

The Use Of An Ecosystem Approach For Tariff Formation In The Field Of Intermodal and Multimodal Transportation

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Abstract: Every day a huge amount of cargo is transported in the world, the dynamics of increasing the volume of which requires constant improvement of transportation efficiency. Intermodal and multimodal transportation is a comprehensive transport and logistics service, which is becoming an increasingly important aspect of the transport system that contributes to economic development. The tariff setting system varies greatly by mode of transport. For example, railway transport provides for regulation of tariffs for infrastructure and locomotive traction services, but the car rental rate is set by the market. Market pricing predominates on road transport, while on water transport, as a whole, it is regulated by the market. The goal of scientific work is to create a methodological approach to the formation of a unified system of tariff formation in the field of intermodal and multimodal transportation, based on the principles of the ecosystem approach. The result is the creation of a methodological basis for improving the efficiency of interaction between transport companies and consumers of transport services. The scientific significance of the article lies in the development of fundamental provisions in the pricing of intermodal and multimodal transportation based on the ecosystem approach. The object of the research is the transport complex of the country, consisting of independent transport companies of different types of transport, offering their services in the market of transport services. The subject of scientific work is the system of tariff formation in the sphere of intermodal and multimodal transportation. The creation of an ecosystem contributes to the formation of effective logistics supply chains. Domestic and foreign sources of information (articles, excerpts from the statements of companies) were used to study the issue. Also were used traditional methods of research - analysis, synthesis, classification, comparison. In the course of the study the results showed positive dynamics from the introduction of the ecosystem approach for the purposes of tariffing, the system of criteria that contributes to the optimization of consumer costs in the provision of transport and logistics services was proposed.


1 INTRODUCTION

The transport and logistics industry is one of the pillars of international trade. Globally, the TLC was estimated at 8.4 trillion euros in 2021 and is expected to exceed 13 trillion euros by 2027. Total global logistics spending rose to nine trillion dollars in 2020, representing 10.7% of global GDP, which was \$85.24 trillion that year. In terms of freight turnover, transport of the Russian Federation was in third place in 2020 (5,401 billion t-km). The U.S. was in second place with 7,401 billion t-km. China was in first place with a freight turnover of 20195 billion tons-km.

Intermodal and multimodal transport account for most of the traffic in world TLC. They are the transportation of more than one mode of transport with transshipment between modes of transport to complete the transportation of cargo. Different types of rolling stock are used to move goods, including ships, wagons, trucks, barges, etc (Tereshina, Podsorin, 2019).

Of the many definitions of intermodal transportation, the most appropriate is: "Transportation movement involving more than one mode of transport... It is defined as the process of considering connections, interactions, and

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movements between modes of transport." Multimodal transport of goods is the delivery of different modes of transport: by sea, road, rail or air freight in any combination. The main purpose of using multimodal transportations is reduction of delivery time and cost. A distinctive feature of this type of transportation is the presence of a single organizational, controlling and coordinating center of the transportation process. For example, improving parcel tracking and meeting delivery deadlines can make companies' supply chains smoother and more predictable, reducing a major source of uncertainty and cost of doing business. Society as a whole can also benefit, as increased rail, air, and sea transportation may well reduce congestion on highways (Kurenkov, 2003; Vakulenko, 2021).

The biggest challenge that intermodal and multimodal transportation faces is the intermodal aspect. Developing and maintaining effective connections between modes is part and parcel of implementing efficient and successful intermodal transportation systems.

Why intermodal and multimodal transportation is relevant at this time:

Firstly, inventory management is fundamentally changing. Many businesses that used to hold large amounts of inventory are now using a just-in-time system that minimizes inventory and increases production and product supply flexibility. Intermodalism and multimodalism are expanding the range of delivery alternatives, allowing shippers to justify a delivery option according to their needs and considering the quality and cost factors of transportation service.

Secondly, the rapid development of IT technology has contributed to improvements in information and communication technology: better tracking of shipments; shorter transit times; fewer reliability problems due to improved coordination and communication.

Finally, containerization of the transportation process. In intermodal transportation, only the container with the cargo is moved; no additional work is done (Reser, Prokofieva, Goncharenko, 2010).

Table 1 shows the dynamics of freight transported and the volume of work of the transport complex of the Russian Federation.

Table 1: Dynamics of cargo transportation and cargo turnover in the Russian Federation.

Cargo transportation and turnover by modes of transport			
Transport	2010	2015	2020

	Cargo transported, million tons.		
All	7 750	7898	7960
Railway	1 312	1329	1359
Auto	5 236	5357	5405
Sea	37	19	25
Transport	Cargo turnover, bln. t*km		
	4752	5108	5401
All	2 011	2 306	2545
Railway	199	247	272
Auto	100	42	43

The table shows the dynamics of growth in the volume of freight transported and freight turnover. Freight turnover of railway transport increased by 239 mln. t*km in 2015-2020. Cargo turnover of road transport increased by 2.5 bln. t*km for 5 years. Cargo turnover decreased by 57 bln. t*km from 2010 to 2020. Currently, containerization of transport in Russia is actively underway, as containers are the most common transport unit in the world. In 2021 the largest share in transportation are 40ft containers with a share of 54.5%. 20ft containers account for 44.6%. More than 81% of container shipments in transit account for 40ft containers. Compared to 2017, the growth in the share of transit rates was 4% and equaled 14% in 2021. Import volumes in 2021 were 10 million tons, an increase of 4.3 million tons over 2017. Significant growth in exports came from 2019-2020, when the volume increased by 4.1 million tons to 23.4 million tons. Domestic shipments peaked in 2020 at 21.1 million tons.

Analyzing the dynamics of container transportation in Russia, we can conclude that 1.74 times the volume of transportation in 2021 compared to 2017. The largest indicator came in 2020 and amounted to 60.6 million tons.

It can be assumed that with the application of the ecosystem approach in transport and the formation of a unified tariff setting system, the efficiency of interaction between the participants of the transport services market will increase, which will contribute to the growth of transportation volumes.

Container transportation may take more time, but large transportation volumes contribute to lower costs. The use of intermodal and multimodal transportation is important because it allows maximum use of the advantages of different modes of transport.

2 METHODS

Tariff setting for intermodal and multimodal transportation is carried out in the context of each type of transport: rail, road and sea.

The system of tariff formation on rail transport for freight involves the establishment of separate tariffs for the provision of rolling stock and infrastructure services and locomotive traction, i.e., tariffs are divided into car, infrastructure and locomotive components (Tardieu, 2014).

The wagon component is a part of the payment for freight transportation (Taliaferro, Ernst, Usman, Anupama, Shiladitya, 2017). The main groups of items included in the wagon component costs: maintenance and repair of common park wagons and containers at depots and factories; depreciation of common park wagons and containers; wagon training costs; general production and general business expenses.

The locomotive component of freight transportation expenses includes costs that have a connection with the operation of locomotives in freight traffic. The main items included in the locomotive component costs are: freight locomotive operation; locomotive equipment; maintenance, operation and overhaul; depreciation of rolling stock;

general operating and business expenses (Buonocore, Grande, 2021).

The infrastructure component for freight traffic consists of a portion of the freight or empty rolling stock mileage charges. Fee for provision of access to infrastructure is a tariff withheld from the carrier for providing an opportunity to carry out transportation on public railway transport (Kurenkov, Kakhrimanova, Mukhamadshoev, 2017).

The infrastructure component includes the following expense items: work on maintenance, current and overhaul repair and maintenance of facilities, depreciation; work on infrastructure operation and transportation process management; freight and commercial work management costs; transportation management costs; electricity costs; locomotive shunting operations; work related to maintenance, equipment, service, repair and overhaul of shunting locomotives, depreciation of shunting locomotives; locomotives, current and overhaul repair of shunting locomotives (Razumovskaya, 2018).

To develop a methodological approach to the formation of a unified system of tariff setting, a system of indicators for all modes of transport in the sphere of intermodal and multimodal transportation was developed. (fig. 1).

Indicators for rail transport	Indicators for auto transport	Indicators for sea transport	Common indicators
<ul style="list-style-type: none"> • Weight of shipment per car • Quantity of wagons • Quantity of wagons Number of wagons • Quantity of axles • Goods (class 1-3; dangerous, liquid) • Speed (freight; large) • Shipment (wagonload; container; small) • Type of wagon 	<ul style="list-style-type: none"> • Shipment weight • Carrying capacity • Class of cargo • Change in cost • Market environment • Macro environment 	<ul style="list-style-type: none"> • Shipment weight • Carrying capacity • Cargo class • Seasonality • Change in cost • Market environment • Macro environment 	<ul style="list-style-type: none"> • Salary level • Prices of petroleum products • Exchange rate (purchase of spare parts for maintenance) • Tax burden • Depreciation of fixed assets (by industry) • Unloading and loading costs (depending on something) • Storage costs (depending on the region)

Figure 1: System of indicators for a single tariff for intermodal and multimodal transportation.

A key issue for intermodal and multimodal transportation is the creation of a unified transport tariff based on an ecosystem approach. The involvement of the three main modes of transport - sea, rail and road - will help integrate transport activities and facilitate interaction between consumers. The recommendations were based on the prospects of introducing digitalization in rail transport and the transition to an online platform in the form of a specially developed application for customers and suppliers. This innovation is applicable not only in the banking and information fields, but also in the field of transport, mainly on the railway, "Russian Railways" in this case can act as a cross-platform.

The positive aspects of tariff setting based on the ecosystem approach are as follows:

- Simplification of contractual relations;
- Reduction of management costs;
- Easy scalability of business;
- Increased flexibility;
- Reduced cost to the customer;
- Adaptability to customer needs.

The elaborated methodology will make it possible to conclude the feasibility of creating a unified transport tariff based on the unification of sea, rail and road transport. With this method, it is possible to integrate the work of transport and transfer to the sphere of ecosystem.

The issue under study involves the development of a logistics route and ensuring the delivery of cargo on the principles of the ecosystem. The underlying vector is a mobile application for companies (Korovyakovsky, Korovyakovskaya, 2010).

In order to create a single tariff, a special scheme of formation consisting of three components is developed. This data greatly facilitates the expected sampling of the above indicators. Integration into the tariff for allied carriers will significantly reduce the total cost of delivery, and the automatic selection of the optimal route and calculation of fees will take the load off the cargo customer himself.

3 RESULTS

The formation of an algorithm involving operators from different modes of transport will allow to use all the advantages of the proposed digital tool. (Fig.2) (Vakulenko, 2021). In the course of the study proposed a system of conditions, taking into account the fundamental criteria of transport efficiency in the field of intermodal and multimodal transport for each mode of transport.

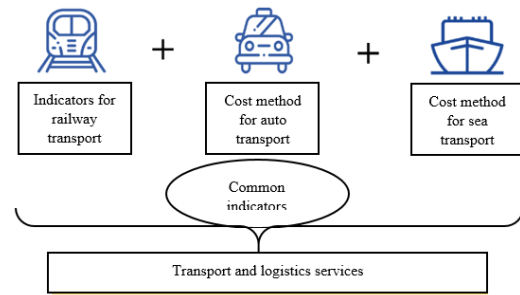


Figure 2: Formation of a unified tariff system.

$$\left\{ \begin{array}{l} T = T_{rl} + T_{at} + T_{sea} \\ T \rightarrow \min \\ I_{qc} \geq I_{qc \text{ norm}} \end{array} \right.$$

where

T_{rl} - tariff for railroad transportation;

T_{at} - tariff for road transportation;

T_{sea} - tariff for sea transportation;

I_{qc} - index of transport service quality

Tariff for railroad transportation is determined as follows.

$$T_{rl} = T_{inf} + T_{loc} + T_{wag}$$

where

T_{inf} – infrastructural component of the tariff;

T_{loc} – locomotive component of the tariff;

T_{wag} – wagon component of the tariff.

The tariff for road transportation is determined as follows.

$$T_{auro} = T_{mar} + T_g + T_{mac}$$

where

T_{mar} – the component of the tariff, which takes into account the volatility of the market;

T_g – the component of the tariff, which characterizes the cargo and carrying capacity;

T_{mac} – the component of the tariff, which characterizes the macro environment.

The tariff for sea transportation is determined as follows.

$$T_{sea} = T_{mar} + T_g + T_{mac} + T_{seas}$$

where

T_{mar} – the component of the tariff, which takes into account the volatility of the market;

T_g – the component of the tariff, which characterizes the cargo and carrying capacity;

T_{mac} – the component of the tariff, which characterizes the macro environment;

T_{seas} – tariff component which depends on seasonality.

To illustrate the ecosystem approach in the tariff setting mechanism, two routes of liquid hazardous cargo delivery from China to the Russian Federation were considered. For this purpose, 2 routes were calculated and all components were studied in detail. In this case the main condition of the route organization is not to worsen the quality level. Table 2 shows the routes for intermodal and multimodal transportation.

Table 2: Routes of intermodal and multimodal transportation.

Route №1	Meaning	Route №2	Meaning
Distance	27 км (auto) +1367 км (Harbin railway), + 6166 км (Trans-Siberian Railway) + 39 км (auto) Итого: 7599 км	Distance	36 км (auto) +1778 км (960,04 nautical miles) + 9296 км (Trans-Siberian Railway) +39 км (auto) Итого: 11149 км
Number of border crossings	1	Number of border crossings	1
Route (countries)	China, Russian Federation	Route (countries)	China, Russian Federation
Types of transport involved in the transport	Railway, auto	Types of transport involved in the transport	Sea, railway, auto
Number of transloadings (permutations)	2	Number of transloadings (permutations)	3
Total (rubles).	89 648 384	Total (rubles).	89 732 455

Model No. 1 consists mainly of rail transport. Rail transport provides: mass transportation; high carrying capacity; high carrying capacity. In model No.2 the

railway transport is joined by the sea transport. Maritime transport has the main distinctive feature - low cost of transportation and maximal lifting capacity of the ship.

The costs of scheme No.2 in their own exceed scheme No.1 by 98,766 rubles. However, the use of the ecosystem approach contributes to the reduction of costs under the scheme №2 at a more significant rate, since the policy of tariff formation in maritime transport is based on market relations.

To optimize the process of intermodal and multimodal transportation, Figure 3 shows the layout of the application.

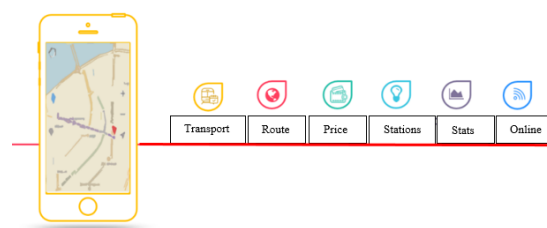


Figure 3: Layout of the application and its main components.

Once in the application, the consumer selects the points of departure and arrival from the drop-down list, the indicators from the table above - then the application builds the optimal route with the selection of suitable modes of transport. Based on the market transportation data, the cost of transportation is calculated.

Based on the above information, we can make the following conclusions and proposals for the implementation of the tariffing mechanism in the transport based on the ecosystem approach:

- Reducing the cost of the total cost of transportation;
- Optimization of the transportation process;
- Integration into the ecosystem through the use of digital technologies;
- Creation of a platform for the introduction of intelligent tariff aggregation mechanisms for intermodal freight transportation in the Russian transportation ecosystem;
- Improving the efficiency of pricing decisions in the freight transportation sector by determining the main parameters for the correct calculation of the cost base of the tariff.

4 DISCUSSIONS

For the transport industry, especially for rail transport, the ecosystem approach is only just beginning to emerge. The study of the category

«ecosystem» is relevant and necessary for rethinking the role of transport systems in modern processes of development of society.

The creation of ecosystems in all spheres and areas of human life is currently being observed. An ecosystem refers to a complex network of individuals, organizations, and systems that interact with each other to create a thriving community. In the business world, an ecosystem typically involves companies that collaborate and compete with each other to create new business value. The benefits of ecosystems are: satisfying a greater range of user needs; adaptive

increase in profits in the distribution of the range; increased competitiveness; the synergy of the value of the product line (Katarzyna, Tuleja, Dembowska, Kiszczak, 2016; Prataa, Arsenio, 2017).

The general idea is that an ecosystem involves a diverse group of entities that interact with each other in complex ways to create a thriving community. It is a holistic approach that recognizes the interconnectedness of different parts of a system and the importance of collaboration and cooperation for achieving shared goals. (Table 3).

Table 3: Interpretation of the «Ecosystem» concept.

Scientist	Interpretation of the concept of «ecosystem»
Dzhejms Mur	A network made up of organisations and individuals from the business community that together form a form of mutual support and evolve together.
Vul'f i Butel'	Focuses on how knowledge sharing between participants is dressed up, examining its fundamental impact on participants' decision-making.
YAnsiti i Levajen	The business ecosystem includes resource providers, consumers and the various firms that influence a firm's operations.
Kapur i Agarval	A structure in which a platform company coordinates the operation of a business system by providing a platform for firms producing complementary products.
Li s soavtorami	The role of the business ecosystem in the context of the start-up lifecycle, considering the system as a whole as a driving force for developing the environment and launching start-ups based on it.
ZHo s soavtorami	Ecosystem on the corporate responsibility side. The ecosystem is understood to be a system that is woven of the various members of the business ecosystem and the relationships between them.
Valkokari	An ecosystem refers to a main actor acting as a platform and providing shared resources to other actors in the network in order to create customer value.

For the transport industry, especially for rail transport, the ecosystem is just beginning its infancy. The issues of studying the main signs of ecosystem development are relevant .

Integrating the above-mentioned concepts, we can derive a single concept: ecosystem is a business system through which the permanent development of the community of companies and their structural subdivisions, which brings new value through cooperation and cooperation (Fig. 4).

The formation of business models based on the principles of the ecosystem approach is as follows:

1. The ecosystem business model encourages collaboration and sharing of resources among participants, leading to cost savings and increased efficiency.
2. The ecosystem also promotes innovation and the development of new products and services through open communication and idea sharing.

3. The ecosystem business model can lead to sustainable growth by balancing economic, social, and environmental factors.

4. The success of the ecosystem depends on the active participation and engagement of all participants, including buyers, sellers, and other stakeholders.

5. The ecosystem business model can be applied to various industries, including agriculture, healthcare, finance, and transportation.

6. Overall, the ecosystem business model offers a new approach to creating value and achieving shared goals through collaboration and innovation/

7. The digital platform replaces all intermediaries between the product manufacturer and the end user, reducing hierarchical vertical relationships.

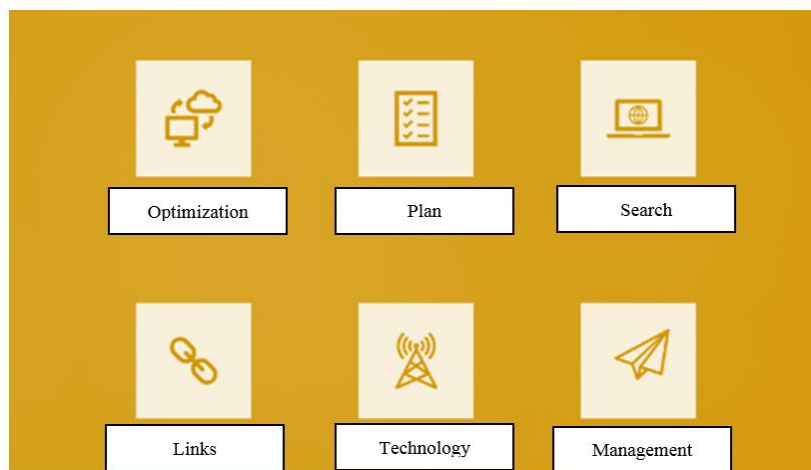


Figure 4: Components of an ecosystem.

This platform owner sets the standards for participation, establishes the rules for sharing resources and information, and provides the infrastructure for communication and collaboration among participants. The success of the ecosystem depends on the ability of the platform owner to create a fair and transparent environment that encourages participation and innovation. In the transportation industry, an ecosystem business model can bring together transportation providers, shippers, brokers, and other stakeholders to collaborate on logistics planning, route optimization, and resource sharing. By sharing data and resources, participants can reduce costs, improve efficiency, and provide better service to customers. Overall, the ecosystem business model offers a new way of thinking about business that emphasizes collaboration, innovation, and sustainability. By creating a shared platform for collaboration and communication, businesses can work together to achieve common goals and create value for all participants .

The basics of ecosystem formation are presented in Figure 5.

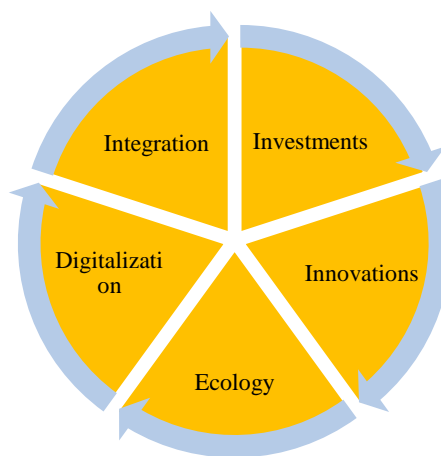


Figure 5: Key points of ecosystem formation.

Based on the five key points of ecosystem formation, it can be concluded that due to the above points in the application to rail transport will have a positive impact on the entire transport sector. Integration with other modes of transport will

increase the impact on infrastructure. Aggregation allows for price regulation in rail transport. As the ecosystem implements customer-centric policies, all participants in the ecosystem benefit.

Intermodal transportation is the transportation of goods by multiple modes of transportation, with one carrier arranging all transportation from origin to destination through all intermediate points. Depending on how the responsibility for transportation is shared, different types of transportation documents are issued. Intermodal transportation is the consecutive transportation of goods using two or more modes of transport in the same loading unit (transport module) or vehicle without overloading cargo when changing modes of transport. The basic technologies of transportation and loading of cargo units in intermodal and multimodal transportation while ensuring high quality are shown in Figure 6.

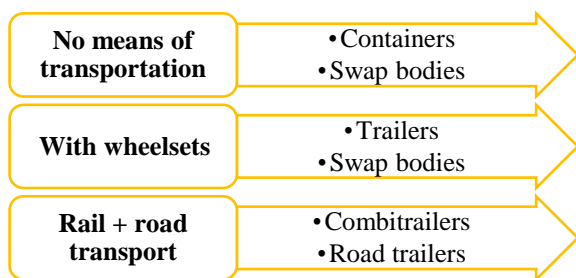


Figure 6: Types of transportation in intermodal and multimodal transportation to ensure high quality and use of universal cargo units.

Nowadays and in the medium term, the role of rail transport in international intermodal and multimodal freight transport is increasing, which imposes higher requirements on the means of transport, both in terms of reliability and adaptability to the transportation of various goods, and in terms of automation of loading and unloading operations.

The main advantage of intermodal and multimodal transportation is that they minimize the cost of the consumer of transportation services while ensuring high quality.

The following should be noted as conclusions and suggestions:

- Intermodal and multimodal transportation is becoming an increasingly important aspect of sustainable development of the transport system of the Russian Federation, capable of stimulating the economic development of the country, contributing to environmental protection, which makes them more attractive.

- The development of a methodological approach to the formation of a tariff formation system for intermodal and multimodal transport based on ecosystem principles will increase the efficiency of interaction between the carrier and the consumer of transport services. The main components of the tariff of each of the three modes of transport have been prescribed. An important condition for selecting a route is high quality transportation.

- The proposed system of criteria will help form an economic mechanism for integrating transport processes and different types of activities and facilitate interaction with consumers. To illustrate the ecosystem approach in the mechanism of tariff formation, two routes for the delivery of liquid hazardous cargo from China to the Russian Federation were considered, routes were calculated and each transport component was characterized.

- The development of the application on the principles of the ecosystem approach based on the digitalization in transport and the transition to an online platform will allow transport companies to interact effectively with the consumers of transport services. The economic assessment of the implementation of the digital platform and the implementation of the digital platform will reduce transportation costs by 5-8%.

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