




# Development of Rail Freight Transport Considering the International Intermodal Transport and Logistics: Lithuanian Case

Aldona Jarašūnienė<sup>(✉)</sup> , Dmitrij Ševaldin, and Stasys Steišūnas

Vilnius Gediminas Technical University, Plytinės Street 27, 10105 Vilnius, Lithuania  
{aldona.jarasuniene, stasys.steisunas}@vilniustech.lt

**Abstract.** Rail transport allows transporting large and heavy loads at relatively low transport costs, in observance of precise departure and arrival schedules, offering safety, reliability, regularity of transport, low dependence on weather conditions, and environmental friendliness, which have a positive impact on logistics decisions. More extensive use and development of railways is essential to meet the demand for sustainable transport, reduce road occupancy, environmental pollution and energy consumption. The Authors examine the importance of the synergies of railway transport, logistics and intermodal transport, as well as the analysis of the indicators and trends of freight transport by rail in Lithuania and recommendations for the development of rail freight transport. The application of expert judgment in order to create a plan for increasing the infrastructure capacity of railway lines, as well as for properly selected measures to increase the capacity of the infrastructure are emphasized.

**Keywords:** Lithuanian railways · Intermodal transport · Infrastructure capacity · Multi-criteria decision making · Freight traffic flows

## 1 Introduction

Lithuania's transport sector determines the country's macroeconomic indicators and is one of the most important sectors in the country. The development of the transport system is aimed at ensuring safe, convenient, and efficient movement and transport of goods not only domestically but also abroad, while complying with all environmental standards and requirements. Over the past few years, freight transport volumes have been steadily increasing in Lithuania. However, freight transport itself is a rather volatile business. In the development of its freight transport, Lithuania has faced the COVID-19 coronavirus pandemic, as well as the complicated geopolitical situation and international tensions in the Baltic region. Given the importance of the Lithuania's transport sector and the existing circumstances, the efficiency of freight transport must be improved through quality planning and organisation of transport processes, ensuring efficient functioning of logistics chains. Rail transport allows transporting large and heavy loads at relatively low transport costs, in observance of precise departure and arrival schedules, offering

safety, reliability, regularity of transport, low dependence on weather conditions, and environmental friendliness, which have a positive impact on logistics decisions. More extensive use and development of railways is essential to meet the demand for sustainable transport, reduce road occupancy, environmental pollution and energy consumption. In order to strengthen Lithuania's competitive advantage in freight transport, it is necessary to continuously develop the rail transport sector in order to exploit its potential even more efficiently. The development of the rail transport sector definitely has a positive impact on logistics.

This article deals with the problem of reduced volume of freight transport by the State Company "Lietuvos Geležinkeliai" (Lithuanian Railways) after the imposition of international sanctions on Russia and Belarus in 2022.

The aim of the article is to evaluate freight transport indicators of Lithuanian Railways in 2022, to assess the opportunities for diversification of freight transport activities and to propose a solution for the development of a plan to increase the capacity of the congested sections of the railway lines of the current freight transport routes.

The development of intermodal transport and a plan for increasing the capacity of Lithuanian railway lines is analysed in this article.

## **2 The Importance of Synergies Between Rail Transport, Logistics and Intermodal Transport**

International business environment is inevitably changing in the face of intensive globalisation processes, and logistics operators have new specific needs determined by the intensive development of economic relations in different business environments. However, there is a lack of application of new solutions and organisational forms, as well as of more detailed research and analyses in order to better coordinate logistics solutions in rail freight transport, not only in Lithuania, but also on a global scale [1]. Rail transport is usually associated with national rail networks and is poorly developed internationally, unable to operate in a coordinated manner due to the existing technical, organisational and technological barriers between different regions of the world. These factors hinder the efficiency of rail transport, effective functioning of logistic chains in freight transport and do not allow to become even more competitive in long-distance carriage.

Poorly developed international marketing does not allow to take advantage of the diversity of transport and logistics services in certain regions and countries, including Lithuania, and the services offered in foreign markets [2].

The Lithuanian rail transport sector needs to adopt international practices using a modern portfolio of rail transport and related services, including the arrangement of rail transport, logistics services, transshipment, processing, and distribution of freight between different modes of transport, storage of freight, as well as additional services related to the development of partial production and packaging services. This would allow creating a fully developed, appealing model of rail transport activity adapted to Lithuanian conditions and operating on a system basis, and drafting a strategy for the development of activities in foreign markets. The level of integration of rail transport into the transport chain is determined by the role of rail transport in the intermodal transport system. One of the most common modes of intermodal transport is rail-road

intermodality, aiming to create a seamless transport chain by combining rail and road modes of transport [3].

Christopher, M. [4] analyses thematic areas related to freight transport and logistics, supply chain management, including intermodal transport, technology deployment and logistics innovation. McKinnon, A., Cullinane, S., & Browne, M. [5] examine strategic aspects of establishment of logistics hubs and intermodal transport, also discussing the technological and environmental sustainability peculiarities that can affect the organisation of freight transport. Rushton, A., Croucher, P., & Baker, P. [6] emphasize the importance of analysing problematic issues faced in the development of a network of logistics hubs, including the integration of modes of transport and the use of technology in logistics processes. Dablinkas, A., & Rutelionė, I. [7] argue that the most efficient rail transport process and the high quality of logistics processes is achieved when it is managed in a coordinated manner. The economic aspect of problem solutions includes activities such as proper routing, use of multimodal transport, proper pricing of services, ensuring quality, and competitiveness. The aspect of solving environmental problems is focused on the use of renewable Transportation energy sources, saving fossil fuel energy, minimising emissions, and other measures related to the concept of environmental friendliness. The social aspect of problem solving is focused on the formation of a “conscious” user and organisation, which includes social responsibility and employee competence (Vienažindienė & et al. [8]).

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The integrated management of the transport process in a freight route allows achieving a high level of service quality in rail transport.

In order to ensure high-level efficiency in the rail transport value chain, railway companies must coordinate their actions and decisions, applying a methodology for managing the transport process and resources, and planning joint actions. In the freight transport value chain, the quality of service provision is determined by interaction and cooperation between railway companies in a single railway network, i.e. in a corridor as an integrated chain of the transport process.

In the case of Lithuania, foreign direct investment should be directed towards the development and integration of logistics services in the rail transport sector into international logistics chains, creating preconditions for establishing a supporting and geographically convenient freight distribution point in the global logistics system and a freight consolidation base abroad.

In order to exploit the potential of rail transport more efficiently, it is important to conduct an analysis of the indicators and trends of rail freight transport in Lithuania.

### **3 Analysis of Indicators and Trends of Rail Freight Transport by Lithuanian Railways**

The main indicator of freight transport is the total amount of freight transported during the year in tonnes (thousands or millions of tonnes). This figure includes the amount of freight transported domestically and internationally [10].

In Lithuania, the average annual rail freight transport accounts for around 49 million tonnes. The indicators of rail freight transport of Lithuanian Railways are presented Table 1.

**Table 1.** Freight carriage and freight turnover of Lithuanian Railways [11].

Year	Freight carriage by rail (thousand t)	Rail freight turnover (thousand tkm)
2022	30,977.4	7,375,058
2021	51,079.6	14,565,850
2020	53,429.7	15,864,679
2019	55,209.2	16,180,599
2018	56,775.7	16,884,825
2017	52,638.2	15,413,521
2016	47,650.6	13,790,109
2015	48,053.2	14,036,238
2014	49,000.1	14,306,751
2013	48,028.1	13,343,682
2012	49,377.2	14,171,644

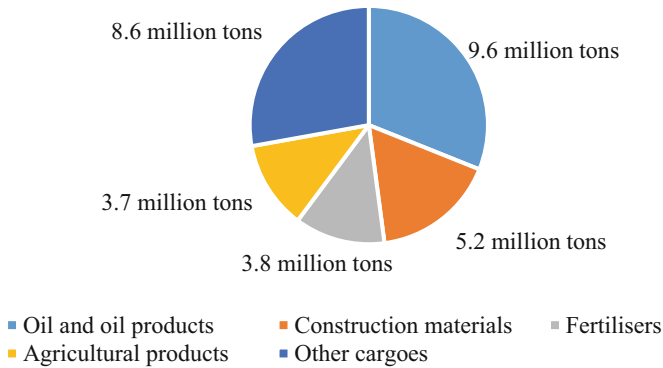
During the period from 2012 to 2021, annual rail freight transport in Lithuania increased by 4%. However, with the outbreak of the war in Ukraine and the international sanctions imposed on Russia and Belarus, annual rail freight transport in Lithuania fell to 31 million tonnes of freight, which is 39% less than the average freight transported in 2012–2021.

According to the Ministry of Transport and Communications of the Republic of Lithuania, oil and oil products, various construction materials, fertilisers and agricultural products accounted for the major share of freight carried by rail in 2022 (Fig. 1).

In terms of domestic freight flows, the majority of rail freight was transported to Klaipėda Seaport, accounting for 10.7 million tonnes. Volumes of domestic carriage were higher than planned, with around 6.4 million tonnes of freight transported in Lithuania. In comparison, domestic traffic accounted for 5.8 million tonnes in 2021. Counting all freight transported to and from Kaliningrad through the territory of Lithuania, regardless of its origin and destination, 8 million tonnes of freight was carried in Kaliningrad transit, and another 5.9 million tonnes headed in other directions [12].

In the current geopolitical context, LTG Cargo, a freight transport company of Lithuanian Railways Group, has been actively diversifying its activities to the West in order to expand the North–South freight route and develop it instead of the East–West route which has been pre-dominant for many years.

Efficient diversification and expansion of freight transport business requires optimising freight transport costs through quality planning and organisation of logistics processes. The first step in the freight transport is to select the right transport technology, carrier, mode of transport and vehicle type. Then, it is necessary to ensure the



**Fig. 1.** Main products transported by Lithuanian Railways in 2022.

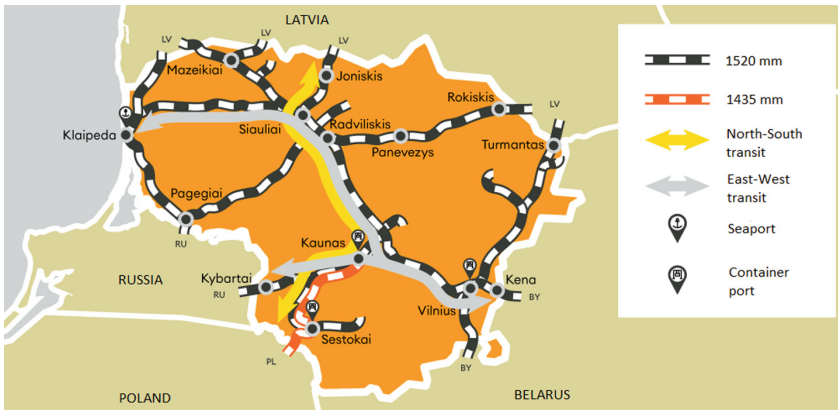
interoperability between the means of transport and the infrastructure structures that support it, followed by proper handling and securing of the goods and selection of the transport route. Finally, it is necessary to ensure transport control in order to preserve the characteristics of the goods during transport and handling operations. To meet these challenges, an increasing number of countries around the world are switching to container freight transport, which significantly reduces freight costs, shortens working time and simplifies transshipment [13].

This situation has led to the emergence of intermodality as a phenomenon. Intermodal transport is a mode of freight transport where freight is transported from the point of origin to the point of destination by several consecutive modes of transport, using transshipment infrastructure, i.e. an intermodal terminal, without unloading the freight itself. The goods transported this way are packed into intermodal load units such as containers or semi-trailers. The intermodal mode of transport has been developed not only as a way of simplifying, standardising and optimising the transport process, but also as a means of transporting goods in a more environmentally friendly way. Containerised freight is therefore a potential for rail transport.

Globally, the share of containerised freight has been increasing by around 10% each year [14]. Such growth is natural, as the carriage of goods in containers is much more advanced compared to traditional transport. Although containerised transport in Lithuania has not yet reached global extent, preparations are underway for the more advanced transport of goods. Lithuanian Railways has a well-developed infrastructure and the Kaunas and Vilnius intermodal terminals established in 2014. The Kaunas intermodal terminal is capable of handling up to 55,000 twenty-foot containers (TEUs) per year, with container capacity of 1,120 TEU. The Vilnius Intermodal Terminal has an annual capacity of up to 100,000 TEU, with container capacity of 1,465 TEU [15]. LTG Cargo already offers its existing and potential customers a sufficiently broad portfolio of container train services, with its transport and service areas covering the Lithuanian, Western European, Scandinavian and Asian markets (Fig. 2).

Current routes of intermodal freight transport by Lithuanian Railways and their lengths:

1. Vilnius (Lithuania)–Klaipeda (Lithuania) – 350 km.



**Fig. 2.** Directions of freight transport by Lithuanian Railways [16].

2. Kaunas (Lithuania)–Gdansk (Poland) – 549 km.
3. Kaunas (Lithuania)–Malaszewicze (Poland) – 557 km.
4. Šeštokai (Lithuania)–Muuga (Estonia) – 671 km.
5. Kaunas (Lithuania)–Sławków (Poland) – 740 km.
6. Kaunas (Lithuania)–Duisburg (Germany) – 1,520 km.

In order to diversify freight transport, Lithuanian Railways Group actively cooperates with Polish, Latvian and Estonian railways.

To strengthen rail links between the Baltic States, the *Amber Train* project was implemented in 2018. The first international intermodal train was formed on the route Šeštokai–Riga–Tallinn, connecting the three Baltic States by rail and opening up new business opportunities for freight carriers. Today, goods can be transported across Lithuania, Latvia and Estonia in less than 24 h. Another unique feature of the project is the link between Western and Northern Europe. The intermodal terminals in Šeštokai and Kaunas allow transshipment of goods from the 1435 mm gauge to the 1520 mm gauge and vice versa [17], allowing the Baltic States to further develop freight transport with other European Union countries.

In order to strengthen the rail links between Lithuania and Poland, LTG Cargo has established a subsidiary in Poland LTG Cargo Polska. The company develops rail freight transport activities in Poland, strengthens logistics supply chains and expands freight mobility between Lithuania, Ukraine and Poland [13].

Since 2023, freight trains on the Kaunas–Sławków route have had a stopover at Warsaw, which allows freight to be carried to the Pruszków terminal near the capital of Poland. The Sławków Euroterminal near Katowice is an important hub of the Polish broad gauge rail network, linking rail lines between Lithuania and Poland and Ukraine and Poland. The terminal also offers regular freight trains to Schwarzheide (Germany), Maddaloni (Italy), Koper (Slovenia) and Gdansk (Poland). The Kaunas–Pruszków–Sławków route is a part of the European transport corridor linking the countries from Finland to Italy by rail. It allows to expand this network with daily connections

to Germany (the port of Bremerhaven, Hamburg and Duisburg), Croatia (Rijeka) and Slovenia (Koper) [14].

Currently, freight trains with a capacity of 36 semi-trailers or containers depart from Kaunas intermodal terminal to Duisburg intermodal terminal and back through the territory of Poland three times a week [18].

In the development of intermodal freight transport to the Northern Poland region, a possibility has been created to transport freight from Kaunas intermodal terminal to Gdansk. Customers shipping freight to and from Gdansk have access to one of the most important deep-sea ports in the Baltic Sea with the largest container ships from North and South America and Asia arriving to the port. It is the only port in the region having regularly arriving freight from the Far East [19].

As part of the development of intermodal freight transport to the Eastern Poland region, transporting freight from Kaunas intermodal terminal to Malaszewicze has become possible. Located in the east of Poland, the Malaszewicze intermodal terminal has a distinctive capacity to receive freight carried by road from East Asia and to tranship it onward to European Union countries. Malaszewicze is home to a number of freight forwarding, logistics and transport companies important for the region [20].

Drivers of LTG Cargo transport intermodal freight in the territory of Lithuania, and drivers of LTG Cargo Polska – in the territories of Poland and Germany (LTG Cargo, 2023d). Last year, LTG Cargo transported 84,000 tonnes of agricultural products from Ukraine to the Klaipeda Seaport via Poland and 120,000 tonnes of oil to Ukraine via Poland. 66,000 tonnes of cargo were transported on the new Kaunas–Duisburg route in April–December of 2022 [12]. In 2022, LTG Cargo Polska, a subsidiary of LTG Cargo, carried 583 freight trains. In comparison, the company transported only 68 trains in 2021 [21].

The long-term strategy for freight transport of the Lithuanian Railways Group provides for the aim to increase the volume of freight transport to 64 million tonnes in 2030 and then – to 103 million tonnes in 2040 [22].

When increasing rail freight volumes, it is important to consider the capacity of the existing railway infrastructure and the available capacities, which is one of the most important tasks for the development of the logistics chain. To solve this problem, it is possible to use the Multi-Criteria Decision Making methods, based on the results of surveys of railway experts.

According to Simanavičienė, R. [23], Multi-Criteria Decision Making methods are used to find the optimal solution and are divided into two groups: multi-object and multi-objective methods. Multi-Criteria Decision-Making methods that use vector optimisation based on a decision-making process model are called Multi-Objective Decision Making methods.

According to Sivilevičius, H. [24], the initial information for processing expert survey results is the numerical data that shows expert priorities and the justification of these priorities (importance).

## 4 Recommendations for the Development of Rail Freight Transport

The capacity of railway lines is increased by organisational and technical measures or by reconstructing parts of the infrastructure. Organisational and technical actions are less pricy and faster to implement than reconstruction, but such capacity increases are limited. Moreover, organisational and technical actions cannot always be implemented without reconstructing the rail network or individual lines.

The most important organisational and technical actions include the optimisation of train timetables, the use of the double-stack method and several locomotives in one train, and shorter intervals in the train schedule. The construction of second and third tracks on interchanges, the lengthening of arrival and departure tracks in railway stations, the electrification of railway lines and improvement of the efficiency of the layout of traffic lights on interchanges are the main steps of a reconstruction.

The measures for increasing the capacity according to the period of their implementation can be divided into three groups: measures that require a short implementation period – measures are implemented in up to 3 years; measures that require a medium-term implementation period – measures are implemented in 3 to 7 years; measures that require a long-term implementation period – measures are implemented in 7 years and more.

All measures for increasing the capacity of railway infrastructure must ensure train traffic safety, the required level of infrastructure capacity, the reliability of the operation of the rail network, and the reduction of freight and passenger transport costs. A key condition for increasing the capacity of railway infrastructure is a timely completion of works and the observance of the principle of staging. The staging principle involves prioritising works on the most congested sections of railway lines. Thus, increasing the capacity of the railway infrastructure requires a plan with a sequential order of implementation of capacity improvement measures.

In order to draw up a plan to increase the capacity of railway infrastructure, experts must be consulted to properly assess certain measures to increase the capacity of infrastructure. Therefore, using expert survey methods for the preparation of a capacity improvement plan is recommended.

Having received expert survey results, data are processed in application of multi-criteria evaluation methods. These methods are used to solve problems involving many functions of an objective that are optimised simultaneously.

The aim of the processing is thus to obtain aggregated data and new information in the form of implicit expert evaluations. The results of the processing are used to formulate a solution to the problem, or, in the case of the problem under consideration, a plan for increasing the capacity of the railway infrastructure.

## 5 Conclusions

The conducted analysis of the literature sources showed that there is a lack of application of new organizational forms, more detailed research, and analysis in order to better coordinate logistic solutions between different countries developing of freight transport by rail.



The conducted analysis of the rail transport of freight by Lithuanian Railways in 2022 revealed that the freight transport rates fell by 39%.

A conducted analysis of the long-term strategy for freight transport of the Lithuanian Railways Group shows that the aim is to increase freight transport volumes from 31 to 64 million tonnes by 2030.

As part of the diversification and development of international freight transport, Lithuanian Railways has been developing access to Poland, Germany, Italy, Slovenia and Croatia. In the context of the development of intermodal transport in the North–South direction, assessing the levels of infrastructure capacity on individual railway lines of the current routes and identifying congested sections is substantiated.

By applying multi-criteria decision-making methods, it is possible to identify problematic areas of railway infrastructure more accurately, their influence on cargo transportation and the functioning of logistic chains.

Multi-criteria decision-making expert survey methods should be used to draw up a plan for increasing the capacity of the congested sections of individual lines, offering measures to increase the capacity of the railway infrastructure in the order of priority.

The development of the railway transport sector, the promotion of intermodal freight transport, and the aim of its more efficient use, emphasize the positive impact on logistics.

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