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ESTIMATION ON THE ATTRACTIVENESS OF PUBLIC TRANSPORT: VILNIUS CITY CASE

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Abstract. The paper analyses the attractiveness problems of urban public transportation in the context of promoting sustainable mobility and multimodality. The article is based on the methods of scientific literature and analysis and qualitative research analysis. The analytical-methodical section of the article discusses the principles of sustainable mobility and multimodality, assess the possibilities of their application. In the research section, the expert analysis that evaluates Vilnius public transport attractiveness is presented, and affecting problems are assessed and considered. Re-search results have shown that experts agree on the issues (factors) that affect the attractiveness of public transport. These factors have been ranked in order of priority and relevance from 1 (big-gest problem) to 10 (smallest problem). In conclusion, the paper presents a structural model which aims to promote and increase the attractiveness of public transport system.

Keywords: public transport, urban logistics, sustainable mobility, multimodality.

JEL Classification: M31, R41, L91, Q56.

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1. Introduction

Public transport is a key component of a sustainable urban transport system and the backbone of the urban transport system. Many countries around the world are moving away from the private car towards more sustainable modes of transport, but the process is not as fast. There are various strategies to encourage people to switch to public transport, but the problem is its lack of attractiveness, which makes public transport less acceptable than any other mode. An attractive public transport system is essential for mobility in large cities, as growing cities continue to put pressure on already congested transport networks. It is therefore crucial to create an attractive and efficient public transport system that meets the expectations of travelers and services the flows. *Research methods:* the study was based on an analysis of the scientific literature and qualitative research. *Purpose:* To carry out a scientific analysis and identify problem areas in public transport and provide a model to make PT more attractive. *Practical implications:* If public transport becomes a more popular mode of mobility, the number of car journeys would decrease and the number of public transport journeys would increase. Furthermore, the research would be useful for studies on the dynamics of public transport ridership, congestion and other related issues.

2. Attractiveness issues in public transport literature review

2.1. Public transport attractiveness in the context of sustainable mobility and multimodality

The fundamental objective of public passenger transport is to mobilize the population to the places that matter to them: workplaces, places of goods and services, educational and health institutions and leisure centers, etc., while ensuring full freedom of movement and the quality of goods and services, combining aspects such as time, comfort, safety, environmental friendliness and financial efficiency. This provides an alternative means of travel to the private car (Engelaitis & Liebuvienė, 2022; Bazaras et al., 2022). However, it is important to note that the main priority and objective of public transport is to improve the quality and attractiveness of public transport services (Zhang et al., 2022). Nevertheless, as the Verbraucherzentrale Bundesverband e.V. (2020) points out, public trans-

port is not only a key pillar of public services in cities and counties, but also the basis for future-oriented and sustainable mobility. The International Transport Forum (2021) argues that if public transport is to be the backbone of the whole system, it must be of sufficient quality, reliability, frequency and attractiveness to reduce the need to drive. Klingenhöfer and Huber (2022) strongly argues that for people to take the bus instead of their own car, bus transport needs to become more attractive and better serve people's needs. Researchers are trying to solve the problems of passenger logistics in public transport, according to Sarimsakov and Gaffarov (2020), the main problems in urban passenger logistics today are: saving passengers' time, ensuring their comfort, stabilizing transport costs, increasing speed, reducing pedestrians' walking distances to the vehicles, and reducing traffic congestion. As Gipp et al. (2020) states, frequency, accessibility, availability, quality of service, network and especially all-day travel are key to the attractiveness of public transport. Litman (2023) argues that high quality (relatively fast, convenient, comfortable and integrated) transport can attract travelers to drive on their own, which reduces traffic problems including congestion, parking costs, accidents and pollution. This has direct benefits for users. The main problem is that COVID-19 period has made public transport seem like a dangerous place for passengers' health and made public transport undesirable (Gkiotsalitis & Cats, 2020; Borkowski et al., 2021). As DeWeese et al. (2022) argue, with the COVID-19 pandemic, European cities have faced unforeseen challenges in managing public transport services – that ensure mobility for many citizens. Many urban dwellers have taken the privilege of adjusting their daily routine and drastically reduced their use of public transport, either by avoiding it altogether, opting for other means of transport or staying at home (Jenelius & Cebecauer, 2020). As a result, public transport has lost its former level of attractiveness, which efforts are being made to rebuild and revive it. Zhang et al. (2021) found that the level of public transport services and private car ownership have positive and negative effects on the attractiveness of public transport, respectively. Göransson and Andersson (2023) discuss that in order to attract car users to the public transport system, it needs to be a cost-competitive alternative to the car, with basic levels of accessibility and reliability, as well as features that the target group deems important. It is important to demonstrate to car users the benefits they can gain from public transport. However, there are more dire outlooks. Timokhina et al. (2020) predicts that demand for public transport services will decline in the long term due to increasing demand for individual vehicles and mobility. Litman (2023) believes that public transport is too slow to be useful or attractive. However, in congested cities, car journeys are also slow due to congestion, so public transport journeys are often competitive. According to Chocholac et al. (2020), the continuously evolving issue of sustainable urban logistics presents opportunities for urban public transport companies to make an important contribution to the concept of sustainable urban logistics. The preference for urban public transport reduces the use of individual car transport, which is linked to the environmental pillar of sustainability. In addition, there is a need to make more efficient use of the transport system's resources. This includes improving multimodal transport options, allowing passengers to combine several modes of transport to reach their destination (Gløersen et al., 2022). And urban multimodality itself can be improved in two ways – by improving the accessibility and quality of public transport and by providing adequate infrastructure for non-motorized transport, especially in central districts (Singal, 2019). In this respect, Zhang et al. (2021) consider it essential to promote the priority between public transport and sustainable urban mobility organization principles. In other words, combining different modes of transport, creating convenience and a framework for their use can increase the impact of sustainable transport and the efficiency of the transport system as a whole (Singal, 2019; Macioszek & Kurek, 2020). As Saeidi (2019) states, high-quality public transport benefits all urban dwellers, including drivers, who experience less congestion and parking congestion, less risk of accidents and less exposure to pollution. Zhang et al. (2021) takes into account the emphasis of different factors in making public transport more attractive and provides relevant management proposals, which can be grouped into three categories: reducing travel demand, limiting private car travel, and encouraging public transport travel. Ultimately, experts argue that more needs to be done to effectively persuade car drivers to use public transport, such as combining free tickets with additional rules that make driving in cities more expensive or difficult, such as congestion pricing or higher costs and parking restrictions (Garay, 2022). While researchers tend to be dominated by strong policy guidelines, Schütze et al. (2020) and Göransson and Andersson (2023) suggest that public transport attractiveness should be promoted by addressing issues of reliability, frequency, convenience, travel time and network size. Schütze et al. (2020) argue that these aspects can be addressed by improving infrastructure and transport facilities. Upgrading public transport infrastructure will meet the needs of potential users, which will create the preconditions for private car commuters to switch to public transport. Göransson and Andersson (2023) emphasize the need to be guided by the phenomenon discovered by the economist Herbert Mohring, known as the Mohring effect. This phenomenon means that an increase in the number of public transport users leads to an increase in frequency, which in turn leads to an increase in passenger numbers. This suggests that the focus should be on increasing the frequency of services, not just on reducing fares or expanding the PT network. More frequent services have a greater impact on reducing waiting times and making public transport more attractive (Göransson & Andersson, 2023). According to Silva (2019), the Mohring effect is also associated with other positive indirect effects of increased demand, such as an increase in the density of

the route, which leads to a reduction in entry time costs. It should be noted that there is a lack of scientific work on this sensitive issue, so the development of a model to promote the attractiveness of public transport could not only serve as a benchmark, but also as a starting point for future research or analysis in the field of public transport.

2.2. Analysis of foreign practices in making public transport more attractive

Eurostat conducts an annual Quality of Life survey, which includes a survey on people's satisfaction with public transport. According to Eurostat (Eurostat. European Commission, 2023), compared to 2019, there is an increase in public transport use in cities where it was already high (Prague, Paris, Bucharest, Stockholm, Warsaw) and a decrease in cities where it was previously low. Prague (Czech Republic), which ranked highest in 2019, saw a further increase of 13 percentage points. According to the Prague Transport Yearbook (Czech Statistical Office, 2018), tram lines serve both radial and tangential functions, as well as connecting metro stations. According to Polad Prahu (2019), Prague's public transport network carries 1.3 billion passengers each year: the metro, trams and buses carry about the same number of passengers (about 30% each), while trains carry 5%. It is argued that multimodality, network coverage and the cost of the service are what attract people to travel by public transport, and that the wide and growing number of P+R sites in the city contributes to this. Indeed, the satisfaction and quality of life of Prague's inhabitants are linked to the reliability and quality of the city's public transport (Gabal et al., 2019). It can be concluded that by ensuring the reliability, efficiency, multimodality and ac-accessibility of public transport, the city of Prague has achieved a high level of attractiveness of public transport, which attracts locals and tourists. According to McKinsey & Company (2021), in the first half of 2020, the Parisian authorities announced the "15-minute city" project to reduce the number of private cars in the city. In addition, Paris is already implementing a project to restrict the use of certain city streets to pedestrians, public transport and taxis. The low cost of public transport has also contributed to the attractiveness of the service, which makes it tempting to change to PT. Bucharest's public transport attractiveness is based on its relatively frequent and fast connections and its very low cost. However, Iacoboaea et al. (2016) argue that while most travelers are satisfied with local public transport services, they still want to improve their quality. As Colesca et al. (2017) argue, passengers in Bucharest care about the short distance between stops and the good network coverage that is provided, but they are less concerned about the availability and provision of information at stops and on board the vehicles than other European passengers. Stockholm was Europe's first green capital and is considered by many to be a forerunner in the field of sustainability, tackling issues such as greenhouse gas emissions, transport and alternative fuels (Francart et al., 2019). According to the Urban Transport Group (2017) it is necessary to highlight that Stockholm follows the "Scandinavian approach", which gives public transport the following characteristics: frequent transport at all times of the day, high quality, modern transport, smart and multimodal ticketing. In summary, Deloitte (2020) suggests that Stockholm's public transport system is attractive because it is of high quality, covers the city extensively, offers a wide range of transport modes and is very easy to access. Due to its size, Warsaw also has the most developed transport network in the country (Stachyra & Roman, 2021). It should be noted that Warsaw's public transport is attractive not only because of its network coverage and multimodal possibilities, but also because of its price and ticket choice. According to Moscicka et al. (2019), the metro and rail system have the greatest positive impact on travel times by public transport. This mode of transport allows to cover long distances quickly across the city and to cover the "last mile" with a slower bus or tram. The attractiveness of public transport in the five cities is unanimously de-pendent on the coverage of the network, the frequency of the service, the modernity of the vehicles, the speed, the cost of the service, and the availability of multi-modal travel options. These aspects are evident in all the cities, which is why the population sees public transport as an attractive way to travel around the city and to leave the car behind, or to leave it behind altogether.

3. Research of Vilnius city public transport attractiveness

3.1. Methodology

To discover the significance of public transport attractiveness issues, it is essential to allude conduct an expert survey. In this manner, this paper uses an expert survey approach. Expert surveys offer more solid data than other approaches, such as common public surveys. Usually because specialists are far more likely to have the understanding and capacity to reply the questions presented. As Flick et al. (2004) claim that the qualitative interviews play an important role in research projects based on participant observation. One of their uses is the expert knowledge about the research field in question as the experts are to be trusted for their competence. Teherani et al. (2015) stated that qualitative research focuses on the events that transpire and on outcomes of those events from the perspectives of those involved. According to von Soest (2022) experts can aggregate and weigh different pieces of information thus increasing expert interviews' analytical value. Ugwu and Eze (2023) state that while there are numerous approaches to qualitative research, they all share a tendency to be adaptable and a focus on preserving rich meaning when interpreting data. On this background, a qualitative study – a survey of experts – was carried out to assess the causes of the public transport attractiveness problems. The survey was carried out with a group of 9 public transport experts. The selected experts have many

years of work experience not only in academic institutions such as Vilnius Tech or Kaunas University of Technology, but also in other companies whose main activity is related to public transport, such as UAB "Vilniaus viešasis transportas", SĮ "Susisiekimo paslaugos", UAB "Kautra", UAB "Klaipėdos paslaugos", VšĮ "Klaipėdos keleivinis transportas" and KTKB "Gintarinis vairas". Respondents to the expert survey rated the questions on a five-point scale ranging from "strongly disagree" to "strongly agree". The main criteria-factors identified were then prioritized according to what the experts contributed.

3.2. Expert evaluation on the attractiveness issues of Vilnius public transport

Vilnius, Lithuania's capital and largest city, also has the largest public transport network in the country, with 89 bus routes and 16 trolleybus routes, but public transport here is also going through difficult times. The city's public transport faces the same problems as other major cities' public transport: poor funding, reliability and frequency, traffic congestion and underdeveloped or not modernized infrastructure. These factors mean that public transport is not as attractive and fast a way to get around the city as the private car or other platforms offering a ride-hailing service. The experts have identified key factors that affect public transport attractiveness and these factors have been ranked in order of priority and relevance from 1 (biggest problem) to 10 (smallest problem) and are shown in Table 1.

It should be noted that the factors presented are not more or less important than each other, but are the problems identified by the experts, in order of priority, which have the greatest negative impact on the attractiveness of public transport.

These factors are also presented in Figure 1, which shows the percentage of experts who agreed on the factors that most negatively affect the attractiveness of public transport. These problems are also presented in order of priority.

Based on the data provided, the experts found that frequency, reliability and speed of public transport have the biggest impact on the attractiveness of public transport. Frequency reflects the actual deployment of public transport vehicles on the lines (routes), i.e. how many buses are operating on each route and at what interval they arrive at a given stop. Reliability refers to the risk that public transport may fail to arrive at a given stop for various reasons: traffic accidents, traffic conditions, climatic conditions, etc. Speed defines the average speed of public transport, which is as low as 20–25 km/h and on some routes as low as 10–11 km/h. Fleet and accessibility issues remain important, but the influence of these factors on the attractiveness of public transport has diminished between 2019

Table 1. Factors negatively affecting the attractiveness of public transport

Rating	Factor / Problem	Explanation
1	Frequency	Insufficient deployment of vehicles on the lines
2	Reliability	Cancelled trips due to vehicle, weather, traffic conditions
3	Speed	The average speed of PT is only 20–25 km/h maximum
4	Fleet	Technically and morally outdated vehicles
5	Availability	High floor vehicles are less accessible
6	Street infrastructure	The lack of bus lanes has an impact on the speed of PT
7	Network coverage	Some residents feel excluded from PT
8	Security	Risk of injury, virus or being attacked
9	Comfort	Insufficient seating or overcrowding in the cabin
10	Ecology	Vehicle pollution, smoke and emissions

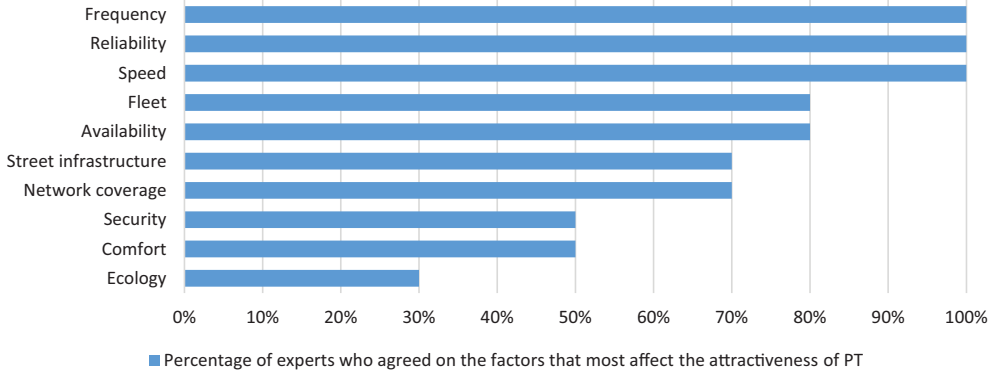

Figure 1. The proposed scientific model for promoting the attractiveness of public transportation

and 2025, as the public transport fleet has been modernized and is still being modernized. Vehicles have become more comfortable and technically reliable. However, these factors will remain until the old buses and the high-floor Škoda 14Tr trolleybuses are completely phased out. Although the results show that the ecological factor is the last priority, this does not mean that it is unimportant. In the opinion of the experts, environmental concerns have the least impact on the attractiveness of public transport of all the issues mentioned. In this case, Vilnius needs a strategy, a model to attract travelers to use public transport, but the endless problems of lack of attractiveness of public transport need to be addressed.

4. Results: a model to promote the attractiveness of urban public transport system

To develop the model (Figure 2), it was decided to use the results of a qualitative survey and the analysis of scientific sources, which showed and highlighted the existing problems of lack of attractiveness of public transport. This strategy was chosen because the experts' assessments were considered to be highly competent and professional and the amount of scientific literature analyzed allowed for an in-depth look into the issues of public transport attractiveness. The analysis of the results shows some factors influencing the attractiveness of public transport, but the causal links between these factors point to a lack of synergies between the institutions involved, and a possible lack of expertise in the financing of the public transport system, which makes public transport stagnate and fall short of standards. These complex problems prevent the public transport system from becoming a more attractive alternative to the private car, as well as preventing the public transport system from becoming a full and integrated part of sustainable mobility and multimodality. It should be noted that there is a dearth of scientific work on this sensitive issue, so the development of a model for promoting the attractiveness of public transport could not only serve as a benchmark, but also as a starting point for future research or analysis in the field of public transport.

The model's principal aim is to make public transport more attractive by encouraging its use and increasing its accessibility through sustainable mobility and multimodality. The full functioning of the model is also conditioned by the attitudes of road users towards the position of public transport in the hierarchy of the urban transport system, the experience and satisfaction of passengers with the public transport service, and, most importantly, their willingness to choose to travel by public transport, as there are various social norms and beliefs in society that discourage a number of potential passengers.

Coordination between the government, municipalities, public transport agencies and carriers is foreseen to ensure the functioning of the model. The Government is committed to the implementation of European Union directives, regulations and strategies such as: Implementation of the Green Deal, Vision Zero, compliance with the Public Transport Passenger Transport Regulation. Also, the Government provides political support and funding for strategic public transport infrastructure projects, with the aim of improving the accessibility and availability of public transport. Municipalities develop their

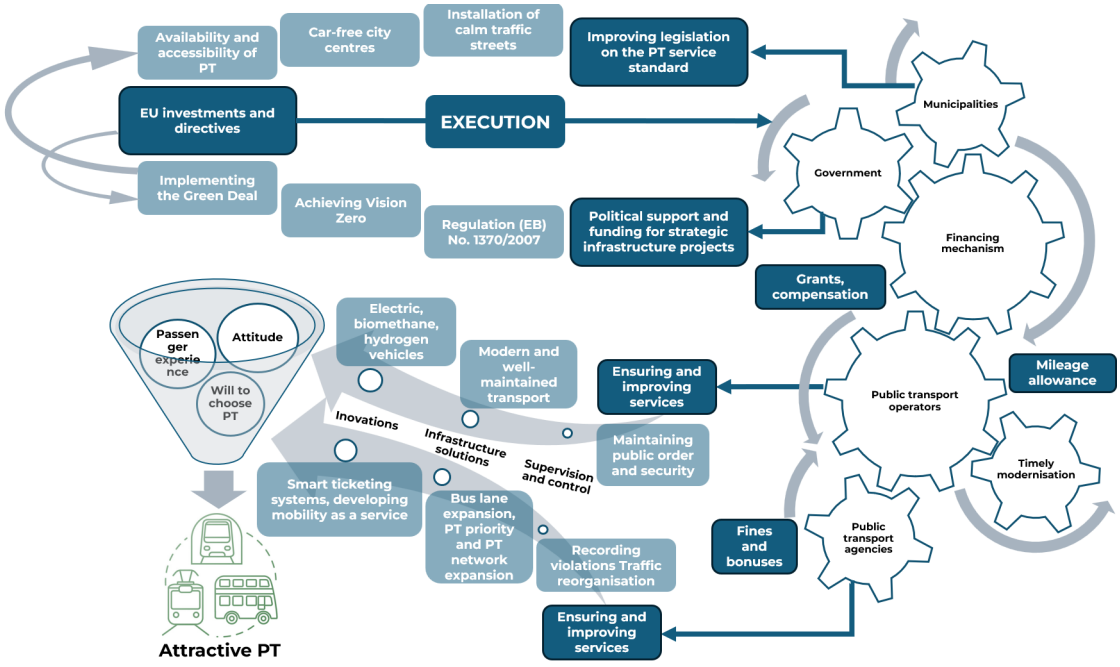

Figure 2. The proposed scientific model for promoting the attractiveness of public transportation (developed by authors)

own Sustainable Mobility Plans for their cities, which decide to close city centers to motor vehicles and create quiet streets and pollution-free zones. Each municipality needs to improve its legislation on the standard of public transport service and the rules governing the carriage of passengers and luggage on public transport. A financing mechanism between the Government, municipalities and public transport operators is in place, providing for grants and compensation to carriers and indexing the remuneration for the mileage they cover. This mechanism should ensure the timely implementation of modernization, which would guaran-tee the quality and improvement of services. The timely modernization mechanism provides for public transport vehicles that are in good working order and meet the latest standards, with a mandatory maximum age of use. In line with European Union directives and regulations, it is envisaged that public transport operators should switch to vehicles powered by alternative fuels or alternative propulsion systems, such as electric, biomethane or hydrogen buses.

The model provides for coordinated action by the public transport agency with the carriers, who are fined for not meeting the service standard and rewarded for the number of journeys made or for a high-quality standard. The main mission of the public transport agency is to organize and improve the public transport ser-vice in the city, to analyze passenger flows and demand and to determine the right amount of transport, by type, to the right routes. It is particularly important to note that in the event of traffic accidents and atypical traffic situations, it is the responsibility of the carrier to deal with the traffic management of public transport and to take appropriate action. Public transport agencies are not competent in this respect and their decisions can be detrimental in emergency situations. Public transport agencies, with the approval of the municipality, plan the expansion of the public transport network, the installation of dedicated lanes, priority traffic lights and other projects of importance to the city. They also modernize public transport ticketing systems and mobile platforms.

The proposed model reflects not only the desired outcome, but also the overall public transport strategy and the implementation of the Green Deal. Therefore, this model is relevant not only for Vilnius, but also for other major Lithuanian and European cities. An important factor is that a seamless organization of the service is envisaged between all the predominant modes of public transport, as this would help to ensure the feasibility and popularity of multimodal travel. This model is defined as an aspiration or strategy (optimistic view), as all stakeholders and institutions need to act in a coordinated way. An important factor is the amount of bureaucracy in public institutions, which can delay the implementation of important projects beyond the regulatory or planned timeframe. The model does not foresee this problem as it is a force majeure factor – factors or problems that cannot be foreseen or changed.

5. Discussion

The study has shown that the attractiveness of urban public transport is a multidimensional problem, with researchers arguing about solutions and failing to reach a consensus. The view of some researchers that public transport will be-come more attractive in the future is at odds with the view of other academics that public transport is doomed to become unattractive and to become even less important. Although public transport is claimed to be a future-oriented way to travel sustainably and making less harm to environment by eliminating private cars (Zhang et al., 2022; Göransson & Andersson, 2023; Chocholac et al., 2020) but there is also considered that demand for public transport services will decline in the long term due to increasing demand for individual vehicles and because public transport is too slow to be useful or attractive (Timokhina et al., 2020; Litman, 2023).

A significant number of researchers argue that the attractiveness of public transport is determined by its sustainability, environmental friendliness, frequency-cy, reliability, comfort, speed, convenience and service quality (Sarimsakov & Gaffarov, 2020; Gipp et al., 2020; Litman, 2023; Göransson & Andersson, 2023; Zhang et al., 2021). However, the study revealed that these factors do not play an equal role in the attractiveness of public transport in Vilnius. The research results revealed that experts consider frequency, reliability and speed to be the most important factors influencing the attractiveness of public transport, which in itself is perceived as quality of service. Whereas sustainability and environmental friendliness – defined as ecology – do not have a significant impact on the attractiveness of public transport and are the least important of all factors. Overall, the re-searchers' studies and experts' opinions suggest that improving the attractiveness of public transport is a priority for municipalities, but without major investment or even a revolution in public transport, it is reasonable to expect a decline in its influence on the urban transport system and decline in demand of it.

6. Conclusions

The analysis of the academic literature shows that the attractiveness and demand for public transport is expected to decline over time due to the increasing demand for individual vehicles, and that public transport is too slow to be attractive. Some scholars suggest that sustainable and sustainable mobility and the attractiveness of public transport should be promoted through strong policy measures, in other words, indirectly forcing people to switch from private to public transport: restricting car traffic, taxing private cars, increasing fuel excise duties, etc. However, other scholars have proposed more rational solutions: developing spatial planning models that are favorable to public transport, reasonable subsidies for public transport, upgrading hardware, increasing the coverage of the PT network, creating opportunities to make journeys by dif-

ferent modes of transport, all of which would encourage rather than force the use of public transport.

The qualitative research showed that the experts agree on the lack of attractiveness of public transport and identified the issues (factors) that affect the attractiveness of public transport. These factors include insufficient frequency and reliability, low speed, outdated fleet, poor accessibility and level of street infrastructure, inadequate network coverage, safety and comfort in transport, and environmental friendliness. It should be noted that these factors are not more or less important than each other, but are the problems identified by the experts, in order of priority, which have the greatest negative impact on the attractiveness of public transport. Experts have identified the biggest problem areas that have a negative impact on the attractiveness of public transport:

- Frequency – insufficient deployment of vehicles on the lines, resulting in less frequent buses, which is reflected in timetables.
- Reliability – non-arrivals at bus stops due to vehicle breakdown, weather conditions, traffic conditions, etc.
- Speed – the average speed of public transport is only 20–25 km/h, with some routes reaching only 10–11 km/h.

Taking into account the existing problems identified in the scientific literature and the results of the expert survey, a model to promote the attractiveness of public transport was developed and proposed. The model's principal objective is to increase the attractiveness of public transport by encouraging its use and increasing its accessibility through the prism of sustainable mobility and multimodality. Coordination between the government, municipalities, public transport agencies and transport operators is foreseen to make the model work. The proposed model reflects not only the desired outcome, but also the overall public transport strategy and the implementation of European Union strategies.

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