</td>
<td>376.3</td>
<td>9408</td>
<td>24.5</td>
<td>32</td>
<td>1492</td>
</tr>
<tr>
<td>Other wooden products</td>
<td>957.3</td>
<td>23932</td>
<td>2.3</td>
<td>92</td>
<td>218</td>
</tr>
<tr>
<td>Dried legume vegetables</td>
<td>568.9</td>
<td>14223</td>
<td>10.2</td>
<td>129</td>
<td>284</td>
</tr>
</tbody>
</table>

Note: One FEU is one 40–foot container; the average price of the exported goods is determined based on data for 2021; the remaining calculated parameters are determined based on data for 2022. Source: calculated by the author on the basis of the above methodology.
The estimated values of the effect of saving delivery time by 20 days for deliveries from St. Petersburg to India in a 40-foot container of various goods are differentiated in the range from 219 to 30219 US dollars (based on 1 unit of a 40–foot container). Thus, the higher cost of delivery via the international North-South corridor (eastern branch) in comparison with shipments via the Suez Canal by sea for many goods is not covered by the economic effect of saving time. At the same time, for such goods as metal structures, cellulose, cellulose, kraft paper, the savings effect is noticeable. Here it can be said that cargo owners of such goods can be economically motivated to increase shipments precisely along the international transport corridor “North-South”. When taking measures to further reduce the cost of shipments via the North-South ITC, one can count on the transfer of high-yield cargo owners to shipments mainly along the eastern branch of the ITC in comparison with the deep sea shipping option.

5 Discussion

Estimating time savings remains a challenging scientific task. In logistics, the correct assessment of the economic effect of reducing the delivery time is an important element of cargo flow planning for various alternative variants of multimodal freight transportation.

The method of economic evaluation of time savings in supply chains proposed by the author is based on the determination of the savings of companies in industry and trade, the assessment of the potential additional profit of these companies by accelerating the turnover of financial resources, increasing the speed of shipments.

Further development of the author's methodology can be based on obtaining indirect effects associated with the generation of companies due to an increase in the turnover of assets, an increase in the volume of sales of goods, inter-industry effects, the effects of accelerated investment, import substitution effects and export growth, and others.

6 Conclusion

The performed research allows us to conclude that the shipper, the cargo owner, when deciding on the choice of a specific delivery option, should be guided not only by calculations of the optimal route, from the point of view of the cost of delivery, but also to evaluate other parameters, in particular, with shorter delivery times - to evaluate time savings.

The method of economic evaluation of the cost of saving time proposed in the work is an important element of the entire system of economic evaluation of freight transportation within the framework of the formation of multimodal transport routes.

Within the framework of the application of the methodology proposed by the author, it was found that it is economically more expedient to deliver certain high-yield cargoes (pulp, paper, metal structures) from Russia to India not through the technology of long-haul ocean container transportation (deep sea), but through the eastern branch of the international transport corridor “North-South”.

References

1. L. Chechenova. Lecture Notes on Data Engineering and Communications Technologiesthis link is disabled, 157, 88-101 (2023)
2. M. Drozdova, O. Pokrovskaya, A. Safronova. E3S Web of Conferences, 402, 01008 (2023)

4. I. Gulyi, V. Shavurskaya, E3S Web of Conferences, 383, 01015 (2023)

5. L. Kazanskaya, S. Rizakulov, Lecture Notes in Networks and Systems, LNNS, 402, 483–492 (2022)


8. E. Volkova, Lecture Notes in Networks and Systems, LNNS, 402, 1–9 (2022)

9. N. Zhuravleva, P. Zhitinev, Y. Anufrieva, Lecture Notes in Networks and Systems, LNNS, 402, 531-539 (2022)

10. Russia's foreign trade with countries outside the EAEU http://www.eurasiancommission.org (Last accessed 11.09.2023)
