



IMPLEMENTATION OF SUSTAINABLE PASSENGER MOBILITY PRINCIPLES IN RAIL TRANSPORT

Irina Solomatina

Lithuania Business University of Applied Sciences

Abstract

The article analyzes the implementation of sustainable passengers mobility principles in railway transport in Lithuania. Railway transport occupies a special place in passenger transportation, it has great potential, as it is an alternative to road transport. The goal of article is to reveal the prerequisites for the implementation of the principles of sustainable passenger mobility in railway transport in the Republic of Lithuania. To achieve the goal, analysis of theoretical sources, analysis of LR and EU legal acts, development strategies of the transport sector, statistical data analysis, monitoring, situation assessment have been committed. The principles of sustainable passenger mobility are modern approach to the saving of natural resources, personal and public interests, taking responsibility for the consequences of own actions as a user of transport services. Railway transport has potential in passenger transportation, as passengers flows are not high, compared to other modes of transport. Electrified railway transport is a competitive, friendly to nature and future generations choice. The opportunities of the tourism sector and railway transport are not exploited. It is necessary to assess the public's favorable attitude towards changes in transport due to ecological aspects, but the public transport sector must ensure high-quality services that meet EU standards and customer expectations. In order to achieve sustainable mobility in rail transport, priorities are set: measures are applied to reduce the negative impact on the environment, measures are applied to reduce the noise level, measures to contribute congestion reduction in the city area, to contribute to the promotion of physical activity of residents. Strategy of Lithuanian mobility development until 2050 projects in railway transport are directly related to the implementation of the principles of sustainable mobility and measures to increase passenger flows. To attract passengers to use railway transport in a sustainable way, to reject to use their own road transport, particular attention must be paid to speed, comfort, costs, connections with other transport modes or modes of travel, road transport, private or public, cycling or walking, and the compatibility of terminals with modern users needs. To implement the principles of sustainable mobility in railway transport, while simultaneously increasing passenger flows, the tasks must be solved in a complex manner, with close cooperation between institutions with different responsibilities. In addition, measures such as ensuring multifaceted connections between modes of transport and other movement alternatives, integration of tourism and railway transport, adaptation of city infrastructure to tourist needs, compliance of railway terminals with the main needs of passengers must be evaluated.

KEY WORDS: railway transport, sustainable mobility, railway infrastructure, passengers

Introduction

Modern society willingly accept changes in the transport sector for the past few years, which are conditioned by ecological aspects, for personal travel, daily or recreational, or cargo movement organization schemes. Preservation of natural resources, sustainable consumption, public interests, personal responsibility for one's health are the main force in today's progressive citizen's approach to transport. Railway transport occupies a special place in passenger transportation, it has great potential, because it is land transport, which can be an excellent alternative to road transport, i.e. for the use of private cars (because road transport is the most harmful type of transport for the environment and the population)

The subject of this article is the sustainable mobility of passengers in railway transport.

The goal is to reveal the prerequisites for the implementation of the principles of sustainable passenger mobility in railway transport in the Republic of Lithuania.

Tasks are set to achieve the goal:

1. to present the theoretical aspects of the conditions for the implementation of the sustainable passenger mobility principles in railway transport;
2. to carry out an analysis of the conditions for the implementation of the principles of sustainable

passenger mobility in railway transport in the Republic of Lithuania;

3. provide additional directions for the implementation of the principles of sustainable passenger mobility in railway transport in the Republic of Lithuania.

The methods used in the research are analysis of relevant scientific literature, analysis of LR and EU legal acts, development strategies of the transport sector, statistical data analysis, monitoring, assessment of the situation.

Theoretical framework

Travel methods and transport evaluation indicators. As it was already mentioned, modern society is already willingly accepting changes that are conditioned by ecological aspects, in the transport sector, for personal travel, daily or recreational, or cargo movement organization schemes. Society has already been introduced to the negative impact of transport on the environment, can assess its own personal contribution, and reduce the importance of that personal contribution by changing its travel habits.

Mobility undoubtedly has an impact on the internal market and the quality of life of citizens enjoying the freedom to travel. Transport also provides an opportunity to ensure economic growth and job creation, so it must meet the principles of sustainability in view of the new

challenges that arise. Transport is global, so active international cooperation is necessary to take effective results (European Commission, 2020).

The main idea for planning the sustainable urban mobility is to seek to establish the sustainable transport system in the city – through achieving goals such as e.g.: improved safety of transport, limiting adverse impact on environment, improved efficiency and effectiveness of transportation of passengers and goods, improved attractiveness and quality of urban area, and improved availability of transport services for the inhabitants. Mobility planning covers all types and modes of transport in the city – public transport, private, passenger and freight transport, motorized and non-motorized transport. (Marcin Wolek, 2018)

Mobility is an integral part of every person's life, regardless of the type of transport used, how often and how far they travel. For some people, travel is very important and significant in their daily life, for tough people it is less important, but less or more often, but everyone travels. In this way, travelers have a great influence on tourism and its development sector, and the formed travel habits affect the environment (Garliaskienė, Stravinskienė, 2015).

The impact of transport on the environment is usually associated with negative results, i.e. air pollution, noise, congestion, traffic accidents, waste, landscape pollution, but the impact can and must be reduced by changing travel habits. Transport demand is concentrated at a certain time, which is related to the current pattern of society's activity. In this case, the demand is both temporal and spatial. In some cases, e.g. travel to work or school, the demand has a certain regularity that allows for detailed estimates. In other cases, e.g. there are many uncertainties in social and leisure travel and in such cases demand forecasting will be unreliable (Johnson Viktoras, Ponnusvamy, 2012). Therefore, the positive point is that most trips, such as trips to work and educational institutions, can be calculated and predicted into the future, leisure trips are undefined, they are characterized by spontaneity, but certain forecasting is possible.

The most important factor for traveling is a properly chosen mode of transport, vehicle, and method of travel. The following types of transport are distinguished: road, water, air, railway transport. According to the ways in which goods and passengers are transported, land (road transport, rail transport, including metro, pipeline transport, cart transport, non-well transport, bicycle and other), water (sea transport, inland water transport) and air transport (civil aviation) are distinguished, according to the nature of the provided services - freight and passenger, according to the ownership of the vehicles - private and public transport, according to the purpose - general use, special (commercial) and personal (residents' cars, motorcycles, bicycles, boats, yachts, airplanes and others). Public transport (city transport, suburban and intercity buses, passenger railway trains, etc.) routes are regular, performed according to the schedule, while private transport carries passengers and cargo at any time and in any direction at the discretion of its owner.

Each person can freely choose the type of transport, the means of transport, with the help of which the trip will be made. Such a choice is determined by the availability of the type of transport and the vehicle at a certain time, in a

certain geographical region, as well as price, quality or reputation. The higher the level of public transport service is created, the more the choice of this type of transport and means of travel is ensured, which also ensures greater public transport passenger flows. Assessing passenger needs is mandatory to change established travel habits. Analyzing international experience, it was found that attracting car drivers to use public transport is a difficult task. This is because car drivers have a negative attitude towards public transport, due to travel times and conveniences such as multi-purpose travel: privacy, independence, transporting children, pursuing personal interests, etc.

To improve the quality of the transport system, the transport system evaluation indicators are distinguished:

1. Fast, convenient and cheap transportation of passengers and cargo.
2. Convenient intercity, interdistrict transportation.
3. Inexpensive infrastructure and operation.
4. Connections with other modes of transport
5. Conformity of terminals to passenger needs

Considering these presented indicators, it is possible to find out the possibilities of expanding the sphere (Sivilevičius, 2012).

Transport infrastructure - the totality of land and waterways, traffic management systems, related structures (including buildings), specially equipped territories and facilities and constructions intended to ensure transport activities. Trips can also be recreational or educational. People use them on weekends, on vacation or in their free time. To get the most out of this type of trip, it is important to choose the right type of transport and vehicle.

Leisure is a phenomenon of industrial society, which gave freedom to choose and satisfy different needs. The scale of choice, ranging from possible to necessary and necessary, becomes a considerable problem for modern man. Leisure has become an attractive and profitable market commodity. Leisure-time activities are becoming a major driver of the international or national economy as they create many jobs in various fields, from travel and tourism to art, various hobbies, sports, health and beauty. On the other hand, the choice of free time depends on a person's social and spiritual values, cultural environment (Liutikas, 2009). It benefits not only the person who uses his free time to travel, but also the surrounding businesses and the country's economy.

When examining the historical aspects of the development of transport, it is obvious that traveling was not always as simple and easy as it is now. Most of the country's citizens worked hard to meet their basic needs. Travel required a lot of expenses, so most of the society could not afford it. The trips were most popularized by merchants and craftsmen who often changed their place of residence due to a better standard of living. Also, the development of transport and the improvement of infrastructure contributed to the popularity of travel (Beležentis, Žuromskaitė, 2012).

Various typologies and classifications of travel and tourism can be distinguished. According to the topic related to the trip, such forms of tourism are distinguished as ecotourism, cultural tourism, religious tourism, tourism for medical purposes, sports tourism, political tourism, economic tourism, village tourism. Travel and tourism can

be divided according to the duration and time of the trip, characteristics of the geographical space, and the motives of the travelers. When classifying, the number of tourists, the method of travel, and the chosen entertainment are often taken into account (Liutikas, 2009). The potential of rail transport and tourism links is currently underrated, although it has great prospects.

Tourism is a rather complicated branch of business directly related to different sectors of society and economy. Without correct and accurate planning tourism

may cause undesirable negative impacts on ecology, social-economic processes and protection of cultural heritage. Strategic planning on national and regional levels should cover policy of tourism development, structural plan, standard of sites, institutional factors and

all the other elements necessary for the further promotion

and management. (Kadagidze, 2016)

Europe's transport system has succeeded in connecting people across the continent and reducing travel times. As society has become more mobile, the carbon residual of transport activities has increased. Transport currently accounts for a quarter of the EU's greenhouse gas emissions, and this figure is growing as demand grows. EU aims to reduce these pollutants by 90% by 2050 shifting to more sustainable modes of transport provides more affordable, accessible, healthier and cleaner alternatives [European Commission, 2020].

The most used vehicle is a private car. A motor vehicle is a vehicle designed to travel on the road, to carry goods and/or passengers or to tow other vehicles, excluding motorcycles, light quadricycles, powered quadricycles, mopeds, tricycles, tractors and self-propelled machines. Cars also include trolleybuses, which are non-rail vehicles that are powered by electric cables [Law of the Republic of Lithuania on Road Traffic Safety, October 12, 2000, No. VIII-2043].

Each user can freely choose the type of transport and means of transport that are more acceptable to him, usually he chooses from road, water, air, railway transport. The choice of the type of transport is determined by such criteria as price, availability, quality, travel distance and time ratio. Traveling for various purposes, e.g. necessary daily trips to work, educational institution, episodic trips, as well as recreational trips and tourism. Leisure trips can be educational or recreational. Every type of transport is important for the country's economy, and the ecological aspect is essential in the modern world. Interaction between modes of transport ensures smooth passenger service in the transport system. Electrified railway transport is a competitive choice, friendly to nature and future generations. The main indicators of the evaluation of the transport system are fast, convenient and cheap transportation of passengers and cargo, convenient intercity and interregional communication, inexpensive infrastructure and operation, connections with other modes of transport and the suitability of terminals for passenger needs. The potential of the tourism sector and railway transport links is currently not being used.

Impact of travel mode choice on society and the environment. The impact of the mode of travel on the environment and society is direct. Since the entire country's passenger transport sector is treated as a system,

the interaction between modes of transport must be fully evaluated. Personal dependence on a private vehicle is significant, and changing this attitude is a difficult task.

Each person's choice in the use of transport has an impact on the person, society and the environment. Sustainable development is inseparable from reducing the negative impact of transport on the environment, the social side of the transport sector and changes in mobility behavior and the formation of mobility demand. The impact on the environment or the safety of the environment due to the increase in traffic flows, and especially the significant growth of road and air transport services, has become very relevant in the recent period. In this case, the goal is to reduce the harmful impact of transport on the environment. This can be done in several ways:

- limiting the transportation process itself;
- tightening operational requirements for vehicles;
- financially supporting and promoting technologies, applying economic sanctions, fines, taxes;
- controlling the choice of the mode of transport through administrative measures

These are some of the most stringent ways to combat pollution. However, a more difficult but more socially acceptable way would be to introduce and encourage innovation. Because only a voluntary change of travel habits, without strict restrictions and without additional financial burden, when the user takes responsibility himself, realizes the importance of his contribution, ultimately gives a significant sense of satisfaction that every citizen is important in contributing to a common noble goal. Social responsibility, emphasizing the importance of sustainable development, is possible to analyse by various aspects: from debate, posed for the formulation of the concept, or socially responsible activities' benefit to society and the environment, to the impact of individual groups on the development of social responsibility and its benefits. Social responsibility is a relatively new concept that is becoming increasingly important relevance (Kareivaitė R. 2015)

Over the past five years, there has been a tendency to increase the use of road transport, as well as a systematic decline in transport by other transport modes. The development of road transport infrastructure (hereinafter also referred to as road transport), the increase in the number of vehicles traveling on the roads have a negative impact on the environment. (Antoszak, 2019)

Cities and their designers are under enormous pressure to overcome today's mobility challenges. Rapid urbanization, infrastructure, population growth and climate change continue to challenge the world's cities. Those who are determined to boldly improve and diversify their urban transport systems will gain a competitive advantage - investments in better and more sustainable mobility will give cities greater productivity, attractiveness and overall quality of life (Arcadis, 2017). Such a statement is also valid for the country. Europe remains the safest transport region in the world. Although traveling by air, sea and rail is very safe, it is not satisfactory, especially when it comes to traffic safety. In 2019 around 22,700 people are died on the EU's roads, and around five times as many suffer serious, life-changing injuries (European Commission, 2020).

Air quality is of particular importance in ensuring the sustainability of urban development. Transport, industry, power plants, agriculture, households and waste management contribute to Europe's air pollution. Emissions of the main air pollutants in Europe have decreased in recent decades, which has generally improved air quality. However, some sectors have not reduced their emissions enough to meet air quality standards, or have even increased their emissions of some pollutants. For example, nitrogen oxide emissions from road transport have not decreased enough to meet air quality standards in urban areas [European Environment Agency, 2020]. Deterioration of air quality is not the only negative impact of the transport system on the environment. Noise is also an element of negative impact on the environment. Noise is caused by traffic, construction, industry and some recreational activities. The external costs of noise in the EU amount to at least 0.35% of its GDP and are mainly driven by road traffic equivalent external costs of over 40 billion EUR per year. [European Environment Agency, 2020]. One of the most common sources of noise is road traffic, which accounts for up to 80-82% of the total noise. This noise is created by running vehicle engines, wheel-road contact while driving, and vibrating structures (Bernotienė et al. 2019). According to medics, noise affects the central nervous system and causes various disorders. Even low levels of noise can cause headaches, insomnia, memory loss, disorientation and difficulty concentrating. Noise has a significant impact on efficiency, coordination of movements, and increases nervous tension (Bernotienė et al. 2019).

The EU meet increasing challenges to develop efficient, resilient and low-emission transport networks that improve citizens' lives and economic performance while reducing environmental impact. The choice of private motor vehicles to move people and goods is a major source of growing problems related to air pollution and congestion. These issues raise concerns for the health, accessibility and quality of life of the population and can negatively affect business through delays and reduced reliability of the road transport network [European Commission, 2020].

The mobility of each person is also determined by the infrastructure. All investments in transport infrastructure have a positive impact on economic growth, help create jobs, promote trade, universal geographical accessibility and the movement of people. The organization and development of infrastructure is mandatory in such a way that the economy grows and the impact on nature is as low as possible (European Commission, 2020). Better transport infrastructure reduces the distance that goods and people have to travel, reduces traffic congestion, allows businesses and people to better predict travel times, provides opportunities to centralize logistics units and build production buildings, warehouses and other objects in geographically diverse areas

The EU is increasingly meet transport-related problems. The question of how to enhance mobility while reducing congestion, accidents and pollution is a common challenge for all major European cities. Congestion in the EU often occurs in and around urban areas. According to data, they cost almost 100 billion annually EUR or 1% of EU GDP [European Commission, 2020].

The possibilities of the road transport mode to achieve economies of scale are limited. This is due to size and weight restrictions imposed by the government and the technical and economic limitations of the engines. Most jurisdictions have specific weight and length limits for trucks and buses, which are imposed for safety reasons, but also because the heavy use of heavy trucks damages road infrastructure and increases maintenance costs (Rodrigues, 2020).

Road users must observe all necessary precautions, not endanger the safety and environment of other road users, other persons or their property, and also, in order to avoid harmful consequences or reduce them, must take all necessary measures, except in cases where this would endanger their own, other people's life or health, or such measures would cause even more damage compared to that which could be avoided (Law of the Republic of Lithuania on Safe Traffic on Automobile Roads, 10/12/2000, No. VIII-2043).

Sustainable ways of traveling are already presented, and society is willing to accept it. The issues of the negative impact of transport on the environment are understandable even to the youngest generation of society. Now is an excellent time to capitalize on the public's favorable attitude towards changes in transport for the ecological aspects. BDA possibilities are not widely used in the formation of social responsibility rules and mechanisms, but it has great potential for the expansion in this area (Miao Li). However, the public transport sector must also provide its customers with high-quality services that meet EU standards and customer expectations. Many vehicles still emit harmful gases into the environment, emit annoying noises harmful to health, change the landscape unattractively, and also cause traffic jams or accidents. Another of the main problems caused by transport is the decreasing physical activity of the population and, as a result, negative consequences for health. All these issues need to be assessed in order to achieve sustainable mobility in rail transport, i.e. measures are applied to reduce the negative impact on the environment, measures to reduce the noise level, contribute to congestion reduction measures in the city area (by diversifying train schedules, combining railway and road transport schedules), contribute to the promotion of residents' physical activity (bicycles and walking trips).

The most common modes of travel. People choose their type of travel based on their financial situation and needs. One of the most popular ways to travel is by own car. According to the European Automobile Manufacturers Association [2019], more than 70% of trips are made by car - private car, taxi or car sharing. Without individual mobility, adequate participation in social and economic life would not be possible in many cases, especially for people living in remote areas, the elderly and the disabled. The automobile greatly improve communication, the speed of movement and adaptation to the environment.

Cities have become the centers of humanity - their planning and design is favorable for the development of businesses. Over the past 10 years, much discussion has focused on sustainability, with the goal of reducing greenhouse gas and carbon dioxide (CO₂) emissions. However, progress is proving elusive in the transport

sector, where private cars still rely heavily on petrol or diesel. In almost all cities, transport emissions are increasing, urban air quality is degraded, and travel by private car is first choice. Many people complain that their daily commute is "the worst part of their daily life". It appears that planning for attractive future lifestyles is becoming more difficult and the quality of life in cities often improves more slowly (Hickman, Banister, 2014).

Although car emissions and noise are a major problem in the world and in the EU, according to the European Automobile Manufacturers Association, the average new car emissions were 123g CO₂/km, compared to 186g CO₂/km in 1995 - decreased by 33.9% in just 25 years, and since 1970 the noise caused by passenger cars decreased by 90 percent.

The increased needs of the population and a relatively better developed road infrastructure network have led to rapid car using grow in the country. Residents choose cars as a means of travel because of faster travel and the possibility to travel "door to door". The number of vehicles is constantly increasing, but it is dependent on the country's economic indicators, so it can be said that it would be one of the indicators of the country's development trends. (Valieka et al. 2019).

With the increasing role of senior citizens in modern societies it is important to know, their transportation preferences and travel behavior (Hebel, 2018).

The characteristics of the Lithuanian railway transport infrastructure and the operated technically and morally outdated passenger rolling stock do not allow increasing the speed of passenger trains. For this reason, rail transport is less attractive to passengers than much faster road transport (The approval of the National Transport Development Program for 2014-2022, 12/18/2013, No. 1253).

The technical state of the railway infrastructure has a significant impact on the safety of cargo and passenger transport. A technical state and the outdated traffic control devices resulted in various speed limits being introduced to increase the safety. This led to a decline of the attractiveness of this transport mode. (Wulgaris, 2018)

Increasing the rail transport competitiveness in the transport services market be achieved may by reducing the transportation time and ensuring the regularity of the passengers and freight delivery. Reducing the passengers and goods time transportation is an urgent problem of all transport modes. On the railway transport, travel time reduction is possible by reducing the train's stoppings and increasing the running speed (Myronenko, 2018)

According to EUROSTAT data, trips in Lithuania are made by own cars, which ranges from 88 to 92 percent, by public transport from 7 to 11 percent, while traveling by railway is unpopular at all, accounting for only about 1 percent of travel. The volume of passenger transportation by rail transport increased after the rolling stock was partially renewed, but a large part of it is still outdated and reduces the attractiveness of rail transport (On approval of the National Transportation Development Program for 2014-2022, 12/18/2013, No. 1253). Therefore, considering the current situation, travel by public transport and railways should be encouraged.

There are 271 million cars on European roads today - their average age is 10.8 years. Alternative powered cars

(electric, hybrid, natural gas, LPG) make up 3.8% of the total EU vehicle fleet and 10.6% of all new passenger car registrations in 2019. [European Automobile Manufacturers Association, 2021].

The location of the given area in the agglomeration affects the modal split of the journey. An increase in the distance from the core of the agglomeration increases the propensity to use passenger cars. Also, the increase in the difference in travel time between car and public transport encourages the use of a car, but these dependencies require more detailed analysis. The most important reasons for choosing a car when traveling, regardless of the place of living in the agglomeration, are convenience and shorter travel times. The increase in the share of rail transport in travel affects the increase in the importance of waiting time and the lack of interchanges as a factor determining the choice of cars on travel (Grzelec, 2019)

According to all the data, it can be concluded that the most used transport is still road transport (own car), but it is necessary to use the potential of public transport and railways for local journeys. To achieve the goal, the interface between modes of transport must be attractive, convenient and acceptable to users. Obviously, due to maneuverability, lack of time, convenience, most of the population chooses a car, although it is the most polluting mode of transport, but it is the most popular means of transport, which is difficult to replace according to the needs of consumers. In such cases, it is important to change the attitude of consumers towards the choice of travel mode. To strengthen the positions of the principles of responsible consumption in society. Free choice, the satisfaction of a personal choice of a well-thought-out sustainable way of travel will give the user a sense of the importance of his contribution.

Sustainable travel methods and combinations.

Sustainable ways of traveling are emphasized in the EU transport sector development policy. It is only possible to achieve positive ecological results through consistent action in society.

From the point of view of the concept of sustainable development, economic growth and consumption cannot be regulated or supervised, it must be coordinated with social needs and it is necessary to safe natural resources for future generations. It is believed that the concept of sustainable development was first mentioned and recognized at the international level in 1972 at the UN conference (Jociutė, 2013). A sustainable transportation system is understood as an effective interaction of social, cultural, economic and ecological aspects. A good transportation system ensures close cultural and social links, increases population mobility, expands international cooperation and tourism, improves business conditions and promotes its development, without harming the environment and people (Approval of the National Transportation Development Program 2014-2022, 12/18/2013, No. 1253).

Sustainable mobility policies are very focused on environmental protection; sometimes, sustainable mobility is identified only as mobility that is able to reduce environmental impacts. Even if this concept is not correct, indeed most of the interventions aimed at the development of sustainable mobility have as their main objective the

reduction of pollutant emissions and greenhouse gases (Gallo, 2020).

Sustainable travel is defined as tourism that manages resources in such a way as to satisfy economic, social and aesthetic needs, while maintaining cultural integrity, ecological processes, biological diversity and all life support systems (Garliauskaitė, Stravinskienė, 2015).

Several sustainable travel systems are distinguished:

1. A political system that ensures the participation of broad sections of society in decision-making.
2. An economic system that guarantees expanded reproduction and technical progress since its base.
3. A social system that guarantees the minimization of tension after making a harmonious economic decision.
4. A technological system that ensures continuous search for new solutions.
5. A financial system that enables stable trade and financial relations.
6. Administrative system, sufficiently flexible and promptly self-correcting.

It is important to popularize the concept of sustainable tourism (its essence is education and training that positively affects the formation of a responsible attitude to recreation and tourism). Also to change the attitude of tourists towards tourism and recreation. Educational programs are necessary to help preserve the potential of world tourism

Passenger awareness, mobility education and sustainable transport marketing are considered part of the mobility management system. Some theorists specializing in agility management consider these aspects remote from the system. It is almost impossible to draw any boundaries [EPOMM, 2019].

The Sustainable and Smart Mobility Strategy (2020) for the future created by the European Commission, whose main intermediate goals for reducing the current dependence on fossil fuels are:

1. Until 2030 at least 30 million cars and 80,000 trucks will be in operation without emissions.
2. By 2050 nearly all cars, vans, buses and new heavy vehicles are low-emissions.
3. Zero-emission ocean liners and large zero-emissions aircraft will be ready for market by 2030 and 2035, respectively.

Stakeholder and public involvement are basic requirements for sustainable mobility. The goal is that citizens and stakeholders can express their ideas, concerns, and contribute creative and innovative ideas to solving transport problems. In addition, it encourages citizens and stakeholders to take action to implement sustainable mobility ideas. (Lindenaua, Böhlner-Baedekera, 2014).

Cycling is an efficient way to use precious and scarce spaces in cities in a healthy, clean and cheap way. This has huge potential when we recognize that almost half of all car journeys in cities are less than five kilometers. However, according to experts, the attractiveness and principles of using bicycles in Lithuania correspond only to the situation of the seventies of the last century (Kučinskienė, 2014)

In the informal meeting of EU transport ministers in 2015 October, The declaration on cycling as a climate-friendly mode of transport was adopted in Luxembourg [European Commission, 2020].

Cycling is increasingly considered a key part of a multimodal and integrated transport system for several reasons:

- It is a more economical choice compared to other modes of transport;
- It is a convenient mode of transport for a large part of short trips, dominating when traveling in the city;
- It has many co-benefits for health, environment and urban life [European Commission, 2020].

City bike systems are also a substitute for travel modes such as walking and cycling. The possibility of renting a bicycle and using it on a one-way journey without incurring costs associated with the maintenance of the bicycle and storage increases the efficiency of travel of people who do not have their own bike or have their own bike, but encounter their problems associated with transporting it in available means of public transport (lack of space in bus, no security guarantee of leaving the bike around interchange places). The development of city bike systems should be related to the possibility of moving between intermediate destinations, i.e. place of residence / work and bus stop / station. A city bike allows to combine different modes of transport and provides higher mobility than standard public transport. (Suchanek, 2019)

A trip on foot is a way of traveling, a component of ecological, nature-lovers tourism or tourist hikes, the purpose of which is to get to know the environment better and not harm nature; in cities, it is associated with visiting famous places. A 30-minute brisk walk or bike ride most days of the week, even if it's just 10 to 15 minutes, provides effective health benefits. The average walk in Europe is around 1.5 km and the average bike ride is around 3.5 km, each taking around 15 minutes: two such trips each day would be enough to provide the recommended daily dose of physical activity.

Another very sustainable and growing way of traveling is electric or hybrid cars. They do not emit harmful, poisonous gases into the environment like cars that run on petroleum-based fuels. Battery electric vehicles are powered entirely by an electric motor, using electricity stored in an on-board battery that is charged when connected to the mains. Plug-in hybrids have an internal combustion engine (running on gasoline or diesel) and a battery-powered electric motor. If necessary, the combustion engine supports the electric motor and the battery is charged when connected to the grid (European Automobile Manufacturers Association, 2021).

Railway transport is one of the most environmentally friendly types of transport, which consumes up to ten times less fuel than road transport when transporting passengers and goods. Together with the constantly improving legal system of the European Union and balanced financial support, this creates the prerequisites for developing a more environmentally friendly railway transport business, improving the technical-technological and organizational mechanisms of the interaction of railway transport with other modes of transport.

The strategic communication plans and challenges envisage three main directions:

- Saving of natural resources, reduction of carbon dioxide emissions;
- Development of ecological, safe and quiet transport;

- Application of environmental protection measures and control system (SC "Lietuvos geležinkeliai" Environmental report, 2017).

There are few electrified railways in the Lithuanian railway network - only 9 percent of all railway. This is the lowest indicator among EU member states. Electrification of railways is one of the provisions of the TEN-T development guidelines. After the electrification of the railway network, the prerequisites would be created to switch from fossil fuels to the use of renewable energy resources in the railway transport sector, to reduce the impact on the environment and to increase the attractiveness of railway transport for passengers and freight using environmentally friendly means (The approval of the National Transport Development Program 2014-2022, 2013-12-18, No. 1253).

Thus, connections with road transport are extremely important for sustainable passenger rail transport, i.e. with sustainable passenger road transport (electric cars, public urban electric transport), and the possibility of using railway transport to reach the destination by bicycle or on foot (whether it is a tourist, recreational or necessary trip) must be ensured. To increase the use of public transport without reducing service quality, it is essential to construct a demand-based timetable (Özbakır, L., 2021)

It should be taken into consideration that the city is a system, a system of connected points and parts. The individual subsystems of this system cannot be considered independently of each other. When analyzing the problems of transport in a city, all its subsystems should be taken into account, in particular with regard to different groups of users or types of transport. It should also be remembered that cooperation between urban and regional self-government is necessary in many aspects because, although it is a city, it is the voivodeship government that may have the right to decide on the railway transport issues (Jurczak, 2019).

After the initial analysis, the following directions for ensuring coherence can be emphasized:

1. Links with sustainable road transport
2. Possibility to transport own bicycle (on all routes)
3. Network of bicycle paths near transport terminals (railway stations)
4. Bicycle storage facilities
5. Integration of railway transport and tourism

The specified directions undoubtedly require additional detailed planning, coordinated inter-institutional cooperation, and financial investments.

Mobility management is the concept of promoting sustainable transport and managing the demand for car use by changing the attitudes and behavior of travelers. At the core of mobility management are "soft" measures such as information and communication, organization of services and coordination of activities of different partners. "Soft" measures usually increase the effectiveness of "hard" measures in transport. Mobility management measures (compared to "hard" measures) do not necessarily require large financial investments and can have a high cost-benefit ratio [EPOMM, 2019].

The sustainable European transport system that the EU is aiming for must be smart, flexible and adaptable to ever-changing transport patterns and needs, based on cutting-edge technological advances to ensure seamless, safe and

secure connectivity for all European citizens. Transport should demonstrate European ingenuity and diligence - be at the forefront of research, innovation and entrepreneurship and promote twin transitions (European Commission, 2020).

The EU's sustainable development policy has unambiguously set the directions for the development of transport markets. It carries the hallmark of qualitative changes in transport systems. According to the assumptions, in the near future the share of road transport should significantly decrease by supporting rail transport and inland navigation over long distances. In addition, the increase of social awareness in the field of sustainable development will be conducive to pro-quality and pro-ecological changes (Rucińska, 2018).

Intelligent Transport Systems (ITS) are vital to improving safety and tackling Europe's growing pollution and congestion problems. They can make transport safer, more efficient and more sustainable by applying various information and communication technologies to all modes of passenger and freight transport. In addition, new services can be created by integrating existing technologies. ITS are crucial to promoting jobs and growth in the transport sector. However, for the implementation of ITS to be effective, it must be consistent and properly coordinated across the EU [European Commission, 2020].

Sustainable transport systems are designed to improve the quality of services, reduce pollution, limit state subsidies for transport, increase the efficiency of transport networks and land use, and increase people's mobility.

Sustainable mobility is understood as the interaction of economic, social, cultural without harming the ecosystem and preserving resources for future generations. In cities, the transition to sustainable mobility is easier than in the countryside, because the distances covered are shorter and the population is larger. Movement that requires physical activity is the most sustainable for the environment and the human body, such as cycling and walking. Railway transport is one of the most environmentally friendly modes of transport, which consumes up to ten times less fuel than road transport when transporting passengers and goods. Therefore, it is necessary to use the possibilities of railway transport, assessing the interaction between modes of transport, as well as alternative possibilities of movement. The integration of the tourism and rail transport sectors can have great potential to achieve the highest level of passenger traffic.

Methodology

To carry out an analysis of the conditions for the implementation of the principles of sustainable passenger mobility in railway transport in the Republic of Lithuania and provide additional directions for the implementation of the principles of sustainable passenger mobility such research directions are selected:

1. assessment of the current passenger transport situation in railway transport considering the available resources;
2. analysis of statistical data (capacity, transport dynamics, possibilities, perspectives)

3. analysis of Lithuanian mobility development strategy until 2050 (possibilities, plans)
4. identification of unmentioned possibilities

The assessment of the current situation of passenger transportation by railway transport is necessary when examining the prospects, the analysis of statistical data reveals the real transportation indicators and transportation opportunities, the analysis of the development strategy presents the actual development plans, and the unmentioned opportunities are highlighted by comparing the collected data and theoretical sources

Results

Trends of sustainable passenger mobility principles implementation in Lithuania railway transport.

Passenger railway services in Lithuania are provided by "LTG Link" (previous name "LG Keleiviams"), the Company is located at Geležinkelios st. 16, Vilnius. Legal form – joint - stock company. JSC "LTG Link" is a subsidiary company under the patronage of SC "Lietuvos geležinkeliai" (<https://www.litrail.lt/>), 100 percent. shares belong to SC "Lietuvos geležinkeliai". The sum of nominal values of shares belonging to SC "Lietuvos geležinkeliai" is EUR 156,237,000. SC "Lietuvos geležinkeliai" shares are managed by the Ministry of Transport. LTG Link is a part of the "Lietuvos geležinkeliai" group, operating as a separate company since September 2019, responsible for train travel in Lithuania, international travel and transit travel to the Kaliningrad region. The company's mission is to become the first choice for travelers and to create a new travel experience by encouraging the choice of a comfortable, safe and nature-friendly means of transport - the train. Over the past few years, the number of the company's passengers has consistently grown, and in 2019, a record number of people traveled by train in Lithuania - 5.5 million. The LTG group of companies, responding to the geographical and economic changes in the transport services market, which determine the changing directions of trade and passenger flows, plans its activities not only in the short-term, but also in the long-term perspective. In order that LTG's long-term corporate strategy for 2018-2030 planned strategic directions and goals would be focused as much as possible on specific activities carried out by the LTG group of companies, long-term strategies of individual LTG business units were prepared. One of them is LTG Link's long-term strategy for 2018-2030, which is reviewed and improved annually.

JSC "LTG Link" is part of SC "Lietuvos geležinkeliai" group, which encourages people to travel with an ecological and safe means of transport - the train. The company's goal is to create a new travel culture and become the first choice for passengers, valued for its high level of service, operational efficiency and management. From 2019 September 1 the company continues its activities as a separate legal entity, which was previously known as SC "Lietuvos geležinkeliai" Passenger Transport Directorate.

LTG Link identifies the following priorities and development plans - it is environmentally and socially friendly transportation. To increase the number of passengers, new flights and routes, both domestic and international, are planned, as well as the adjustment of

routes and schedules to the needs of passengers and the implementation of a new ticket sales system. New services such as additional sales on trains, rental services, etc., dynamic pricing, and greater average travel distance are expected to increase revenue. Measures such as optimization and modernization of the rolling stock, automation and digitization of daily work operations are planned to increase operational efficiency. The priority activities for strengthening the partnership are integration with other modes of transport, international partnership.

The updated strategy also presents summarized priorities:

- Renovation of the train fleet by purchasing environmentally friendly electric trains adapted to passengers with different needs. Including passengers with mobility issues.
- A long-term contract with the state is the basis of successful passenger transport.
- Train travel tickets - in modern ticket sales channels.
- New routes that meet the needs of passengers: connecting the capitals of Lithuania and Poland with a comfortable train that meets the needs of modern travelers
- Business digitization solutions

In Lithuania, the railway network consists of 1520 mm and 1435 mm gauge railways, thus creating connections both with EU countries and Eastern countries. Based on the 2020-2021 according to the regulations of the official train schedule network, the Lithuanian railway transport network in 2019 consisted of 1910.7 km of operated railway roads, of which: 1459.2 km (76.3%) were single roads; 449.4 km (23.6 percent) of double-road; 2.1 km (0.1 percent) of triple-road.

The major part of the railway network (93.7%, 1790.6 km) in Lithuania consists of railway lines with a gauge of 1520 mm, the rest (120.1 km, 6.3 %) – from 1435 mm in Lithuania in 2019 only 152.4 km (7.97 percent of the network) were electrified. Electrified traction in 2019 only passengers were transported, freight transportation by railways is carried out by locomotive traction (diesel fuel is used), which causes GHG emissions into the environment.

2010-2019 during the period, the number of passengers transported by railways increased by 22 percent. (4.3 million passengers in 2010, 5.5 million passengers in 2019). Main travel directions of residents: Vilnius – Kašiadorys – Kaunas, Vilnius – Šiauliai – Klaipėda, Vilnius – Turmantas.

Below is a summarized extract from the SWOT analysis of railway transport from the Lithuanian mobility development strategy until 2050, relevant for sustainable passenger transport.

Strengths are:

- The part of the railway network that transports the largest volumes of cargo and passengers belongs to the main TEN-T network.
- Corridors of European importance stretch through Lithuania in the east-west direction, and the Rail Baltica project is being developed in the north-south direction.
- There are two main railway systems in Lithuania (1435 mm and 1520 mm wide tracks), which allow serving different markets and ensuring compliance with the requirements of both systems.

- Demand for passenger and freight transportation has been growing for the past fifteen years.

- Part of the railway sections are electrified, on the most popular passenger route Vilnius - Kaunas, passengers are transported by low-impact electric trains, as well as on the international route Vilnius - Minsk.

Weaknesses are:

- Part of the main TEN-T network is not electrified.
- Most of passenger railway stations and platforms are not adapted for persons with special needs.

- There is a lack of compatibility of railway transport infrastructure with road transport, which ensures efficient interaction for passenger and cargo transport.

- Most of the fleet of passenger vehicles does not meet the quality requirements established by the EU and national law, and is not adapted for persons with special needs.

- The railway network is more suitable for freight transport than for passenger transport.

- Diesel traction is mostly used in freight transport and passenger transport, which causes GHG and environmental pollution.

- There is no long-term and consistent funding for the provision of public services by rail transport, which would allow service providers to clearly plan investments.

- No mechanism has been developed to finance the railway infrastructure from the taxes collected by the state.

Opportunities are:

- Construction and extension of the Vilnius Airport - Kaunas Airport branch of the Rail Baltica project to Klaipėda for fast passenger transportation.

- Electrification of the entire railway network in use (including conversion of rolling stock to electric traction).

- Railway development in cities and industrial zones, in combination with the directions of urbanization and job development.

- Development of international passenger transport routes.

- Increasing the volume of passenger transport by attracting passengers from passenger cars.

- Launching of high-speed trains from Kaunas / Vilnius to the cities of EU countries.

- Synergy of the development of passenger transport with strategic directions of development of other types of passenger transport (development of airports, maritime transport, etc.).

Threats are:

- Delayed Rail Baltica project.

- The capital costs of the infrastructure created with EU funds are not included in the costs, but in the future it will be necessary to maintain the infrastructure from income.

- The geopolitics of the eastern neighbors may lead to the fact that goods from eastern countries will not be transported through Lithuania in the direction of Klaipėda port and passenger flows (especially transit flows) will decrease.

- The expectations of the Government of the Republic of Lithuania regarding the financing of public projects (e.g. the Rail Baltica project) do not meet the financial capabilities of LTG.

So, in summary, it can be said that the opportunities to increase passenger transportation by rail transport by applying the principles of sustainable mobility are real, it

is important to properly set priorities and direct investments to the most demanding areas, i.e. development of passenger transport routes, electrification of the railway network, development of international passenger transport routes, increase in the volume of passenger transport (various directions and measures must be provided for this), attracting passengers from passenger cars, launching high-speed trains from Kaunas / Vilnius to cities in EU countries

Thus, the potential of passenger transportation by railways is not fully used, as the sector is currently more focused on freight transportation, and the infrastructure is not fully adapted to users with special needs.

Below is an excerpt from the Lithuanian mobility development strategy until 2050, Annex 1 "Projects until 2030 list" (it is emphasized that the list of projects must be constantly reviewed and changed/completed according to emerging needs and changing circumstances. The list of projects also includes projects provided for in other National documents, so project scopes, budgets and indicators may change depending on the changes made in other documents).

Only projects relevant to the implementation of sustainable passenger mobility in rail transport are presented.

The following data are indicated: instrument, project type, project, description of the project or the values to be achieved, responsible entities, period (beginning - end)

- Electrification of railways. Investment project. Electrification of the section Kaišiadorys - Klaipėda (Draugystės st.). After electrification of the planned section, the length of electrified railway tracks would increase to 478.8 km. i.e. 25.1 percent of the operated network, and in the entire section V.S. – Kena – Klaipėda (Draugystė st.) the IXB corridor belonging to the TEN T core network would provide conditions for activities using electric traction (LTG Infra 2019-2023)

- Electrification of railways. Investment project. Electrification of the Vilnius railway hub. After the electrification of the railway sections Kyviškės - Valčiūnai - Vaidotai - Paneriai and Vilnius - Kirtimai - Valčiūnai, which make up the Vilnius bypass, the attractiveness of railway transport for passenger and cargo transportation will be increased, and environmental pollution will be reduced. The implementation of the project will significantly contribute to the integration of the country's railway communication system into the TEN-T transport networks. (LTG Infra 2019-2023)

- Electrification of railways. Investment project. Electrification of the railway sections Kaunas–Kybartai, Palemonas–Vaidotai–Stasylos, Kužiai–Bugeniai. 50 percent electrified railway network (EU average 52.7%), which would contribute to lower CO₂. (LTG Infra)

- Electrification of railways. Investment project. Development of infrastructure at battery charging stations for passenger trains. Infrastructure in battery charging stations would contribute to CO₂ reduction in the transport sector. (LTG Infra 2022-2024)

- Encouraging the habits of the population not to use polluting vehicles. Communication / investment project. Wide social dissemination, public information, habit formation, pilot projects that reduce fossil fuel consumption The fuel consumption of the affected

population will decrease by 3.7 percent due to the application of the measures. (Ministry of Transport, Ministry of Environment, Ministry of Energy, Ministry of Health, Ministry of Economy and Innovation, Ministry of Education and Science, municipalities. 2021-2030)

- Development of efficient communication. Regulation project. Long-term contract with the institution authorized by the Government on the provision of public passenger rail transport services. Signing and implementation of a long-term contract with an institution authorized by the Government on the provision of public passenger transport services by rail in order to ensure the sustainability of passenger transport activities and stabilize the profitability of the activity. (LTG Link, Ministry of Transport 2021-2030)

- Promotion of sustainable mobility in cities and promotion of sustainable mobility in non-urban areas. Investment project. Construction or reconstruction of pedestrian and bicycle paths. Built/reconstructed pedestrian and bicycle paths, 343.9 km. (Municipalities 2021-2030)

- Adaptation of infrastructure for persons with limited mobility and persons with special needs. Investment project. Adaptation of railway transport services for persons with reduced mobility. Implementation of a specialized service program for persons with limited mobility in railway transport. (LTG Link 2021-2024)

- Adaptation of infrastructure for persons with limited mobility and persons with special needs. Investment project. Station information system and barrier-free route adaptation for people with disabilities in station areas. Adaptation of bus and railway infrastructure for persons with limited mobility and companies with special needs, ensuring the requirements of the WHO agreement. (LTG Infra, LTG Link, municipalities 2019-2022)

- Adaptation of infrastructure for persons with limited mobility and persons with special needs. Investment project. The ratio of public transport (buses, city transport, trains, ferries) adapted for persons with disabilities to the number of all public transport means is 40 percent. (LTG Infra, LTG Link, municipalities 2019-2022)

- Ensuring intermodality and functional compatibility in passenger transport. Investment project. Creation of a unified open transport database. (Ministry of Transport, municipalities)

- Ensuring intermodality and functional compatibility in passenger transport. Investment / regulatory project. One electronic ticket system when traveling throughout Lithuania. A single electronic ticket system when traveling in the country. (Municipalities)

- Development and maintenance of TEN-T railway infrastructure. Investment project. Development of new railway lines in Lithuania (Klaipėda–Kretinga–Palanga, Kaunas–Kaunas SEZ–Kaunas airport, etc.) Increased population and workforce mobility. Increased volume of rail transportation. (LTG Infra, municipalities 2021-2030)

- Development and maintenance of TEN-T railway infrastructure. Investment project. Reorganization of the infrastructure to increase train speed and capacity (e.g. Kaunas–Vilnius– Klaipėda, Panevėžys (Gustonys)–Klaipėda) – Reduced CO2 emissions; – 0 railroad fatalities. (LTG Infra 2021-2031)

- Development and maintenance of TEN-T railway infrastructure. Investment project. (LTG Infra 2015-2026)

- Development of railway transport infrastructure. Investment project. Reconstruction of the Marcinkonys - Druskininkai railway section. (LTG Infra, municipalities 2021-2025)

Summarizing the data presented, it can be said that all planned until 2030 projects in railway transport are related to the implementation of the principles of sustainable mobility and means of increasing passenger flows, i.e. electrify lines, renew, develop and adapt infrastructure for persons with limited mobility and persons with special needs, ensure links between modes of transport, as well as ensure intermodality and functional compatibility in passenger transport, promote the habit of residents not to use polluting vehicles, promote sustainable mobility in cities and non-urban areas .

However, it should be emphasized that the user's dependence on a personal car is a high, and such aspects are important when choosing a travel method:

1. Fast, convenient and cheap transportation of passengers and cargo.

2. Convenient intercity, interdistrict transportation.

3. Infrastructure and operation.

4. Connections with other modes of transport

5. Conformity of terminals to passenger needs

Thus, in order to attract passengers to use sustainable rail transport, special attention must be paid to speed, comfort, price, connections with other modes of transport or modes of travel, i.e. by road transport, private or public, by bicycle or by walk, and for the adaptation of terminals to the needs of the modern users.

To reveal the trends of passenger transportation by railway transport in Lithuania, the article will examine the statistical data of passenger transportation by rail (according EUROSTAT and Official LT Statistics portal).

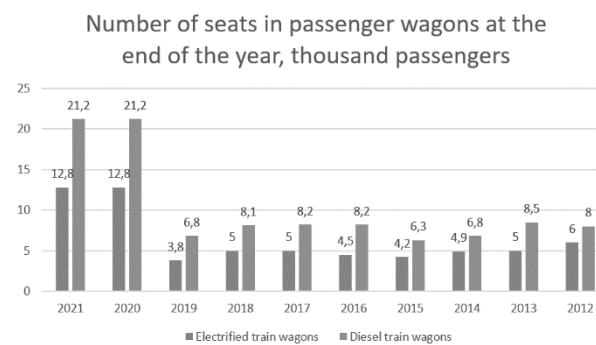


Fig. 1. Number of seats in passenger wagons 2012-2021
Source: Lithuanian official statistics producers

Fig. 1 presented changes in the possibilities of passenger transportation in railway transport in 2012 - 2021, i.e. the total capacity of passenger wagons, or otherwise available passenger transportation capacity during the specified period. The unit of measurement is the number of seats in passenger wagons at the end of the year. There are two groups, i.e. the number of seats in electric train passenger wagons and diesel train wagons. In 2020, there is an obvious increase in passenger seats, both in electric and diesel wagons. Thus, the offer to passengers is consistently implemented.

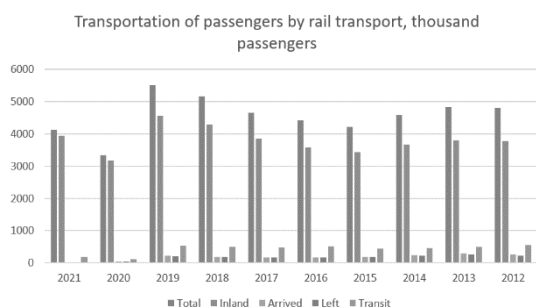


Fig. 2. Transportation of passengers by railway transport in 2012-2021.

Source: Lithuanian official statistics producers

The presented diagram (fig. 2) shows the distribution of passenger transportation by railways in 2012-2021 by types of transport - inland transport, arrivals, departures and transit. It should be noted that the essential passenger flows, which make up the volume of passenger transport in the territory of the Republic of Lithuania, are domestic transport (inland), i.e. movement in the territory of the Republic of Lithuania, transit, arrival and departure make up only a few percent of the total volume of transportation during the entire period under consideration.

Due to this trend, a fundamental attention should be paid to ensuring the quality of domestic transport (timetables that meet the needs of passengers, flexible price policy, infrastructure, connections between modes of transport, etc.) so that the positive indicators do not decrease over time, i.e. promoting the use of public rail transport. High results were achieved in 2019, has already decreased significantly in 2020 - the impact of the pandemic on the number of transported passengers is reflected in the presented graph.

With low arrival and departure rates, it would be appropriate to develop these activities to increase the volume of transportation in the segment.

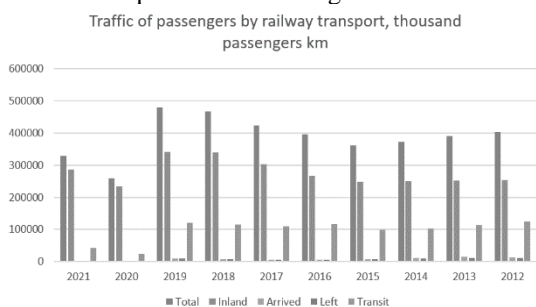


Fig. 3. Traffic of passengers by railway transport in 2012-2021

Source: Lithuanian official statistics producers

Passenger turnover (fig. 3) is an indicator of passenger transportation, which is measured as the product of passengers and the distance traveled, i.e. passengers multiply by km. The diagram also clearly shows the consequences of the pandemic and, as a result, decreased passenger flows in 2020-2021, although in 2012-2019 an obvious increase in passenger flows in rail transport was observed. Also, domestic carriages form the main part of all carriages.

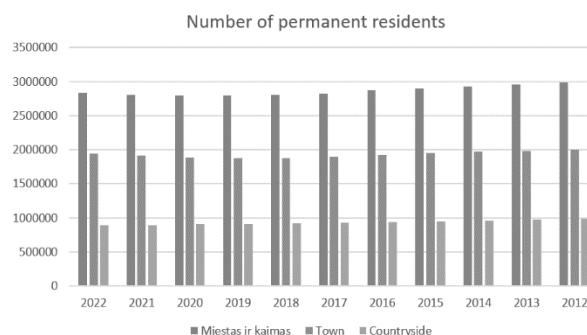


Fig. 4. Number of permanent LR residents 2012-2022

Source: Lithuanian official statistics producers

The presented statistical data (fig. 4) confirms that the total number of permanent residents in Lithuania decreased by 5.27% during the considered period decreased in total, 2.87% population decreased in the city, 10.10% in the village. The change in demographic indicators also affects the mobility of passengers within the country.

Passenger railway services in Lithuania are provided by "LTG Link". JSC "LTG Link" is a subsidiary company under the patronage of SC "Lietuvos geležinkeliai" (<https://www.litrail.lt/>), 100 percent the shares belong to SC "Lietuvos geležinkeliai". The shares of SC "Lietuvos geležinkeliai" are owned by the Ministry of Transport and Communications. In Lithuania, the railway network consists of 1520 mm and 1435 mm length railways, thus creating connections both with EU countries and Eastern countries. Possibilities to increase passenger transportation by rail transport by applying the principles of sustainable mobility are real, it is important to properly set priorities and direct investments to the most demanding areas, i.e. development of passenger transport routes, electrification of the railway network, development of international passenger transport routes, increase in the volume of passenger transport (various directions and measures must be provided for this), attracting passengers from passenger cars, launching high-speed trains from Kaunas / Vilnius to the cities of EU countries. All planned until 2030 projects in railway transport are related to the implementation of the principles of sustainable mobility and means of increasing passenger flows, i.e. electrify lines, renew, develop and adapt infrastructure for persons with limited mobility and persons with special needs, ensure links between modes of transport, as well as ensure intermodality and functional compatibility in passenger transport, promote the habit of residents not to use polluting vehicles, promote sustainable mobility in cities and non-urban areas. Thus, in order to attract passengers to use sustainable rail transport, special attention must be paid to speed, comfort, price, connections with other modes of transport or modes of travel, i.e. by road transport, private or public, by bicycle or by walk, and for the adaptation of terminals to the needs of the modern user. The increase of passenger transportation capacity in railway transport is consistently implemented. The main passenger flows that make up the volume of passenger transport in the territory of the Republic of Lithuania are domestic transport, i.e. movement in the territory of the Republic of Lithuania, transit, arrival and departure make

up only a few percent of the total volume of transportation during the entire period under consideration. Attention should be paid to ensuring the quality of domestic transport (timetables that meet the needs of passengers, flexible price policy, infrastructure, connections between modes of transport, etc.), so that the positive indicators that have changed do not decrease over time, i.e. promoting the use of public rail transport. The change in demographic indicators also affects the mobility of passengers within the country.

Additional measures for the implementation of the principles of sustainable passenger mobility in rail transport. After the analysis of theoretical sources, the assessment of the current situation and the analysis of statistical data, the Strategy of Lithuanian mobility development until 2050, analysis of relevant to sustainable passenger transportation by rail transport, additional measures for the implementation of the principles of sustainable passenger mobility in rail transport are noted. Thus, it can be concluded that connections with road transport are extremely important for sustainable passenger rail transport in Lithuania, i.e. with sustainable passenger road transport (electric cars, urban public electric transport), and must be ensured the possibility to reach the destination by bicycle or by walk when railway transport is the main (whether it is a tourist, recreational or necessary trip).

The following additional directions for ensuring coherence can be emphasized:

- Links with sustainable road transport, i.e. parking lots, e. recharge at terminals, car rental points, e. car taxi services, location of public transport station and stops.
- The possibility to transport bicycle without physical damage and without a significant financial cost (on all routes)
 - The network of cycle roads near transport terminals (railway stations) must be particularly modern and safe, regardless of the importance of the station.
 - Bicycle storage/rent in the terminals
 - Attractiveness of sightseeing tours of the city (trails, routes, tourist attractions) and connecting them with the railway passenger terminal - a complex task, the implementation of which must include representatives of the city municipality and the tourism sector. It is a difficult task, because usually the station areas are not attractive, not safe enough, due to high passenger flows, criminal situation, although most of the stations are geographically located in the historical parts of the city.

It is clear, that LTG Link's strategic plans are precisely focused on the implementation of sustainable passenger mobility principles. Priority infrastructure renewal, electrification of routes is the first step to ensure changes in the ecological direction. However, to ensure the implementation of the principles of sustainable mobility, aspects of the customer's needs must also be evaluated.

Also important moment is the conformity of terminals (stations) with the needs of users. Physiological, safety, convenience, and equal opportunity requirements of users must be ensured. Terminals in railway transport must fully meet the needs of the modern users, regardless of whether it is a central railway station or a regional station (the primary needs of users must be satisfied, i.e. physiological - hygiene, rest, comfort, food and safety). Obviously, the

size of the terminal will vary depending on the hierarchical position of the station, but the minimum range of services available must be ensured in all terminals.

Among the measures already mentioned, an important element is cooperation in the regional and not only with the tourism sector, since internal and external tourism can promote the use of rail transport, abandoning road transport trips. The train route may additionally include stops with tourist attractions, if the facility is far from the terminal, it must be possible for the passenger to easily reach the facility. However, cooperation between institutions must be an essential prerequisite for the successful implementation of the goal.

The tourist object and the railway station must be connected by a clearly visually presented route, so that without additional help (guide) the object can be reached by bicycle, by walk or by public transport. The infrastructure and decisions must ensure this possibility. Another possible alternative is a special train route focused on visiting tourist attractions. However, not only the terminal, the tourist object and the existing infrastructure must be attractive to users, it is very important to have a safe, aesthetic area near the railway station, which is already the responsibility of municipalities. Thus, to implement the principles of sustainable mobility in railway transport, while simultaneously increasing passenger flows, the tasks must be solved in a complex manner, with close cooperation between institutions with different responsibilities. In addition, such measures as ensuring connections between modes of transport and other mobility alternatives, integration of tourism and railway transport, adaptation of city infrastructure to tourist requirements, matching of terminals to passenger needs must be evaluated.

Conclusions

The principles of sustainable passenger mobility are a modern approach to the saving of natural resources, personal and public interests, taking responsibility for the consequences of one's actions as a user of transport services. Railway transport occupies a special place in passenger transportation, it has great potential, as it is a land transport that can be an alternative to road transport, i.e. for the use of private cars (because road transport is the most harmful mode of transport for the environment and the population)

Each user can freely choose the type of transport and means of transport that are more acceptable to him, depending on the transport need, he chooses from road, water, air, railway transport. The choice of the type of transport is determined by such criteria as price, availability, quality, travel distance and time ratio. Interaction between modes of transport ensures smooth passenger service in the transport system. Electrified railway transport is a competitive choice, friendly to nature and future generations. The potential of the tourism sector and railway transport links is currently not being used.

It is necessary to take advantage of the favorable public attitude towards changes in transport due to ecological aspects, but the public transport sector must provide customers with high-quality services that meet EU standards and customer expectations. Many vehicles

exhaust harmful gases into the environment, make tiring noises harmful to health, change the landscape unattractively, and also cause traffic accidents. One of the main problems caused by transport is the decreasing physical activity of the population and as a result, negative consequences for health. All these issues need to be assessed in order to achieve sustainable mobility in rail transport, i.e. measures are applied to reduce the negative impact on the environment, measures to reduce the noise level, contribute to reduction measures of traffic overload in the city area (by diversifying train schedules, combining railway and road transport schedules), contribute to the promotion of residents' physical activity (bicycles and walking trips). The most used mode of transport is road transport (private car), due to maneuverability, lack of time and convenience, most of the population choose their private car, even it is the most environmentally polluting mode of transport. It is important to change consumers the way of thinking about the choice of travel mode. To strengthen in society the positions of the principles of responsible consumption. Voluntary choice, the satisfaction of a personal choice of a sustainable way of travel will give the user the opportunity to feel the importance of his action. Sustainable mobility is understood as the interaction of economic, social, cultural without harming the ecosystem and preserving resources for future generations. Mobility that requires physical activity is the most sustainable for the environment and the human body, such as cycling and walking. Railway transport is one of the most environmentally friendly types of transport, which consumes up to ten times less fuel than road transport when transporting passengers and goods. Therefore, it is necessary to use the possibilities of railway transport, assessing the interaction between modes of transport, as well as alternative possibilities of movement. The integration of the tourism and rail transport sectors can have great potential to achieve the highest level of passenger traffic.

Lithuanian mobility development strategy until 2050 projects in railway transport are related to the implementation of principles of sustainable mobility and means of increasing passenger flows, i.e. electrify lines, renew, develop and adapt infrastructure for persons with limited mobility and persons with special needs, ensure links between modes of transport, as well as ensure intermodality and functional compatibility in passenger transport, promote the habit of residents not to use polluting vehicles, promote sustainable mobility in cities and non-urban areas. In order to attract passengers to use sustainable rail transport, special attention should be paid to speed, comfort, price, connections with other modes of transport or travel modes, rejecting own road transport, i.e. by road transport, private or public, by bicycle or by walk, and for the adaptation of terminals to the needs of the modern user. The increase of passenger transportation capacity in railway transport is consistently implemented. The main passenger flows that make up the volume of passenger transportation in the territory of the Republic of Lithuania are domestic (inland) transportation, i.e. movement in the territory of the Republic of Lithuania, transit, arrival and departure make up only a few percent of the total volume of transportation during the entire period under consideration. Attention should be paid to

ensuring the quality of domestic transport (timetables that meet the needs of passengers, flexible price policy, infrastructure, connections between modes of transport, etc.), so that the positive index that have been achieved do not decrease over time, i.e. encouraged using of public rail transport.

To implement the principles of sustainable mobility in railway transport, while simultaneously increasing passenger flows, the tasks must be solved in a complex manner, with close cooperation between institutions with different responsibilities. In addition, measures such as ensuring multifaceted connections between modes of transport and other movement alternatives, integration of tourism and railway transport, adaptation of city infrastructure to tourist needs, compliance of railway terminals with the main needs of passengers must be evaluated.

References

- Antoszak, P. (2019). Cargo and Passenger Transport in Poland. *Transport Economics and Logistics*, 83, 9–18. <https://doi.org/10.26881/etil.2019.83.01>
- Bernotienė I., Jotautienė E., Juostas A., Aboltins A., Zdanevičius M. (2019). Kelių transporto sukeliama triukšmo tyrimai priemiesčio gyvenvietėje. *Darnios aplinkos vystymas*. Nr. 1, p. 62-69.
- European Commission. Clean transport, Urban transport https://ec.europa.eu/transport/themes/urban/urban_mobility_en
- European Commission. Cycling Policy and Background [2022-09]. https://ec.europa.eu/transport/themes/urban/cycling/guidance-cycling-projects-eu/cycling-policy-and-background_en
- European automobile manufacturers association. Passengers cars [2022-09]. <https://www.acea.be/automobile-industry/passenger-cars>
- European Commission, (2017). European Urban Mobility. Policy Context. European Union.
- European automobile manufacturers association. Electric vehicles [2022-09]. <https://www.acea.be/industry-topics/tag/category/electric-vehicles>
- Europos aplinkos agentūra [2020]. Transportas. [2022-09]. <https://www.eea.europa.eu/lt/themes/transport/intr>
- Europos komisija, (2020). Tvaraus ir pažangaus judumo strategija - Europos transporto kėlimas į priekį ateityje. Briuselis.
- Garliauskaitė R., Stravinskienė V. (2015). Kauniečių nuomonė apie darnų turizmą ir jų kelionių įpročiai. Vilnius: VDU.
- Grzelec, K. ., & Okraszewska, R. . (2019). The Influence of the Place of Residence on the Behavior and Transport Preferences of the Inhabitants of the Agglomeration. *Transport Economics and Logistics*, 83, 163–178. <https://doi.org/10.26881/etil.2019.83.13>
- Hebel, K., & Wyszomirski, O. (2018). Transportation preferences and travel behaviour of senior citizens in Gdynia in the light of marketing research. *Transport Economics and Logistics*, 76, 167–177. <https://doi.org/10.26881/etil.2018.76.14>
- Hickman R., Banister D. (2014). *Transport, climate change and the city*. New York: Routledge
- Jurczak, M. . (2019). The Role of Railway Infrastructure in Servicing Freight and Passenger Transport in Agglomeration - on the Example of Poznań. *Transport Economics and Logistics*, 82, 113–128. <https://doi.org/10.26881/etil.2019.82.10>
- Jociūtė A. (2013). *Visuomenės darnus vystymasis*. Vilnius: MRU.

- Johnson Victor D., Pnnuswamy S. (2012). *Urban Transportation– Planning, Operation and Management*. Tata McGraw-Hill Education.
- Jurczak , M. . (2019). The Role of Railway Infrastructure in Servicing Freight and Passenger Transport in Agglomeration - on the Example of Poznań. *Transport Economics and Logistics*, 82, 113–128. <https://doi.org/10.26881/etil.2019.82.10>
- Kadagidze L., Piranashvili M. (2016). The Role of tourism as of an interdisciplinary subject in the development Georgian economy. *Journal of Management*, Vol. 28, No. 1 2016, 97–103 [https://old.ltvk.lt/file/zurnalai/Vadyba%20Nr.%201\(28\)%20-%202016.pdf](https://old.ltvk.lt/file/zurnalai/Vadyba%20Nr.%201(28)%20-%202016.pdf)
- Kareivaitė R. (2015). The relationship between sustainable development and corporate social responsibility. *Journal of Management*, Vol. 26, No. 1 2015, 85–93. https://old.ltvk.lt/file/zurnalai/Vadyba_2015_26.pdf
- Kučinskienė M, Mačerinskienė A. (2014). Ar gali kelionės dviračiais paskatinti regionų plėtrą? *Regional Formation and Development studies*. Nr. 2, p. 72.
- Lale Özbakır et. al. (2021). A modelling approach to the train timetabling problem using adaptive headways for dynamic passenger demand. *International Journal of Rail Transportation*.
- Lamont, M. (2009). Reinventing the Wheel: A Definitional Discussion of Bicycle Tourism. *Journal of Sport & Tourism*. Nr. 1, p. 5–23.
- Lindenau M., Böhler-Baedeker S. (2014). Citizen and stakeholder involvement: a precondition for sustainable urban mobility. Germany: *Transportation Research Procedia*.
- Lithuanian official statistics producers. Transport and communication, Railway transport indicators - Overview. Retrieved September 19, 2022, from website: <https://osp.stat.gov.lt/statistiniu-rodikliu-analize/>
- Marcin W. (2018) Sustainable mobility planning in Poland, *Zeszyty Naukowe Uniwersytetu Gdańskiego. Ekonomika Transportu i Logistyka, Uniwersytet Gdanski*, vol. 76, pp. 13-22, <https://repozytorium.bg.ug.edu.pl/info/article/UOGcb9a89d964c848a58137a5c04fdd0bde/>
- Mariano Gallo, Mario Marinelli. Sustainable Mobility: A Review of Possible Actions and Policies. *Sustainability* 2020, 12(18), 7499; <https://doi.org/10.3390/su12187499>
- Miao Li (2022) Green governance and corporate social responsibility: The role of big data analytics. *Sustainable Development. Journal*
- Myronenko, V., & Hrushevska, T. (2018). Problems of passenger and freight trains combined traffic on high-speed railway lines. *Transport Economics and Logistics*, 76, 101–106. <https://doi.org/10.26881/etil.2018.76.08>
- Rodrigue J.P. (2020). *The Geography of Transport Systems*. New York: Routledge.
- Rucińska, D., & Kędzior-Laskowska, M. (2018). Sustainable transport development and the quality of road freight transport. *Transport Economics and Logistics*, 76, 33–47. <https://doi.org/10.26881/etil.2018.76.03>
- Sivilevičius, H. (2012). *Transporto sistemose elementai. Automobilių keliai ir jų statiniai*. Vilnius: Technika.
- Spirin I., Zavyalov D., Zavyalova N. (2016). Globalization and development of sustainable public transport systems. *Globalization and its socio-economic consequences*. Nr. 4, p. 2076–2084.
- Spirin I., Matantseva O., Grishaeva M. (2020). The Strategy of Sustainable Development of Urban Transport. *Far East con*. Nr. 128, p. 2624–2628.
- Suchanek , J. . (2019). Success factors for the development of urban bike systems. *Transport Economics and Logistics*, 84, 91–102. <https://doi.org/10.26881/etil.2019.84.08>
- Valieka G., Matijošius J., Rimkus A. (2019). Transporto priemonių skaičiaus kitimo tendencijos Lietuvoje. *Darnios aplinkos vystymas*. Nr. 1, p. 47–49.
- Wulgaris, P., & Wojewódzka-Król, K. (2018). Infrastructure and safety in the Polish railway transport. *Transport Economics and Logistics*, 77, 131–142. <https://doi.org/10.26881/etil.2018.77.13>
- Normative legal acts:
Lietuvos susisiekimo plėtros iki 2050 m. strategija (patvirtinta Lietuvos Respublikos susisiekimo ministro 2020 m. gruodžio 7 d. įsakymu Nr. 3-746)
Lietuvos Respublikos kelių transporto kodeksas // TAR 1996, Nr. I-1628 (2020-07-01). <https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.33417/asr>
Lietuvos Respublikos transporto lengvatų įstatymas // TAR 2000, Nr. VIII-1605 (2021-01-01 – 2021-08-31). <https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.98950/asr>
Lietuvos Respublikos transporto veiklos pagrindų įstatymas // TAR 1991, Nr. I-1863 (2020-07-01). <https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.2971/asr>
Lietuvos Respublikos saugaus eismo automobilių keliais įstatymas // TAR 2000, Nr. VIII-2043 (2021-01-01).

RECEIVED: 01 May 2022

ACCEPTED: 28 November 2022

Irina Solomatina, Lithuania Business University of Applied Sciences, lecturer. Master degree “Organization of International Transportation” Vilnius Gediminas Technical University 2006. Field of scientific research: logistics, logistics activity, modern logistics principles, global logistics, transport logistics, optimization of supply chain, sustainable logistic, sustainable mobility. Address: Turgaus St. 21, Klaipėda LT-91249, Lithuania, +37067237161. irina.solomatina@ltvk.lt