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FINANCING PUBLIC TRANSPORT SERVICES FROM PUBLIC FUNDS

Summary. The paper deals with the issue of efficiency of public passenger transport through financial support from public funds from the perspective of improving road safety. The aim is to verify the hypothesis that financing public passenger transport from public funds is a significant tool to influence the number of passengers carried by individual automobile transport, and thus it can be used a tool for influencing road safety in a particular territory. The first part of the paper analyses the sources for financial support of public passenger transport. The next part describes the assumptions for improving road safety through increasing the support of public passenger transport. The last part analyses possible impacts of financing public passenger transport on the road safety in relation to the specified hypothesis.

1. INTRODUCTION

Public passenger transport is currently recording declining performance and development across the Central and Eastern European regions. This results in the increased financial constraint for public transport provision by public authorities. Even in regions with sufficient use of public transport, it is not possible to provide transport service without public support. It can be generally stated that regular public passenger transport cannot be provided on a commercial basis without the support from public funds [39]. Therefore, there are mechanisms through which public passenger transport could be ensured. Service operators may provide transport services based on either awarding exclusive rights to operate regular passenger transport in a certain territory or through the possibility of obtaining financial support for transport service provision [52]. The support of public passenger transport with the use of public funds is a usual practice not only in Europe. Public funds are used worldwide to finance the difference between revenue from fares and operating costs [50]. In the U.S., public funding contributes to cover 57 – 89 % of operating costs of bus service. In area of rail passenger transport, this proportion represents 29 – 89 % of operating costs [36]. Within the EU, operating costs are covered from public funds in the range of 23 – 50 % depending on the funding system in a particular EU Member State [9]. A prerequisite for the support of public passenger transport is the provision of the sustainable system of transport serviceability. With the support of public transport, there is also an assumption that the population will use passenger cars to a lesser extent. In Central and Eastern Europe, however, the undesirable development arises when the decline in public transport use increases the number of persons using passenger cars.

When considering that the number of passengers using public transport increases with the increasing financial support for public transport, there is an assumption that higher number of

passengers carried will increase revenue from fares. Therefore, it is possible to expect reduction in the need for funding transport serviceability in future owing to the increase in revenue from fares [48]. On the other hand, it is possible to offer passengers a greater range of transport services while maintaining the same level of fares and public support.

The aim of the paper is to verify the main hypothesis H1 that financing public passenger transport from public funds is a significant tool to influence the number of passengers carried by individual automobile transport, and thus it can be a tool for influencing road safety in a particular territory. Verification of the hypothesis is even more significant because the regions where public transport is entirely financed from public funds exist within the EU for the support of road safety, and thus the residents may use public transport for free (e.g. some cities in Estonia, Czech Republic, and a similar system is being prepared also in Zilina in Slovakia). The first part of the paper analyses the sources for financial support of public passenger transport. The next part describes the assumptions for improving road safety through increasing the support of public passenger transport. The last part analyses possible impacts of financing public passenger transport on the road safety in relation to the specified hypothesis.

2. SOURCES FOR FINANCIAL SUPPORT OF PUBLIC PASSENGER TRANSPORT FROM PUBLIC FUNDS

To examine the relation that higher support of public passenger transport increase road safety, it is necessary to identify the existing resources available for public authorities to support transport serviceability. For this reason, the hypothesis H2 that the public authorities have possibilities to acquire the resources for the higher support of public transport is established. In general, public passenger transport cannot be financed only from revenue from fares, and other revenue sources should be established while service provision such as advertisement. This fact was already confirmed by the studies elaborated before 1990; for instance Bly et al. [6], Pucher and Markstedt [44]. But, the conditions have not changed even in the present as it is demonstrated by Tscharaktschiew and Hirte [50], Poliak [39] or Drevs et al. [12]. The mentioned studies also point to the fact that the financial support from public funds tends to decrease the level of fares and to increase the frequency of public transport links. Lower fares make public transport more accessible for low-income population groups [49] as well as groups of people with specific needs such as the disabled and elderly [2]. Higher financial support from public funds also allows using vehicles with a larger capacity in the provision of transport serviceability [43].

The most common financial support from public funds (state or local government budget) is in the form of compensation [52] that is also referred to as subsidies in some literature [5]. A subsidy or compensation represents a payment that does not require a direct exchange of goods or services in the market economy. It is used to achieve a specific social objective or a specific intended effect [5]. It represents a payment transfer; however, it is not a gift because there are certain rules that must be kept in order to obtain subsidies for public transport provision.

In most EU Member States, public passenger transport is financed traditionally from general taxes [51]. State or local government generates revenue from various taxes which include direct and indirect taxes. Within the EU, indirect taxes represent in general the highest proportion of incomes of state budgets [41]. Under this support, there is no direct link between the source of incomes and their allocation to financing transport serviceability. The main problem of this form of financing is that there is considerable competition between the requirements for subsidies from public funds [52]. Public passenger transport is often financially supported from one budget along with other public services such as education and healthcare [48]. It is very difficult to maintain financial support for public passenger transport, because this support represents high financial resources provided for a long period of time. For this reason, new forms of obtaining funds from public sources are being sought in the area of public passenger transport in some states. These are linked to specific incomes of public budgets. The possibilities for direct connection of public transport financing with the incomes are as follows:

- Fees for using road infrastructure – a traditional reason for introducing road fees is to obtain the incomes for construction of new roads and maintenance of the existing roads. The second and even more significant reason is to cope with traffic congestion and air pollution [29]. Linking the incomes from the fees for using road network with the support of public passenger

transport would be a good instrument for financing public transport in case if passenger cars are subjected to those fees. The use of such a method of financing is common in Scandinavian countries [15], [48] and the U.S. [46].

- Excise duties – excise duties can be defined in general as indirect taxes of the selective character. These taxes apply only to selected goods. In the EU, Member States must apply excise duties to alcoholic drinks, tobacco products, mineral oils and energy (e.g. coal, electricity, natural gas). Given that consumption of mineral oils (gasoline, diesel) is directly dependent on the extent of transport, some of states (e.g. Germany, Switzerland) have introduced a specific proportion of collected excise duties on mineral oils as a source of the financial support of public passenger transport [15]. Thus, the higher fuel price assumes lower fares in public passenger transport and it also assumes reductions of traffic congestion and greenhouse gas emissions. Besides some EU Member States, this method of financing public transport is also used in the U.S. [51].
- Motor vehicle tax – it is a tax which is compulsory within EU Member States, and it applies to all vehicles that are used for business [41]. In some EU Member States, this tax applies to all vehicles regardless of whether they are used by entrepreneurs or private persons. Although the tax is related to transport, its collection in the EU is not directly linked to financing public transport. Incomes from collecting taxes on motor vehicles are directly used for the financial support of public transport in some regions in the U.S. and Canada.
- Income tax for legal entities and natural persons – incomes from these taxes represent the income of state or local budgets according to a particular state. A direct link between the revenue of income tax and financial support of public transport is applied mainly in the U.S. (e.g. Portland and Eugene) and also in some EU regions such as France [53] and Germany [3].
- Property tax – It is as an instrument of creating sources for financing public transport. It is a commonly applied method in the world and it is used in several states in Europe, Asia and North America [51]. The principle of linking property tax with the support of public transport is that owners or users of properties may benefit from the fact that the territory, where their properties are located, is served by public passenger transport. This benefit is reflected in the increased value of the properties. Therefore, a higher property tax is applied to those properties (the tax includes a fixed part which is determined for the financial support of public passenger transport).
- Parking fees – these fees are only exceptionally directly determined for the financial support of public passenger transport. However, there are regions, especially city centres, where parking fees or their part are directly determined for financing public transport in order to reduce traffic congestion and to reduce occupation of space by passenger cars in cities. For example, this method of the financial support of public transport has been applied in France since 1973 [42].

Based on the identification of the resources for financing transport serviceability, it can be stated that public authorities have possibilities to acquire additional resources to finance public transport, and therefore, the hypothesis H2 can be confirmed. It is impossible to clearly identify which method of the financial support of public transport is most effective or which combination of sources would bring the best results. Efficient use of funding sources is addressed in detail by Pawlak [37], Slowinski [45], and Beck [3].

3. ASSUMPTIONS OF THE IMPACT OF FINANCING PUBLIC PASSENGER TRANSPORT ON ROAD SAFETY

The higher support of public passenger transport may contribute to a greater range of transport service or higher quality of the services provided. As a basis for verifying the hypothesis H1, it is essential to identify significant factors affecting road safety. According to Evan [14], Elvik et al. [13] and Gitelman et al. [18], the most significant factors affecting road safety are mainly driver's behaviour, vehicle construction and infrastructure conditions. Within the support of public passenger transport, public authorities try to influence all these factors with the aim to achieve a multiplier effect from financing public transport.

By supporting public transport and by transferring passengers to bus service, density of traffic flow, which is expressed in number of vehicles per one kilometre of infrastructure, reduces [40]. If the

passengers used bus service instead of rail transport for the same journey, density of traffic flow at a particular moment would change from H_A to H_B (Figure 1). Intensity of traffic flow (the number of vehicles per unit of time) is a function of the density. Therefore, it is possible to state the following:

$$M = f(H) \tag{1}$$

It is possible to decrease intensity of traffic flow by changing density of traffic flow:

$$\Delta M = f(H_A\text{-}H_B);\ under\ condition\ H_A \leq H_{opt} \tag{2}$$

In case that $H_A > H_{opt}$, congestion arises in the infrastructure. By transferring passengers to the public passenger transport, a decline in density of traffic flow would release traffic congestion and intensity of traffic flow would increase. Figure 1 depicts the change of density of traffic flow from H'_A to H'_B. It also depicts speed S_{opt} which can be achieved at maximum intensity of the traffic flow. By exceeding this intensity, the speed of the traffic flow decreases. Therefore, zero speed and zero intensity of the traffic flow are achieved at maximum density of the traffic flow (H_{max}). This means that the density of traffic flow would be decreased by the support of public passenger transport.

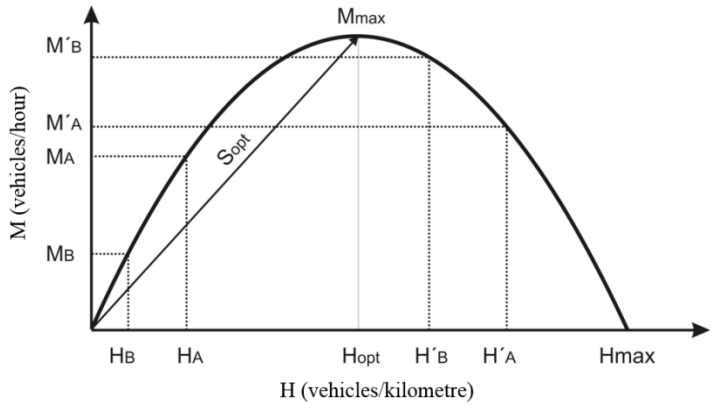

Fig. 1. A change of intensity of the traffic flow while changing density of the traffic flow under the support of bus service. Source: processed by the authors

Yannis, G. et al. [54] defined the relationship between the probability of an accident and intensity of traffic flow. Yannis, G. et al. [54] described the likelihood of an accident as a function of the intensity of traffic flow where a course of the function is dependent on road network categories. Courses of dependence are shown in Figure 2. The figure depicts four road categories (R1 – the lowest category, R4 – the highest category). The following relationship can be stated for a particular category of roads:

$$re = f(M) \tag{3}$$

Assume that a particular road of R1 category has the intensity of traffic flow - M_A and the probability of an accident - r_{e1A} which exceeds the acceptable value of the accident probability - r_{eacc}. In practise, such a road is usually modified to a higher category - R2, which leads to decreasing the accident probability from r_{e1A} to r_{e2A}. However, within urban areas, this solution is not always possible and so a decrease in the probability of an accident can be also achieved by decreasing the intensity of traffic flow from M_A to M_B.

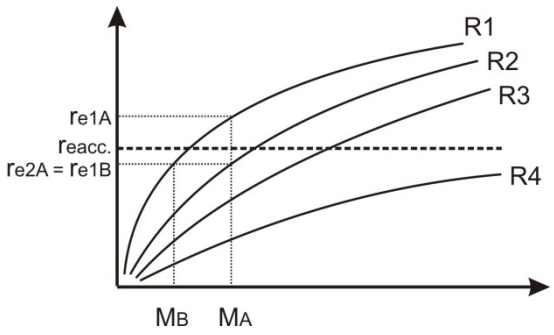

Fig. 2. Relationship between the accident probability and intensity of traffic flow. Source: processed by the authors

This means that the result of the support of public passenger transport, through which density of traffic flow would be decreased, can be expected in the reduction risk of an accident owing to application of following:

$$\Delta r_e = f(M_A\text{-}M_B) = f(\Delta M) \tag{4}$$

under condition $H_A \leq H_{opt}$ *further applies*

$$\Delta r_e = f(f(H_A\text{-}H_B)) \tag{5}$$

Based on the above equation, it can be concluded that the density of traffic flow decreases through the support of bus service (a case when passengers change to bus service). In case passengers frequently use public transport service, the assumption defined in the hypothesis H1 would be confirmed. The reason is that there are less means of transport on roads, which results in increasing road safety.

A significant factor affecting road safety is driver's behaviour. According to the outcomes published by Elvik et al. [13], it is possible to significantly increase road safety by influencing this factor. If people used more bus service within the support of public transport, the proportion of bus drivers among the total number of drivers would be increased. Bus drivers regularly attend courses for safe driving and control, and the results of which are reflected in the following factors:

- Physical condition of a driver – bus drivers must comply with the conditions determined for their working hours. These conditions stipulate compulsory rest periods after specified time of driving (e.g. Regulation (EC) No. 561/2006). Drivers of passenger cars are not time limited as bus drivers. This may deteriorate the reaction time of drivers mainly in case of long continuous driving time. Thus, the accident probability increases.
- Psychological condition of a driver – bus drivers undergo regularly a psychological examination. On the other hand, drivers of passenger cars are not obligated to undergo such an examination after obtaining a driving license. Therefore, it can be assumed that bus drivers are in a better psychological condition.
- The use of drugs, medicine, and alcohol – bus drivers are regularly or randomly inspected for the consumption of alcohol or other narcotic substances at the beginning of their working shift. Moreover, bus drivers are also under the control while driving through online equipment of a vehicle or a camera. Therefore, there is significantly less probability of drunk drivers.
- Risky driving – bus drivers are drivers with greater experience of driving and they are able to better respond in risky situations. Bus drivers are also regularly trained for safe driving. Therefore, it can be assumed that a technique of driving of bus drivers is safer compared to the average driving technique of other drivers. Furthermore, negative response of passengers can be expected in case of risky and unsafe driving of bus drivers.

The assumption that bus drivers are safer drivers can be confirmed based on the statistical data relating to the number of accidents from the period of 2012 and 2013 in the Slovak Republic [29]. Table 1 provides a comparison of the death of passengers while driving a passenger car and a bus. The probability of the death of passengers in bus service is about half compared to individual automobile transport.

Table 1

Probability of the death of passengers in the Slovak Republic

Type of transport	Probability
Bus service	0.000000239
Individual automobile transport	0.000000417

Source: [29].

Based on the above analysis, there is an assumption that the support of public passenger transport under transferring passenger to rail and bus transport has a multiplier effect on increasing road safety. The multiplier effect also relates to the hypothesis H1. This means that the assumption of increasing the road safety by supporting public transport exists. Moreover, the age of vehicles used in public transport is often regulated under the provision of public authorities. This raises further assumption that the support of public transport increases road safety because people are transported by safer and newer vehicles [39].

4. POSSIBLE IMPACTS OF FINANCING PUBLIC PASSENGER TRANSPORT ON THE ROAD SAFETY

Based on the H2 hypothesis confirmation, it can be stated that public authorities are able to find financial resources for the support of public passenger transport. If the public uses the public passenger transport offer instead of individual transport, the road safety will improve. To verify the hypothesis H1, it is necessary to examine the assumption that the road safety will be increased when passengers change their way of transport (from passenger cars to public transport). This part of the paper examines whether financing public transport from public funds motivates passengers to change their way of transport. Molander et al. [34] pointed out that there is a relationship between the financial support of public transport from public funds and willingness of passengers to pay for using public transport. The importance of this relationship increases with the significance of the debate on transparency in public spending [20, 21]. According to available sources, direct impact of the increasing financial support from public funds on the willingness of passengers to pay for transport has not been examined yet. However, the results of research on the impact of the financial support for cultural events from public funds show that such financial support may increase as well as reduce the willingness of the private sector to finance cultural events [4, 7 and 33]. Considering public transport, it is possible to increase the willingness of passengers to pay fares if the passengers will understand the financial support from public funds as sufficient support alongside incomes from fares. Therefore, public authorities must present the reasons for the financial support of public transport in an appropriate manner. There are also cases when willingness of passengers to pay fares decreased with the increased financial support from public funds. Those passengers had an opinion that they already paid for public transport in the form of taxes and the fares were understood as an additional payment for the same services. The similar problem is also addressed by Souche et al. [47] and Tscharaktschiew and Hirte [50].

In terms of verifying the hypothesis, it is necessary to address the issue whether the increased number of passengers and increased road safety can be achieved through increasing the financial support of public passenger transport. The increased financial support from public funds increases also the willingness of passengers to pay fares [25]. The willingness to pay fares in public transport is defined by Homburg et al. [22] as an amount of money that customers are willing to spend for provided services in case of knowledge about further support of the service provision from public funds. Phanikumar and Maitra [38] point out that the willingness to pay for public services includes not only the user's values but also non-user's values. This means that the willingness to pay for public transport services includes the amount of fares and public financial resources which are being spent to ensure transport serviceability. The similar definition can be found in studies elaborated by Kotchen and Reiling [30], Cooper et al. [11], Geurs et al. [17], Humphreys and Fowkes [24], and Liebe et al.

[32]. Horne et al. [23] emphasized that knowledge of the financial support from public funds influences the opinion on the level of fares which passengers are willing to pay for provided services.

Based on Lai and Chen [31], it can be stated that passengers are willing to bear with an increase in fares in case that they have sufficient knowledge of the financial support of public transport from public funds. Passengers are more willing to accept a price increase in case they are satisfied with provided services [28].

On the other hand, the payment of fares and public funding can be understood as double financing by persons who pay taxes to public budgets [8]. In this context, Andreoni and Payne [1] pointed out that the financial support of public transport may cause unwillingness to pay fares. The unwillingness is mainly manifested in case of increasing fares. Nyborg and Rege [35], and Liebe et al. [32] pointed to the fact that knowledge of financing transport services from public funds elicits the requirement for public transport provision for free.

Taxpayers who do not use public transport may also accept financing public transport from public funds [26]. In this case, the financial support from public funds is understood as the support of maintaining the availability of services for a taxpayer in case he/she needs the services.

The question is whether the financial support of public passenger transport increases the road safety in that a part of travellers start to use public transport instead of individual automobile transport. In order to verify the hypothesis H1, it is necessary to examine a change in the number of passengers under the support of public transport through the elasticity of demand for public transport [19]. In general, the elasticity of demand refers to the relationship between the percentage change of the selected factor and the percentage change of demand (e.g. performance in public transport expressed in passenger-kilometres). If fares in public passenger transport decreased due to the financial support from public funds obtained from using passenger cars (e.g. an increase in excise duties on mineral oils), it would be possible to anticipate behaviour of the population based on the elasticity of demand for fuels.

According to the measurements of Storchmann [48], the results of which were also confirmed by Gnap et al. [19] for Slovak conditions, it can be stated that the demand for driving by passenger cars during holiday (-0.240) and leisure time (-0.120) significantly decreases due to fuel price increases. However, those travellers do not change to public transport because price elasticity of demand equals to only +0.016 in case of holiday and +0.045 for leisure time. Price elasticity of demand for the use of passenger cars for the business and shopping purposes is very low (-0.009 and -0.020). This means that number of journeys of those groups of traveller does not change. Comparable elasticity can be seen only in case of commuting to schools where travellers change their type of transport from automobile transport (-0.136) to public passenger transport (+0.121).

Table 2

Price elasticity of demand for automobile transport and public passenger transport in relation to fuel prices

The purpose of journey	Automobile transport	Public passenger transport
Commuting to work	–0.092	+0.202
Commuting to schools	–0.136	+0.121
Business trip	–0.009	+0.047
Shopping	–0.020	+0.031
Leisure time	–0.120	+0.045
Holiday	–0.240	+0.016
Average	–0.102	+0.070

Source: [48].

Development of commuting to work is also interesting. Elasticity of demand for driving to work by passenger cars is significantly inelastic in relation to fuel price increases. Very few travellers are willing to switch to public transport. However, those, who have already started to use public transport, carry out more than double journeys compared to individual automobile transport. In relation to transport, it is necessary to point out that a price of transport does not represent the most important factor [19]. The most important factor is the travel time (Table 3).

Table 3

Factors affecting the volume of public passenger transport

Factors	Elasticity
Regional employment	0.25
Occupancy of city centres	0.61
Offer of transport (volume of vehicle-kilometres)	0.71
Waiting time	–0.30
Travel time	–0.60
Fare level	–0.32

Source: [19].

Demand for transport services is characterized by inequality during a day. Fig. 3 depicts the changes in demand for public transport services. The graph in this figure is processed based on the measurements carried out by the authors in particular regions of the Slovak Republic. The demand is characterized by two periods of peak hours in the morning and afternoon. During peak hours, offer of transport can be lower than demand for transport. Morning peak hours are in the interval from 6:00 till 8:00 when the proportion of nearly 15 % of the total daily number of passengers is transported. The number of vehicles which are need in public transport is determined based on morning peak hours. Maximum utilization of their capacity is taken into account during this period. During off-peak hours, offer of transport exceeds demand and therefore vehicles are not sufficiently utilized in terms of their capacity.

If the financial support of public transport increased with the aim to decrease number of travellers in passenger cars, the desired effect would not be achieved because there are other important factors influencing transport mode choice. When considering the factors affecting the demand for transport services in particular a significant role of transfer time, it can be concluded that the hypothesis H1 cannot be confirmed. In the process of decreasing the fares, it is necessary to take into account that the increase in numbers of passengers is related to the fact that the passengers prefer public transport to walking or cycling. Further, it is necessary to note that a higher increase of passengers can be expected during peak hours.

A new passenger during off-peak hours causes below-average marginal costs (there is no need for investment into new vehicles because the existing vehicles are not sufficiently utilized). On the other hand, a new passenger during peak hours causes above-average marginal costs because the existing vehicles are fully utilized under actual conditions. Decreasing fares or public transport provision for free has a greatly limited impact on the road safety. To decrease number of passenger cars, it is necessary to take other measures that make travellers to use public transport. The example can be restrictions on parking vehicles at the traveller's destination or limitations for the ride of passenger cars what results in significantly longer travel time compared to the use of public transport.

5. CONCLUSION

The road safety is currently a topical issue given the fact that an increase of transport performance still persists and infrastructure capacity is limited mainly in cities. The probability of accidents increases with increasing performance of road transport. This results in decreasing road safety. This paper verifies the hypothesis that road safety improvement can be achieved through the support of public passenger transport from public funds.

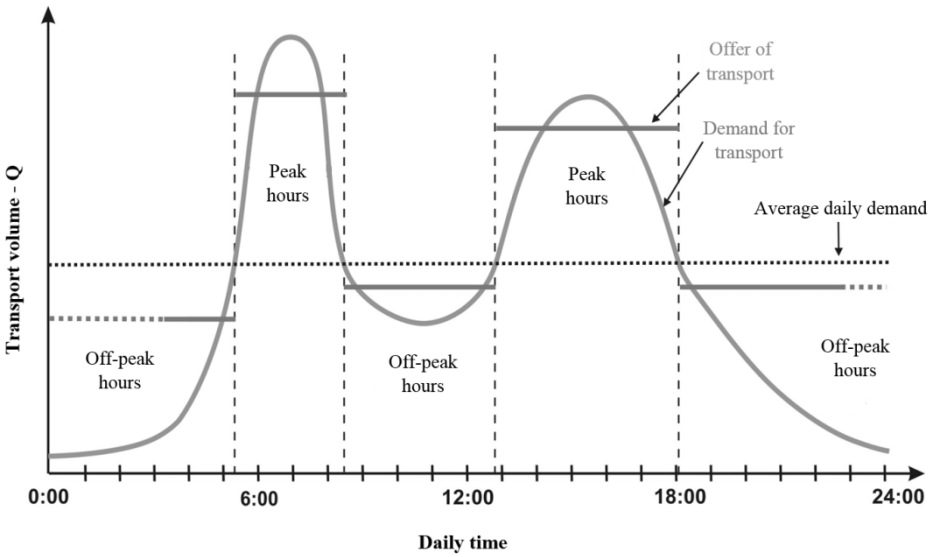

Fig. 3. Offer of transport capacity and demand for public passenger transport depending on the daily time. Source: processed by the authors

The paper analysed the possibilities of financing public passenger transport from public funds. It was concluded that public transport is operated by service operators with the support from public resources. To handle demanding financial requirements for public transport support, several countries have established a financing system which is directly linked to specific taxes and fees. Financial sources are often generated from incomes of public budgets related to transport.

This paper confirmed that if travellers started to use public transport instead of passenger cars, the number of vehicle on roads and the probability of accidents would decrease. It is also possible to state that professional drivers have better prerequisites to handle risk situations on roads with respect to their practise and checks.

However, financing public transport from public funds itself does not directly mean increasing road safety. It is also necessary to address the elasticity of demand of individual groups of the population. Based on the elasticity, it can be concluded that a significant change in the road safety cannot be achieved unless other measures are taken alongside the financial support of public transport (e.g. reserved bus lines, parking bans for vehicles). Decreasing fares or public transport provision for free would attract only walkers and cyclists. Furthermore, it can be expected that the increased demand of those users could occur mainly in morning peak hours, and this could result in the need for investment and further requirements for financial support from public funds.

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