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## SAFETY AND SECURITY ASPECTS IN SHARED MOBILITY SYSTEMS

**Summary.** Shared mobility systems are becoming quite popular around the world. This trend has led to the continuous development of vehicle fleet and use by a growing number of individual users. Due to this, the services of shared mobility have been analysed from the viewpoint of many different aspects. Safety and security issues are particularly important for both the user and the operator.

This paper is dedicated to the concept of different issues of safety and security in shared mobility solutions such as bike-, car- and scooter-sharing, peer-to-peer sharing services and on-demand riding systems. The idea of shared mobility and case study, based on problems with safety and security aspects related to that kind of mobility is presented in the text. The aim of the work was to show the importance of safety and security aspects in the shared mobility solutions.

**Keywords:** shared mobility systems, shared mobility problems, safety in shared mobility systems, security in shared mobility systems, on-demand transport services, urban logistics.

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## 1. INTRODUCTION

Current cities have become centres where new types of urban logistics solutions are being tested. This is due to the need for implementation of sustainable development policies in the field of transport, improvement of the quality of life of the residents and the state of the environment [7,10,12,13,14,24].

Of such solutions introduced to the urban transport systems in order to implement the policy of sustainable transport development are the shared mobility services [1,11,17]. Initially, systems that appeared in cities were mainly based on providing factors such as [15,23,25,29]:

- providing the right number of vehicles in the operator's fleet
- location of vehicle rental zones in strategic city points (centres, stations, transfer nodes, etc.)
- adjusting the price of services to users' capabilities
- ensuring proper access to vehicles in a mobile application
- proposing an appropriate system of renting and returning the vehicle, that is, in docks or dockless in the case of sharing bicycles, or with the possibility of returning the vehicle in another part of the city, at the discretion of the user in the case of car-sharing which provides free-floating solutions, etc.

However, apart from the above criteria, which is very important from the viewpoints of organisation and systems management, little attention was paid to the aspects related to ensuring an adequate level of user safety and the system security. Because vehicles in fleets in urban conditions more visible, they become an integral part of vehicle traffic in urban transport systems, hence, the authors decided to focus on safety and security aspects in all services offered in the shared mobility concept.

## 2. SHARED MOBILITY SOLUTIONS

Shared mobility concept refers to the shared used of a vehicle – bicycle, car, scooter or other transportation modes, for example, Segway. Shared mobility is the range of transport services offered in municipal logistics including shared services like bike-sharing, car-sharing scooter, sharing organised by specialised operators in the industry. It includes peer-to-peer ridesharing – the possibility of renting your own vehicle through organised platforms providing advertising services. Furthermore, on-demand ride services – ordering car transport services through a mobile application by associating passengers with drivers using the application, that is, Uber, micro-transit, and other modes.

The fleet of shared bikes and scooters is called micro-mobility initiatives [22].

Shared mobility is the transportation strategy that allows users to access transportation services on an as-needed basis. The idea gives the possibility to ride or drive the vehicle without owning it. Initially, the systems were single initiatives, now we are dealing with global, national and local enterprises providing shared mobility services, giving an alternative to travelling by own vehicle.

The shared mobility services in urban logistics appeared as first initiatives in 1948 in the case of car-sharing, 1965 in the case of bike-sharing and 2012 in the case of scooter-sharing [5,6,27]. In the case of on-demand ride-sharing systems, services started to be popular in years 2009-2012 [3,28].

However, the development of shared mobility services in the world dates back to the years: 2000 in the case of car-sharing, 2005 in the case of bar-sharing and 2018 in the case of scooter-sharing solutions [2,9,21]. The future of shared mobility solutions looks very promising. The statistics indicate that in 2025 there will be 36 million users in the world using the car-sharing offer [26]. On the other hand, in the case of ride-hailing services like Uber, it is forecasted that the world market in 2025 will be worth over 125 \$ billions [18]. Such forecasts show that the shared mobility market will gain increased importance for the society, which is the reason it is particularly important to ensure an adequate level of safety and security for services provided by it.

### 3. SAFETY AND SECURITY IN SHARED MOBILITY SOLUTIONS

Safety in the context of transportation is one of the most important factors for the society. Here safety refers to the methods and different measures of preventing road users from being injured or killed [26]. Road safety is a complex problem. The impact on traffic accidents has many factors. The cause may be human errors, vehicle malfunctions and defects of the road environment.

In the case of shared mobility systems, safety problems are connected with traffic safety aspects. Based on the analysis of the authors, two main groups of factors related to the shared mobility services – engineering aspects and behaviour aspects were realised. Features associated with an insufficient level of safety in shared economy services among others are presented below:

- insufficiently monitored technical condition of vehicles offered in shared mobility services leading to frequent lack of vehicle equipment elements from the lack of windscreen washer fluid to the lack of emergency equipment such as a warning triangle, theft of hubcaps, saddles in bicycles or whole scooters
- failure to provide sufficient infrastructure for the safe parking of vehicles in designated places, for example, envelopes in the case of cars or separate parking spaces for scooters. As a result, the chaos of communication is widening. This chaos is associated with the abandonment of vehicles on sidewalks or roads, reducing the comfort of walking or disabled people
- vehicles are often not equipped with additional protective elements for users such as child seats or helmets for people riding scooters
- unknown technical condition of the vehicle and driver's skills in the case of Uber type services
- insufficient knowledge of users in the use of vehicles offered in shared mobility services, and thus, problems with charging electric vehicles or driving/riding electric vehicles in bad weather conditions - frequent skidding
- not respecting rental vehicles and moving them too fast without complying with traffic regulations

All the above factors can be ordered to issues related to the vehicles safety, infrastructure safety or issues related to education with the mobility management requirements. The proposal to divide the safety aspects related to sharing mobility services is presented in the scheme in Figure 1.

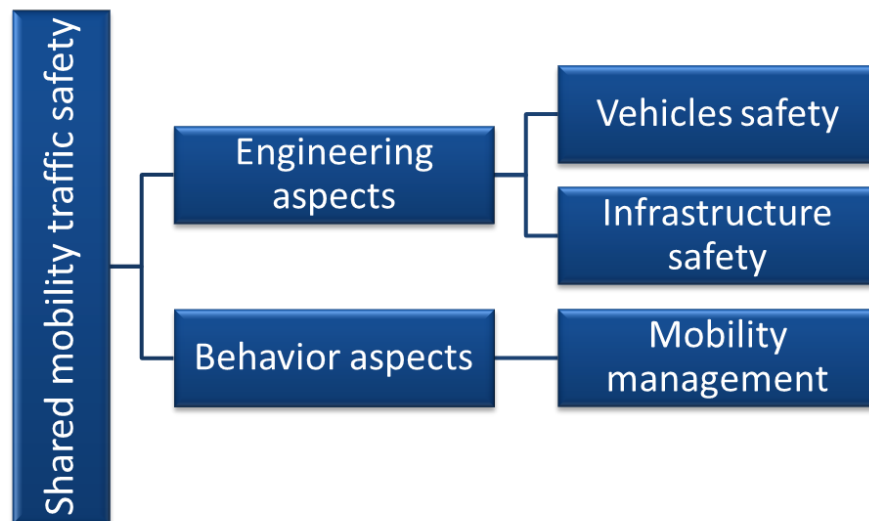


Fig. 1. Shared mobility traffic safety division scheme

Source: authors own collaboration

One should also remember about the aspect of vehicle safety related to age and wear, and the multiplicity of various monitoring systems [4,16,19,20].

The second important viewpoint of the two parties - users and shared mobility operators - are the security issues. Security from the point of view of shared mobility services are connected with the following factors, among others:

- monitoring and sharing with other authorities and operators, information about users who used the service without paying its fee, and then rented another car at the next operator
- existence of a small number of shared mobility service system operators who offer users the opportunity to top-up their account on a "money box" basis
- due to internet activity, there is a need to ensure an adequate level of data security for both personal users and payment data
- some operators have insufficient level of checking driving permissions or only one-step verification is carried out, consisting of sending only photos of user's documents
- exposure to hacking attacks and competition attacks, inter alia, the possibility of reserving all available vehicles of a given operator so that a competitor can offer his services at that time

The proposal to divide the security aspects related to sharing mobility services is presented in the scheme in Figure 2.

The presented factors affecting the level of both security are the problems that operators and users of shared mobility services face on a daily basis. Undertaking any attempts to counteract them provides the opportunity of contributing to real improvement in the quality of the use of these services to the public.

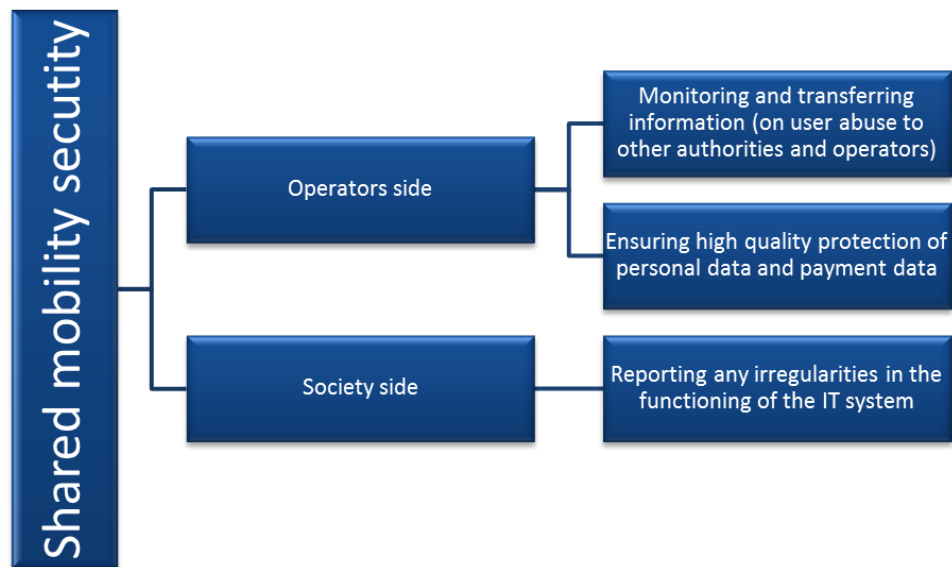


Fig. 2. Shared mobility traffic security division scheme  
Source: authors own collaboration

#### 4. SUMMARY

In conclusion, this paper showed the different aspects to be considered for the secure operation of shared mobility systems. Often, due to the quick profit or takeover of a given market, the issues of adequate safety are omitted, and this is particularly important especially in the case of shared micro-mobility services. In the case of cyclists and users of scooters, we talked about unprotected road users, who often due to the lack of appropriate legal conditions, lack of education in the field of mobility are not aware of the dangers that await them moving along the road in the company of cars.

Therefore, it is of utmost importance that detailed legal guidelines are adapted for moving vehicles from the shared mobility offer. In addition, appropriate recommendations and instructions should appear in the applications of service providers before the start of the journey. Besides organisational issues, worth focusing are the technical elements related to appropriate vehicle equipment, helmets and child seats, as well as appropriate marking of vehicles and equipment with reflective elements. It is also significant to note the need to undertake attempts to develop systems (databases) that register users who default when using these systems such as devastating vehicles, exceeding speeds or unpaid journeys. Such activities would have the potential to increase the level of security for service operators. In furtherance of this research work, the authors want to develop recommendations for the safe movement of vehicles with shared mobility services.

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