

ASSESSMENT OF SUSTAINABLE ROAD TRANSPORT IN LITHUANIA

Renata ČINČIKAITĖ  

Faculty of Business Management, Vilnius Gediminas Technical University, Vilnius, Lithuania

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Abstract. Road transport plays an important role in our lives. In Lithuania, passenger road transport accounted for more than 47% in 2022, and freight road transport more than 87% of the transport sector. Up to 15% of the Lithuanian population works in this sector (in 2020). However, road transport is one of the most polluting. In 2021, it represented 72% of all greenhouse gas emissions from EU domestic and international transport. In order to solve this problem, the EU plans to ban the sale of vehicles with internal combustion engines by 2035. So, the question arises: what challenges will the country's transport sector face, what measures/innovations will it adopt to reduce greenhouse gas emissions? To answer this question, the article analyzes the road transport sector and identifies measures to improve the sustainability of the sector, increase turnover, and observes the impact of those measures on road transport turnover. The purpose of the research is to determine the factors affecting the circulation of passengers and cargo by road transport based on scientific literature and to empirically verify their influence on the sustainability of the country. In order to achieve the set goal, the analysis is carried out in two blocks: the study of the turnover of road transport cargo and the study of the turnover of road transport passengers. The following methods are used for the research: correlation regression analysis, forecasting. The research results are important for policy makers and practitioners in the context of sustainable transport development.

Keywords: sustainable transportation, road transport, air pollution.

JEL Classification: R40.

 Corresponding author. E-mail: renata.cincikaite@vilniustech.lt

1. Introduction

Due to changes in the economic situation, changing political and demographic situation, and the constant development of transport technologies, as in every modern economic activity, the trends in passenger transportation by road transport are changing. Transport has the following basic requirements, mobility and safety, and must also be combined with the quality of the urban environment (Robert et al., 2005). It is the responsibility of the city government to strive to make mobility accessible, that is, services (work and education) would be easily accessible (European Environment Agency, 2007). According to Markšaitis (Raslavičius & Markšaitis, 2007), automobile or otherwise called road transport is an integral part of the transport system, including the transportation of passengers and/or goods on non-rail roads. Passenger transport occupies a special place in society. To achieve sustainable mobility, a non-motorized transport infrastructure is being developed and public transport lanes are being installed in areas of vehicle congestion; increasing the share of bicycle trips in the overall structure of trips. The beginning of Lithuanian public transport was considered in 1940. on January 1,

when the first bus transport company was established in Vilnius (Rimké, 2018). This led to the development of passenger transport not only in Vilnius but also in other Lithuanian cities. Nowadays, in the 21st century, in modern and growing cities, the population's need for transportation is one of the most important areas that influence all economic, daily and commercial activities. The appropriate development of passenger transportation is one of the aspects that shape the urban image (Damidavičius et al., 2016). Freight transportation is an integral part of the life of every citizen of the world. All existing products sold in each store are transported from the factory to the consumer locations. Therefore, it is very important that this area works properly and smoothly. To ensure these requirements, the state provides provisions, develops ideas, and strategies to improve the transport infrastructure. However, on-time delivery is only one of the existing objectives. According to data from the Environmental Protection Agency, the total amount of GHG (greenhouse gas) emissions from the transport sector in 2019, compared to 2005 was more than 40% higher. Road transport is the main source of air pollution that affects humans (Lietuvos Respublikos Vyriausybė, 2004). Thus, objectives such as re-

duction of pollution caused by transport (especially road transport); improvement of cargo transportation routes; security assurance. Road traffic flows on highways and city streets are constantly increasing. Road congestion is an important traffic safety problem in cities. Thus, the transport of passengers actively influences the social and economic environment of the country's inhabitants and determines the environmental friendliness of the environment. In the last few decades, the turnover of Lithuanian cargo transportation has started to grow rapidly. However, in recent years, problems have arisen in the development of freight transport, leading to a decline. For this reason, to summarize the level of scientific examination of this problem, study investigates the following research question, i.e. RQ1: What factors have the greatest influence on changes in road transport in Lithuania and what challenges are faced? To address this question, this study focuses on the primary dimensions: transport of passengers by road transport and freight transportation by road transport through a systematic analysis of statistical data in order to assess the trends of this phenomenon.

2. Literature review

Transportation of passengers by road transport ensures proper and timely delivery of people to the intended objects, thus ensuring the connection between cities, districts, counties, and settlements. Researchers (Aleksionis, 2013; Nowakowski, 2012) describe the process of properly using the transport system to realize and overcome the tasks of transporting people as complex due to various factors. Other authors, such as (Economou et al., 2017; Organisation for Economic Co-operation and Development [OECD], 2000; Melentyev, 2012), describe that passenger transport by road transport is the delivery of people to specific and planned objects using various types of vehicle. In summary, it can be said that passenger transportation is the transportation of groups of people or individual individuals, using certain infrastructure and means of transportation, transporting passengers from the starting point to the final formed route. Transportation of passengers by road transport is transportation by selected road transport from the starting point to the final point. The transport of passengers by road is determined by various factors, which can be divided into several main categories: economic, social, geographical, technological, and political. Studies and calculations by various scientists have shown that physical infrastructure is correlated with GDP, labor productivity, and investment. For example, the European Commission, implementing the TransEuropeanNetwork (TEN) project, plans that in the years 2005–2025, the GDP of the European Union will increase by 0.25 percent and employment by 0.11 percent due to transport projects. and 800 thousand jobs will be created (North Atlantic Marine Mammals Commission, 2005). Transport needs – mobility and safety must align with the quality of the city environment and the livability of the districts (Robert et al., 2005). According to Vitkūnas et al. (2021), passenger transport has always

been one of the main social and economic factors. Its function is irreplaceable and definite. Currently, there are many modes of transport (road, rail, air, sea, and inland waterways). Many factors influence the choice of one or another mode of transport of the passenger. Some of the main criteria they evaluate are safety, accessibility, cost of travel, frequency, speed and ease of use, and existing infrastructure. Aleksionis and etc (Aleksionis, 2013; Popovas, 2012; Vasiljevas, 2022; Yannis & Chaziris, 2022) talked about how road transport is affected by the constantly changing population of the country. Vasiljev, who stated that due to constant changes in the number of people and their place of residence, the burden on public transport is constantly increasing (Vasiljevas, 2022). Aleksionis mentions that demographic changes are an external factor that influences passenger transportation (Aleksionis, 2013). The author notes that the total population of Lithuania is constantly decreasing. This affects the unprofitability of public transport (buses and trolleybuses) business and its decreasing demand. According to the opinions expressed by Popov, it can be seen that the demand for passenger transportation services in a city or district is affected by the change in population and by how the ratio of cities and residents changes every year (Popovas, 2012). Therefore, the changing number of permanent residents of a country, region, or city affects the transportation of passengers by road transport, its demand and load. The rapid growth of automobilization is discussed by all of the authors. Yannis and Chaziris (2022) say that in recent years, much attention has been focused on improving the comfort and speed of their own cars. According to the authors, not enough effort was put into popularizing the city's public transport. Although the aspects of improving their own car are still important, the authors Yannis and Chaziris (2022) emphasise that such popularisation reduces the balance of car and public transport. Aleksionis (2013) and Jaržemskis (Jaržemskienė & Jaržemskis, 2024) emphasise that the growth of the number of cars is one of the external factors that influence the choice of consumers when travelling. According to the authors, with the emergence of a larger choice of passenger cars and their prevalence in society, the user sometimes has a quicker choice of how to get to a certain point. Researchers have conducted a study to incorporate safety into traffic flow analysis, which has traditionally focused only on mobility and stability (Li, 2022). Researchers have also investigated advanced vehicles equipped with various functions, such as connected automated vehicles (CAVs) that boast comprehensive platoon capability and connected vehicles (CVs), which essentially mean human-driven vehicles (HVs) with connectivity features applicability (Qin et al., 2023). Aleksionis writes that, as in the whole world, with the growth of people's income, especially of city dwellers, the number of private cars is constantly increasing (Aleksionis, 2013). The author claims that the largest part of people in Lithuania are transported by road transport. The following main urban communication problems are highlighted in sources

from the scientific literature: increased congestion (Vaitkus et al., 2017), which influences the increase in the number of traffic accidents; travel (Schlich et al., 2004); and rural transport through the urban area (Griškevičiūtė-Gečienė & Burinskienė, 2012). Therefore, as the level of carization increases, an increasing number of people choose to travel by car instead of public transport. Popovas claims that with increasing number of cars in cities, traffic jams on roads increase, the amount of exhaust gases in the environment increases, and the free area on the roads that could be occupied by public transport decreases (Popovas, 2012). Owning a car, although a convenient attribute of daily life, clogs the general area of the roads and reduces the free space, causing traffic jams. Therefore, the growing number of private cars at the disposal of people influences the lower demand and popularity among consumers. Fluctuating population income is one of several factors that influence passenger transportation. Popovas extensively studied this topic, mentioning in his scientific work that passenger income is one of the main reasons that determine changes in the demand for passenger transportation services. According to Jaržemskis, public passenger transportation services are usually oriented towards certain social groups of the society. According to the author, public transport services are used primarily by people with low income or social support (Jaržemskienė & Jaržemskis, 2024; Jaržemskis & Jaržemskis, 2017). This topic is also described by the author Vasiljevas (2022), mentioning that not all people these days can use their own car or taxi services every day; this is influenced by the lack of disposable income and rising fuel prices. According to Yannis and Chaziris (2022), free public transport encourages people to use it. Aleksonis (2013) adds that as income grows, people naturally look for new amenities and buy their own transportation. In conclusion, it can be said that the income of the residents can influence the transport of passengers by road transport. As income increases, passengers will choose to use private cars or taxi services more often. According to Damidavičius et al. (2016), even 92% of trips are made in private cars. This affects the formation of traffic jams, the lack of parking spaces, and large amounts of poisonous and polluting gases are emitted. Therefore, it is important to travel not only by car, but also by other possible means of transport. Public passenger transport for transportation within or between cities is an alternative to private cars. Intensive use of public transport is a preventive measure for local problems (Sampaio et al., 2008):

- traffic jams;
- polluted air;
- public health.

Public transport also solves global problems (Bazaluk et al., 2022):

- climate change;
- oil crisis;
- Security problems in the energy sector.
- Scientists studied the connection between the transport sector and the greenhouse effect (Van den Berg & De Langen, 2017; Činčikaitė &

Meidutė-Kavaliauskienė, 2023; Shanmugam et al., 2020; Vitkūnas et al., 2021; Zhao et al., 2020). Types of sustainable transport (Litman & Burwell, 2006; OECD, 2000): walking or walking; cy-cling, using bicycles for travel, recreation, sports; electric cars; hybrid electric cars; hydrogen powered cars. Scientists have proven through research that public transport, in addition to the obvious reduction in the number of private vehicles and the impact of congestion, can contribute to the reduction of air pollutant emissions and become a significant engine for the introduction of electromobility in cities (Pietrzak & Pietrzak, 2020). Researchers (Ceder, 2021) say that the key operating principle of smart city mobility will be the ability to optimize mobility connectivity to achieve seamless mobility, while giving new meaning to the phrase door-to-door travel. The future of transportation is to harness the untapped potential of IoT technologies to meet the needs of future travelers and ensure sustainability (Porru et al., 2020).

The choice of means of passenger movement is determined by different motives and criteria. It is necessary to evaluate the advantages and disadvantages of the types of vehicles, modes of transport, and routes. According to the author Nowakowski the passenger must always choose the way he would like to travel (Nowakowski, 2012). The user's choice could be influenced by the availability of the chosen method in terms of price, route, and time. These three factors generally determine how a passenger will travel. The author names these factors as vehicle reliability. This reliability is determined by the accuracy and frequency of the routes and the speed, comfort, and cleanliness of the vehicle. If the passenger is not satisfied with these conditions, he will probably try to find a way to use his own transport. Ridulis (2013) indicates only two most important conditions in passenger transportation: speed and price. According to the author, these are the two criteria that most determine the passenger's choice because in the modern world, lack of time and money costs are inseparable problems of modern day-to-day life. Thus, the passenger's choice of how to travel by road transport is influenced by monetary rates, time costs, number of routes, and reliability.

Aleksonis (2013) states that the importance of the public passenger transport system increases every year. With the expansion of urbanization, it is necessary to connect the suburbs with the regional centers. In this way, we are able to properly implement social guarantees for the entire society. Jaržemskis states that with the growth of cities and their population, passenger transportation by road transport can become an affordable alternative to passenger cars, and public transport has a significantly higher energy efficiency and reduces the total energy consumption, which city residents consume a lot (Jaržemskis & Jaržemskis, 2017). Therefore, due to traffic congestion, users could possibly choose public transport. Yannis and Chaziris (2022) state that much less space is needed for one traveler. Public transport systems can reduce traffic

congestion and improve road safety at the same time. Therefore, the increasing number of people in cities and the increase in urban areas influence people's choices to travel more often by public transport. According to Popovas (2012), with the growth of cities, it is difficult for transporters to transport many people in different directions. In low-density cities and counties, commuters are not concentrated in one place, and as a result, often in such cases, some parts of urban neighborhoods or smaller settlements may be completely inaccessible or rarely accessible by public transport. This may be influenced by economic reasons. Another factor influencing the transportation of passengers is the price of fuel (diesel, gas, gasoline). Popovas (2012) notes that an important factor is the increase in fuel prices, as it accounts for a large part of transportation costs. The increase in fuel prices makes passenger transportation more expensive, the price of a transport ticket increases, and this can make this service unattractive to passengers. According to Yannis and Chaziris (2022), the increase in fuel prices can have a dual effect on passenger transport by road. Fuel accounts for a large proportion of transport costs, which may increase the cost of fuel for passenger transport and could make the passenger transport service unattractive to consumers. In the second situation, he mentions that people with higher earnings may change their own car to a public car just as the price of fuel rises. Therefore, a change in the price of fuel can affect passengers in public transport in various ways. Due to increased fuel costs, some people may choose not to own a car and travel by public transport, while others may abandon unnecessary and unnecessary public transport trips and travel by bicycle, foot or carpool. According to the researcher (Jaržemskienė & Jaržemskis, 2024; Vitkūnas et al., 2021), the total employment of the population is influenced by the demand for public transport. Vasiljevas (2022) discusses in his scientific article that people living in remote areas or the countryside simply do not have the opportunity to travel quickly and efficiently by public transport.

Although road transport is one of the most profitable forms of transport, it causes great damage to the environment and is the most dangerous form of transport for human life. These reasons lead to a change in the trend towards other types of transport and the desire to use road transport more as an assistant in intermodal transports. The following advantages of road transport are distinguished: maneuverability, free movement independent of other transports, and ability to accurately deliver cargo from point A to point B; flexible in terms of time, it is possible to avoid wasting time on additional loading and unloading; can move on both good and poor quality road faces. Cargo can reach any required point; cars are much faster than rail and water transport. Local transfers are much faster than air transport. However, there are also disadvantages: logistics in road transport are usually high cost and cargo is small; traffic jams can cause serious losses and change plans; road transport pollutes the environment the most, for this reason efforts are being made to reduce it in the freight transportation market;

road transport cannot transport such a large amount of goods in one year as rail or water transport can. With the increase in the turnover of transport, especially international transport, and the rapid increase in the number of road vehicles, the lack of more and more drivers is a major concern for transporters. Strong migration affects not just one profession but the entire economic field. The greatest influence on them is the volume and structure of industrial and agricultural production, the distribution of production forces and interregional relations, the organization and specialization of production supply and execution, the quality of transport planning, the improvement of communication roads and the distribution of cargo by transport types (Pranevicius et al., 2003). The researchers pointed out that the level of industrial production development is the most important factor in the development of freight transport. The development of industry increases the need for freight transportation, and the role of freight transportation cannot be reduced to just freight transportation. Transport is a participant in the extended reproduction process, thus contributing to the development of industry. At the same time, transport itself cannot be without industrial products, because spare parts and tools are needed to service transport, which are produced in industrial enterprises (Grigoryeva & Fisunov, 2015). According to the authors (Pranevicius et al., 2003; Grigoryeva & Fisunov, 2015), the volume of industrial and agricultural production also makes an important contribution to the turnover of cargo. Production and freight volumes depend directly on each other. Thus, in the work, we will conduct a study of how the turnover of passengers and cargo is influenced by the following factors most often mentioned in the scientific literature: population; automobilization; infrastructure, population income; fuel prices; unemployment rate; urbanization, emigration, international trade.

3. Methodology

The study will be conducted in three steps. In the first step, the statistical data is described and the relationships are determined. Correlational analysis is used to determine relationships. The correlation coefficient r can be calculated using the formula (Pabedinskaitė & Činčikaitė, 2016).

$$r = \frac{1}{n-1} \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{S_x S_y}, \quad (1)$$

where: factor x_i / independent variable; y_i – dependent variable; n – number of observations; S_x , S_y , dispersion.

In the second step, a regression analysis is performed. The regression model can be both pairwise, when the relationship between the dependent variable and one independent variable is analysed, and multinomial, when the relationship between the dependent variable and all selected independent variables is examined, but in the general case the equation is written as follows (Pabedinskaitė & Činčikaitė, 2016).

$$Y = a + \sum b_i X_i, \tag{2}$$

here: a – free member; b – direction coefficients; Y – dependent variable; X_i – independent variable.

In Step 3, the forecast is made and its accuracy is evaluated. The moving average method is based on the fact that when a new time series value is learned, it replaces the oldest value in the formula and then a new average is calculated (Pabedinskaitė & Činčikaitė 2016; Volodkienė & Snieška, 2016).

$$\hat{Q}_t = \left(\frac{Q_{(t-1)nesez.} + Q_{(t-2)nesez.} + \dots + Q_{(t-N)nesez.}}{N} \right) \times S_t, \tag{3}$$

where: \hat{Q}_t – predicted value; $Q_{(t-N)nesez.}$ – past period value without seasonality; S_t – seasonality index; N – number of periods.

The method of exponential smoothing, its application allows one to smooth the dynamic line and perform short-term forecasting. With this method, predictions can be made based on the trends of change in indicator values (Volodkienė & Snieška, 2016).

$$\hat{Q}_t = (\alpha \times Q_{(t-1)nesez.} + (1-\alpha) \times \bar{Q}_{(t-1)nesez.}) \times S_t; \tag{4}$$

$$n = \frac{2}{\alpha - 1}; \tag{5}$$

$$\bar{Q}_{(t-1)nesez.} = \frac{Q_{(t-1)nesez.} + \dots + Q_{(t-n)nesez.}}{n}, \tag{6}$$

where: \hat{Q}_t – predicted value; $Q_{(t-1)nesez.}$ – value of the value of the past period without seasonality; S_t – seasonality index; n – number of periods; α – smoothing factor, ($0 < \alpha < 1$).

After calculating the prognostic values using the three methods described above, it is important to choose the best. This can be done by calculating the errors; the smallest errors will show which method is the best. Errors are calculated according to the following formula (Pabedinskaitė & Činčikaitė, 2016):

$$MAPE = \left| \frac{\hat{Q}_t - Q_{(t-n)nesez.}}{Q_{(t-n)nesez.}} \right|, \tag{7}$$

where: $MAPE$ – error estimate; \hat{Q}_t – predicted value; $Q_{(t-n)nesez.}$ – past period value without seasonality.

To determine which factors have the greatest and least influence on road transport, a table of factors is compiled based on the analysis of the scientific literature (see Table 1).

On the basis of the table, it is observed that the study will consist of two parts, i.e. passenger traffic and cargo traffic are analyzed.

4. Results

When analyzing the statistical data, we found that in Lithuania, road transport accounts for the largest turnover. This

Table 1. Factors affecting road transport

Traffic of passengers and cargo	Population (X_1)	Lithuanian Data Agency (https://osp.stat.gov.lt/statistiniu-rodikliu-analize?indicator=S5R022#/)
	Automobilization (X_2)	
	Fuel prices (X_3)	
	Income (X_4)	
	Urbanization (X_5)	
	Unemployment rate (X_6)	
	Emigration (X_7)	
	Infrastructure (X_8)	
	International Trade (X_9)	
	Sustainable transport (X_{10})	
	Air pollution (X_{11})	
	Charging stations (X_{12})	

trend is also observed in Lithuania’s strategic documents and institutional recommendations (according to the Ministry of Transport and Communications of the Republic of Lithuania’s development plan until 2050). As stated in the above strategy, the factors for changes in logistics systems can be both external and internal to the country. Based on Figure 1 it is noticeable that the turnover of passengers by road transport has a tendency to grow in the future.

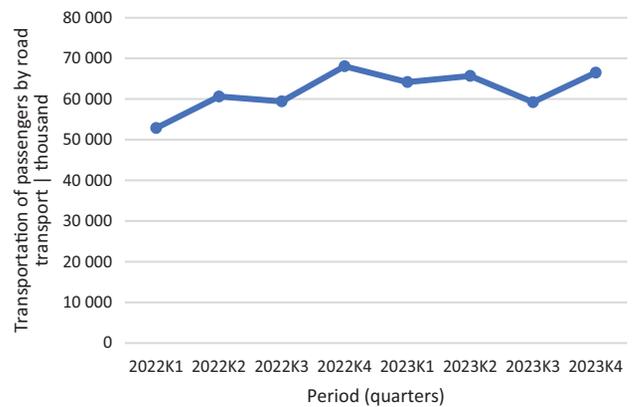


Figure 1. Change in passenger turnover

However, the growing number of vehicles in Lithuania (about 526 vehicles per 1,000 inhabitants) leads to a growing general increase in air pollution and greenhouse gas emissions (Lietuvos Respublikos Susisiekimo ministerija, 2020). Traffic jams have a negative impact on the socio-economic environment, and especially on air pollution. According to scientific studies, air pollution is 50 times higher than the general average at the time the car starts moving. Increasing the speed to 90 km/h reduces fuel consumption and emits less than half the emissions. However, not only do cars themselves cause air pollution, they also create vortices when driving and raise dust together with health-threatening microorganisms (Rutkovicienė & Sabienė, 2008). Therefore, the state encourages companies to abandon this type of cargo transportation by applying additional taxes and providing support and assistance to those companies that have chosen a sustainable type of cargo delivery. However, if this pressure is applied to road transport,

its turnover decreases (see Figure 2), affecting the overall figure.

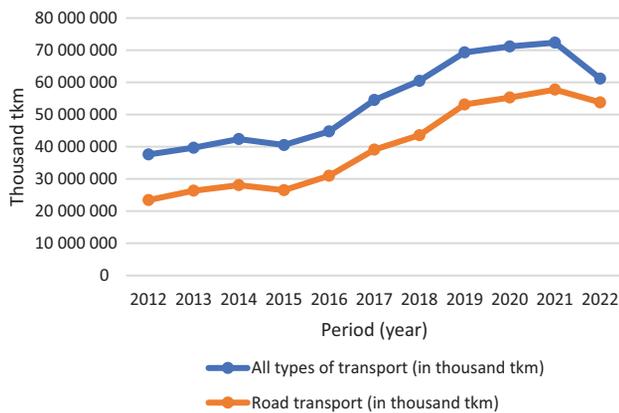


Figure 2. Dynamics of cargo transport

As for total turnover, it can be observed that there is an increasing trend; cargo turnover increased for a period of 10 years and had a sharp drop in 2022. At this time of year, the turnover of freight vehicles in Lithuania during the last 10 years has also suffered sharp drops and is currently growing very slowly (Figure 3).

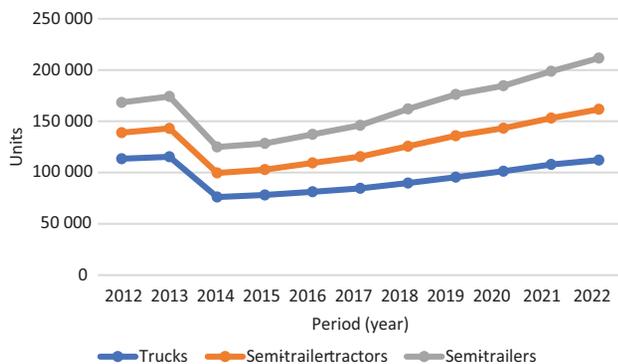


Figure 3. The number of vehicles on the road at the end of the year for the period 2012–2022 (source: Official statistics portal, 2012–2022)

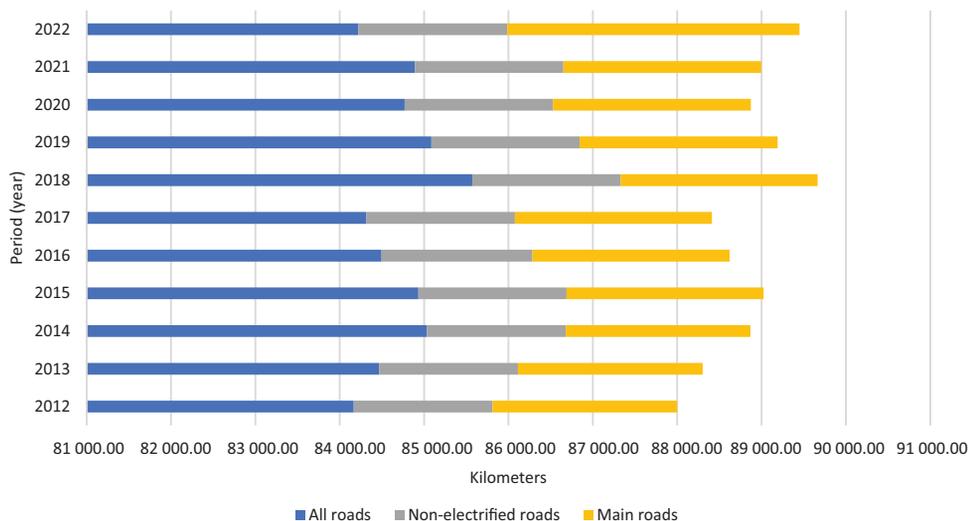


Figure 4. The length of road and rail transport routes at the end of the year for the period 2012–2022 (source: Official Statistics Portal, 2012–2022)

The condition of almost half (45%) of the main roads in Lithuania, where the most intensive vehicle traffic occurs, is satisfactory, bad, or very bad. The A19 roads are in the best condition and the A20 roads are in the worst condition. 3.6 thousand (74%) of the 4.9 thousand km of land and 5.9 thousand (75%) of the 7.9 thousand km of district roads are in satisfactory, bad, or very bad condition. 523 (34%) of the 1,522 bridges of state importance are in satisfactory, bad, or very bad condition. The length of roads decreases every year, while the lengths of the railway roads are increasing, and according to future forecasts, their length will continue to grow, which can affect cargo circulation (Figure 4).

Emigration and immigration in Lithuania are also of great concern and have an impact on cargo turnover (see Figure 5). According to the “Linava” specialists, there will be a shortage of about 3,000 employees in the near future. Truck drivers alone (Linava, 2024).

In Lithuania, there is a particular shortage of drivers for international trailer transport. Drivers must be at least 21 years old for this type of transportation, so many young people who have graduated from high school at a younger age do not wait for this age and choose another profession. A big problem is also the departure of drivers to work abroad, because salaries are higher there. When analyzing the import and export indicators, we can say that the amount of both imported and exported goods is increasing (see Figure 6).

According to Figure 6, it was observed that the balance of export and import was negative, which can determine the strategic plans and directions of transport companies, but it is also important to take into account the fact that the indicators of imported and exported goods are growing, which can increase the amount of turnover. When these indicators rise, the demand rises, and the produced production cannot be stored, it must be exported. Taking into account the increase in imports, we can determine that consumer demand for goods is growing, which requires more transportation.

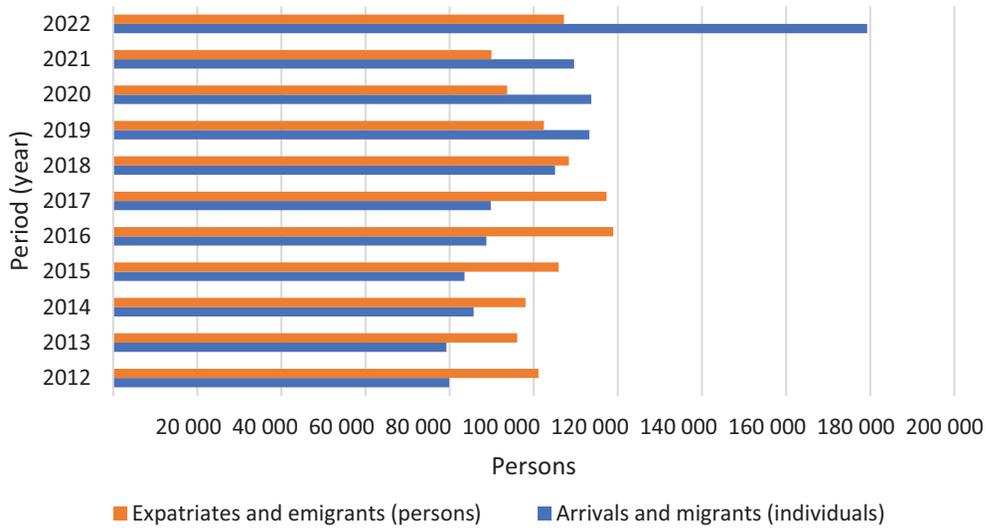


Figure 5. Number of arrivals and departures for the period 2012–2022 (source: Official Statistics Portal, 2012–2022)

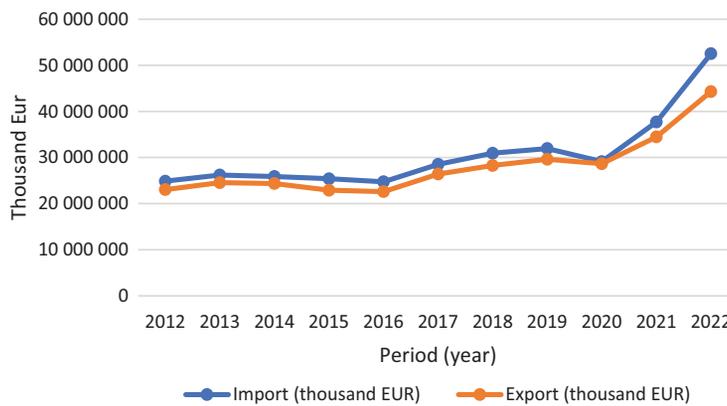


Figure 6. Import and Export Indicators for the Period 2012–2022 (source: Official Statistics Portal, 2012–2022)

Table 2. Correlation analysis results

End of Table 2

		Passenger traffic	Cargo traffic
Air Pollution (X11)	Pearson Correlation	-.098	.353
	Sig. (2-tailed)	.774	.286
Automobilization (X2)	Pearson Correlation	-.023	.267
	Sig. (2-tailed)	.030	.427
Charging stations (X12)	Pearson Correlation	-.798**	.270
	Sig. (2-tailed)	.253	.422
Emigration (X7)	Pearson Correlation	.628*	-.531
	Sig. (2-tailed)	.038	.003
Income (X4)	Pearson Correlation	-.596	.525
	Sig. (2-tailed)	.003	.007
Infrastructure (X8)	Pearson Correlation	.305	-.106
	Sig. (2-tailed)	.361	.757
International Trade (X9)	Pearson Correlation	.188	.674
	Sig. (2-tailed)	.580	.013
Population (X1)	Pearson Correlation	-.730	-.236
	Sig. (2-tailed)	.012	.015
Sustainable transport (X10)	Pearson Correlation	-.723	-.432
	Sig. (2-tailed)	0.01	.015
Unemployment rate (X6)	Pearson Correlation	-.025	-.038
	Sig. (2-tailed)	.942	.911
Urbanization (X5)	Pearson Correlation	-.711*	.402
	Sig. (2-tailed)	.014	.220
Fuel prices (X3)	Pearson Correlation	.019	.036
	Sig. (2-tailed)	.025	.012

To determine the influence of factors, a correlation analysis is performed. The results of the study showed that of all the factors discussed in the Table 2, the greatest influence is sustainable transport (-0.723) and population (-0.730). No significant linear relationship was found between passenger turnover and the following factors: charging stations, unemployment rate, and international trade. When studying the factors that influence cargo turnover, it was found that resident income (0.525) and international trade (0.67) have the greatest influence. No significant linear relationship was found between freight turnover and the following factors: automobilization, infrastructure, unemployment rate, and urbanization. In the second and third steps, a pairwise regression analysis is performed, the result of which showed how each factor affects the turnover of passengers and cargo. A polynomial regression line model is created.

$$Y = 3749836.76 - 16.91X_7 + 740.63X_5 - 139.22X_4 - 24\,788.94X_2, \quad (8)$$

where: X_7 – Emigration; X_5 – Urbanization; X_4 – Income; X_2 – Automobilization.

Based on this model, we can perform a simulation of how the passenger turnover rate would change if certain factors change, say 1%.

$$Y = 813\,093\,592.43 + 0.34X_1 - 183.95X_7 + 1678.01X_{10} + 972\,905.10X_9 - 9009.43X_3, \quad (9)$$

here: X_7 – Emigration; X_1 – Air pollution; X_{10} – Sustainable transport; X_9 – International Trade; X_3 – Fuel prices.

Based on this model, we can simulate how the cargo turnover rate would change if certain factors change by, say, 1%.

After forecasting (see Figures 7–8) the turnover of cargo and passengers using the moving average and exponential smoothing methods, it was observed that the mileage of freight cars will decrease, while the transportation of passengers by public transport will increase.

5. Conclusions

This study discusses the change of road transport and examines the case of Lithuania. It has been empirically tested that road transport has been identified as the largest part

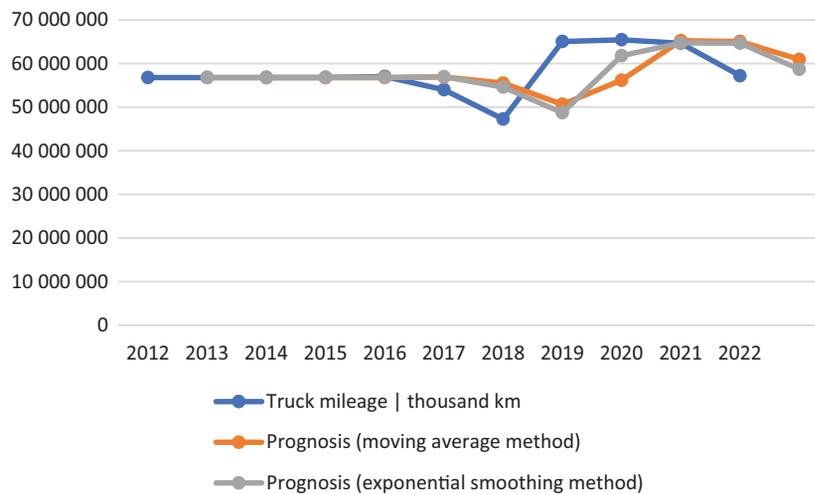


Figure 7. Truck mileage prognosis

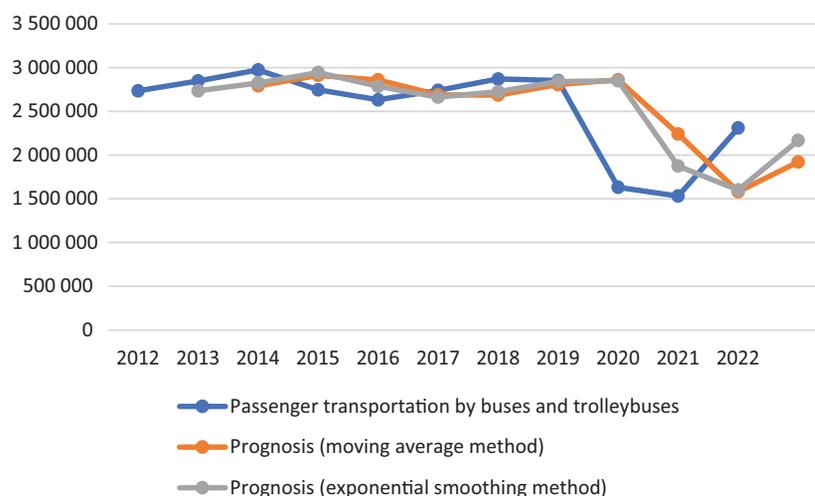


Figure 8. Prognosis for passenger transportation by buses and trolleybuses

of the transport system. This study has theoretically substantiated that changes in road transport are extremely important, and so in order to have a regulatory instrument, it is necessary to know which factors have the greatest influence. Many studies have been conducted from scientific sources (Jian et al., 2019; Sharma & Biswas, 2021; Vitkūnas et al., 2021; Vitkūnas & Meidutė, 2011; Weerasinghe & Bandara, 2023). The originality of research can be noted as a study that provides valuable insights into the detailed analysis of the logistics process. The authors of the article presented a study of the dynamics of road transport indicators in Lithuania, evaluating the increasing number of road vehicles, emigration, urbanization, and other factors. It was determined that Lithuanian freight and passenger turnover can depend on many factors, but the authors claim that the most influencing factors are population, car ownership, fuel prices, population income, urbanization, unemployment rate, emigration, infrastructure, international trade. All existing factors directly and indirectly affect existing turnover. After conducting the correlation analysis, it was found that the greatest influence on passenger turnover is caused by automobiles (−0.723) and the number of inhabitants (−0.730). No significant linear relationship was found between passenger turnover and the following factors: fuel price, unemployment rate, and international trade. When studying factors influencing cargo turnover, it was found that resident income (0.525) and export indicators (0.67) have the greatest influence. No significant linear relationship was found between freight turnover and the following factors: automobilization, population income, unemployment rate, and urbanization. Pair regression and polynomial regression models have been created, which allow modeling the situation, how the passenger and cargo turnover rate would change if certain factors change, for example.

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