1. Introduction

Road safety represents an all-society problem not only in the EU but also in non-member states of the EU [1]. The number of persons killed per 100,000 population represents a value higher than 2 persons per year depending on the EU member state [2]. Many authors agree, e.g. Koorntra et al. [3] or Subramanian [4], the safety of road transport is improving because of the decrease of the share of killed persons in road traffic. However, the number of traffic accidents and particularly the number of fatalities is significantly higher than the aim specified in strategic documents of the EU [5].

So far, all measures aimed at increasing road safety have been focused on infrastructure, vehicles and drivers. Road safety in relation to infrastructure was increased through increasing capacity of infrastructure. However, the increased infrastructure capacity often results in further increase of traffic flow which causes additional requirements for the capacity increase. Particularly in the urban areas, possibilities for increasing the capacity of infrastructure are limited. Measures aimed at vehicles improve technical equipment which increase safety of vehicles for passengers as well as the surroundings of vehicles (e.g. ABS components, airbags, and crumple zones of vehicle). By improving technical equipment of vehicles, however, drivers drive more risky because they rely on this equipment. The smallest share of attention is currently devoted to the third factor which is driver behaviour. Various courses on road safety are recently organized but public authorities try to control the compliance with safe driving only by direct road checks. The aim of the paper is to point out that the positive effect on road safety can be achieved through significant support of bus service. The authors of the paper try to prove the hypothesis that the support of bus service has a multiplier effect which is reflected in the change of all three groups of the factors affecting road safety.

2. Factors affecting the road safety

Road safety is affected by many factors. According to Evans [6], Elvik et al. [7] or Hakkert and Gitelman [8], the most important factors are: driver's behaviour, vehicle construction and infrastructure conditions. Based on the analysis of existing scientific outputs, individual elements of those important factors affecting road safety are defined in Fig. 1.

Change in the quality of traffic infrastructure

Traffic engineering and operating characteristics of the road network provide the background for increase of road safety [9].
knowing and increased enforcement of drunk driving laws has improved safety [13]. As Evans [6] notes, “The basic skills to stop, start, and steer vehicles are acquired remarkably easily and quickly. Complex higher level skills that are acquired only after many years of experience can contribute to reducing crash risk.” Based on the analysis of factors affecting road safety it is necessary to aim at the driver, driver’s behaviour and skills. The driving while intoxicated and effective control of alcohol use before driving have important role within driver’s behaviour. Ramsted [13] demonstrates that there is a correlation between the overall alcohol consumption in countries or provinces and fatal accidents rates. Yet, this correlation varies between different regions of the world and between the genders and age groups. An increase of 1 l of pure alcohol per inhabitant of 15 years and above increases motor vehicle fatalities per 100 000 inhabitants for men by 0.05 in Northern Europe; 2.1 in Central Europe and 0.8 in Southern Europe, by 3.2 in the US, and 3.6 in Canada. For women, the increase in motor vehicle fatalities is generally smaller than for men. Sheehan [14] demonstrates parallel trends for alcohol consumption and percentage of fatally injured drivers and motorcycle riders with BAC of 0.5 g/l or greater for Queensland, Australia for 1982 – 2005. The research states, that in traffic, it is possible to check a very small part of drivers despite of the fact that driving while intoxicated increases the risk of an accident. It is possible to check drivers of public passenger transport before starting working shift so increasing the share of those drivers can reduce the SPI level of driving while intoxicated.

3. Multiplier effect of support of bus service on the road safety increase

Within the support of public passenger transport it is possible to achieve change across all of the significant factors affecting the safety of road transport. Provided we proceed from the individual groups of factors and we assume that will not change the intensity of traffic flow (which implies the number of realized paths of

| Infrastructure | Vehicle | Driver |
|----------------|---------|--------|
| Speed limits   | Structure (aggressive/protective) | Physical/congnitive impairment |
| Congestion     | Mass    | Fatigue |
| Traffic segregation/integration | Power | Drugs and medicines |
| Traffic calming | Conspicuity | Alcohol |
| Readability of the road | ABS | Risk taking (speed) |
| Fixed obstacles |              | Seat belt wearing (front/rear) |
|                |              | Children seats use |
|                |              | Helmet use |

Fig. 1 Factors affecting road safety [Source: authors]
Let us 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 practice, such a road is usually adjusted 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 the decrease of accident probability can be also achieved by decreasing the intensity of traffic flow from $M_A$ to $M_B$.

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

$$\Delta r_e = f(M_A-M_B) = f(\Delta M) \quad (4)$$

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

$$\Delta r_e = f(f(H_A-H_B)) \quad (5)$$

Based on above equation, it can be concluded that the density of traffic flow decreases through the support of bus service. The reason is that there are less transport means on roads which results in increasing road safety.

While increasing the safety of road transport in the current period, most options are in the change of accident rates, in particular in connection with the driver. In supporting public passenger transport, the proportion of drivers of bus transport would increase in the total number of drivers who lead vehicles in respect of the carriage of the passenger. To an increase in the share of buses would improve the value of the following factors:

- The physical condition of the driver - the drivers of the bus have set out the conditions for the implementation of travel (e.g. Regulation (EC) No 561/2006) according to which, after
Based on the above mentioned, it is possible to verify the statement that the support of bus service has a multiplier effect on increasing road safety. On the one hand, it decreases the probability of a road accident through decreasing the intensity and density of traffic flow. On other hand, it increases the proportion of professional drivers whose probability to be involved in an accident is lower.

### 4. Conclusion

The aim of the paper was to prove the hypothesis that the support of bus service has a multiplier effect on increasing road safety. The paper confirms this hypothesis, and thus it can be stated that the support of bus service can significantly increase road safety. By increasing the number of individuals transported by public passenger transport, the multiplier effect of road safety increase can be achieved. The support of public passenger transport significantly decreases the risk of road accidents caused by drivers. Based on statistical findings, the probability of an accident caused by the professional drivers is lower by 42.7% compared to drivers of passenger cars. In addition, the risk of an accident is also decreased due to the change in intensity of traffic flow.

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