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Original scientific paper

Micromobility – Infrastructure, Legislative and Safety Challenges

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Abstract – **Modern cities and their transportation systems are challenged by new mobility options – micromobility, which includes light vehicles such as electric: scooters, skateboards, bicycles etc. Regardless of whether they are private or public service offer, the micromobility opened many questions concerning legislation, infrastructure limitation and traffic safety, which will be briefly discussed in this paper.**

Keywords – **Electric micromobility, Street redesign, Legislation, Safety, MaaS**

I. INTRODUCTION

Rapid technological advancement and innovations lead to continuous social changes, which consequently has an impact on the development of the complete traffic system. Standard vehicles powered by fossil fuels are being replaced by electric and hybrid vehicles – more environmentally friendly and cleaner ones. Drivers do not have to operate vehicles since this is done by a computer. Due to the development of artificial intelligence, computers have made the implementation of autonomous vehicles possible. Artificial intelligence has enabled the development and testing of the V2X system for informing, warning and communication, which encompasses V2V, V2I, V2P, V2N technologies. The collection and usage of data in real time, development of new transportation modes, such as drones, electric bicycles and electric scooters, represent further technological advancement, developed with the aim of sustaining urban mobility and creating intelligent and ecologically clean cities.

Bicycles, skateboards, electric bicycles and the most recent transportation mode which is the subject of this paper – electric scooters – are representatives of a relatively new concept – micromobility. The term micromobility has become a catch-all term for previously named modes of transportation, and can be considered as a trip in short distances. This trip is usually between walking and driving distances or trip related to the first or last kilometer of traveling with another transportation mode, usually public transport.

Popularity of this transportation mode rose rapidly, primarily due to favorable features of e-scooters: easy to use, faster than the traditional public transport and more compact than bicycles, available to a wide range of users, healthy and environment friendly.

By the end of 2018, electric scooters mostly replaced bicycles and electric bicycles so there were 85 000 e-scooters in 100 cities in the USA. In the same period in the USA, 38.5 million of trips were realized by e-scooters, out of which 40% of the trips were in Los Angeles, San Diego and Austin [1]. Similarly, in all larger European cities, the offer of public renting of e-scooters has been enabled. Thus, it is estimated that Paris has approximately 20 000 e-scooters, Copenhagen about 7000, while in Cologne this number is estimated to reach 40 000 by the end of the year [2]. In Belgrade, approximately 35 000 e-scooters were sold during the period of several months in 2019 [3].

As urban population grows, car ownership is growing, along with the increase of urban mobility resulting congestion on street network. Micromobility could play a crucial role of additional mobility service in cities, thus helping tackle with increasing congestion. Due to its advantages, micromobility could easily replace cars for the significant number of short trips and especially short trips in cities, which can help in reducing and excluding cars from city centers.

II. INFRASTRUCTURE FOR E-SCOOTERS

Basic precondition for the efficient functioning of e-scooters is adequate infrastructure. Currently, this is one of the most important issues micromobility is facing. Physical limitations of the street network and road profile, different structures and characteristics of the base course and the existing separation represent the obstacle for the safe usage of e-scooters.

Traffic experts worldwide agree that streets with the surface course made of cobblestone or sheets, as well as the streets with tramway tracks, are not safe for e-scooter riding. The characteristics of these vehicles, primarily their small wheel circumference and radius, limit their use on the above-mentioned streets. Although a large number of countries have started introducing amendments to the law in order to properly handle this transportation mode, insufficient attention is still paid to infrastructure development and modification.

In the countries and cities where the arrangement and adaptation of the space has already begun, e-scooter users are mostly redirected to the cycling infrastructure. Such examples can be found in Tel Aviv, Paris and most American cities. In London the government intends to legalize the use of e-scooters primarily in business zones, parks and campuses. Company Voi in Sweden plan to introduce “Zones 20” where e-scooters would be allowed to move. The city of Copenhagen intends to introduce and test 200 electric scooters in the historical city center, as well as of 3000 e-scooters in satellite zones [4].

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For instance, in Texas it is allowed to ride e-scooters on sidewalks, while in Colorado sidewalks are the only places where they can be used. In California, it is strictly forbidden to ride e-scooters on sidewalks, but riding is allowed on the carriageway along the right brink of the sidewalk. In reality, the situation is considerably different, and e-scooters are frequently ridden on sidewalks in spite of the prohibition and warnings that this compromises traffic safety. A similar situation can be found in Serbia, where the use and movement of e-scooters is not regulated, so users frequently ride them on carriageways, sidewalks and bicycle paths, as can be seen in Fig. 1.

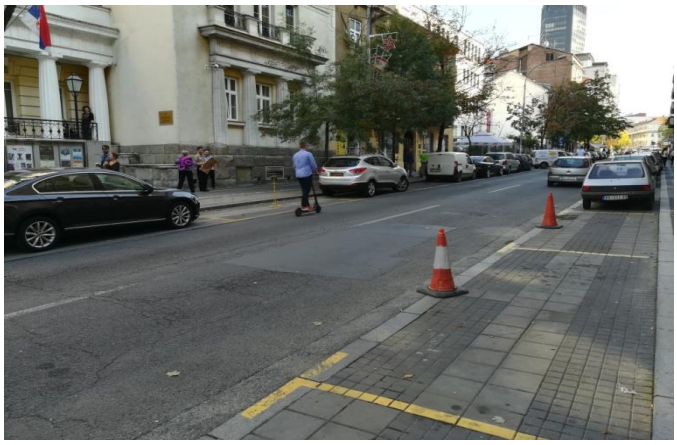

Figure 1. An example of using an e-scooter

At the moment there is the issue of parking management as well as the implementation of the equipment necessary for e-scooter charging. Although most companies choose the system of parking on sidewalks, and the possibility of leaving e-scooters at any location in the city, after using them, has had an effect completely opposite to the desired one.

Generally speaking, there are two concepts regarding the redefinition of the space for electric scooters. The first one, based on the example of Germany and several American cities, relies on the complete separation of all user categories, as it is shown on Fig. 2.

Figure 2. Physically segregated lane for e-scooters

This concept assures higher level of traffic safety for users of e-scooters, given that there is no interference with different categories of users: pedestrians, car drivers, cyclists etc. The main disadvantage of this principle is that it requires a lot of space for infrastructure implementation.

The second concept is based on the idea of "naked streets" where all traffic users operate in the shared space without separation [5]. The example is shown in Fig. 3.

Figure 3. An example of a concept „shared space"

In essence, this concept creates a greater sense of uncertainty who has the right of way on a street, which consequently raises awareness of the presence of other road users.

Generally speaking, two mentioned concepts have their advantages, but present two completely opposite approaches. With the current situation in cities, which face both the exponential growth of the e-scooter number in the street network and the lack of space, the solution could lie somewhere between these two concepts, and could be a result of their combination and coordination.

III. LEGISLATION

The existing laws could not follow the increasing popularization and development of this transportation mode, even in the countries where e-scooter services can be used, a large number of traffic accidents and inadequate behavior have appeared.

For example, in Britain it is illegal to ride electric scooters on public roads, sidewalks and bicycle lanes and paths. In addition, an e-scooter rider has to be at least 14 years old [6]. E-scooter riders are fined with £300 and 6 penalty points on their driving licence. Consequently, the exponential growth of e-scooters and changes that came with them, induced active measures on the improvement of legislation in Great Britain. As a result, the strategy: "Future of Mobility: Urban Strategy" was adopted, at the beginning of 2019, in which micromobility holds an important place [7].

Some countries such as France and Germany have already defined or are currently classifying a new vehicle group (PLEVs – "personal light electric vehicles" [8]. Electric scooters are treated as PMD ("personal mobility devices") in Singapore, while in Poland there is an initiative for amendments to the law in order to introduce a new vehicle category (PTD – "personal transport device") [9].

California if one of the first states that regulated the use of e-scooters. For example, the driver has to possess a driving licence and the use of cycling infrastructure (paths of class II and IV) is allowed at the maximum speed of 25 km/h. It is allowed to ride an e-scooter on the street with the 40km/h speed limit, but only if the e-scooter moves at the speed of up to 25 km/h. Also, it is allowed to use the roads with the speed limit of up to 56km/h, with the previous permission of the authorities. In this case, the speed of the e-scooter must not exceed the 25 km/h speed limit [10].

In Serbia, there are no regulations regarding the use of e-scooters. However, certain amendments to the existing Law on Road Traffic Safety have been announced. The Road Traffic Safety Agency has proclaimed the amendments to the law to start in 2020. Until then, the users are only offered experts' recommendations, which are mainly related to the use of protective helmets and careful operation of e-scooters.

IV. MICROMOBILITY SAFETY

In spite of many advantages, electric scooters have aroused strong public opposition. The main opponents of this transportation mode are cyclists and pedestrians. Namely, they are placed under a lot of pressure due to the need for sharing the infrastructure and the fact that their safety is jeopardized. Pedestrians are generally the most vulnerable category since in most countries riding e-scooters on sidewalks has not been regulated by law yet. As a consequence, traffic accidents including pedestrians are very frequent.

In the 2018. approximately 1500 recorded injuries were caused by the use of e-scooters, and eight people were killed in 47 American cities, [11].

A study conducted in Austin, Texas, for the period of three months (from September to November) found out that 271 people had been injured as a consequence of using e-scooters. A more thorough analysis showed that during the observed three-month period at each 100 000 trips by e-scooters 20 people were injured. In the total sample, 58% of the injured were the users younger than 30. Head injuries (48% of the respondents) and fractures (35%) were the most frequent. It is important to mention that in the total number of the injured, 62% were novice users, while only 4% of the users wore a helmet while riding [12]. Similar injury distribution is present in California, for one-year research period. Results are shown in Fig. 4.

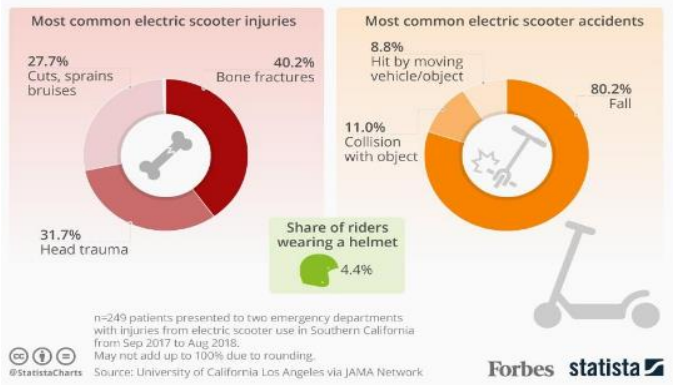

Figure 4. Injury distribution in Southern California

Situation is not any different for European countries and cities. For example, in France, one e-scooter driver has been killed and dozens injured in 2019. Germany had its own negative statistics with seven people seriously injured and 27 with minor injuries since mid-June, in 2019. In Britain first ever death involving an e-scooter was in London on July 12. The day after, a 14-old boy suffered a head injury after crashing into a bus stop [2], [13].

These two incidents have alarmed the government which initiated, previously mentioned, major project addressing the possibilities of micromobility in the United Kingdom.

In spite of the frequent occurrence of injuries, but due to the lack of regulations, certain companies, organizations and associations offer only recommendations related to using e-scooters, for example: wearing a helmet, reduce the driving speed or drive slow, avoid driving on bumpy surfaces etc. These recommendations are treated as the system of pre-legislative activities until the amendments to the law or new laws are adopted.

V. SWOT ANALYSIS

The biggest contribution of micromobility is in its role as a part of MaaS, which could be the perfect solution for filling the empty spot between walking and public transport, as it is shown in Fig. 5. Moreover, micromobility has a potential of serving the user transport needs, for a distances up to 8 km [14]. Given its benefits, an increasing number of researchers and decision makers are recognizing and promoting micromobility as a promising mode of transportation.

Having previously said in mind, a SWOT analysis was conducted in order to highlight the main properties and characteristics of micromobility. SWOT analysis is a structured planning method that helps to evaluate the strengths, weaknesses, opportunities and threats.

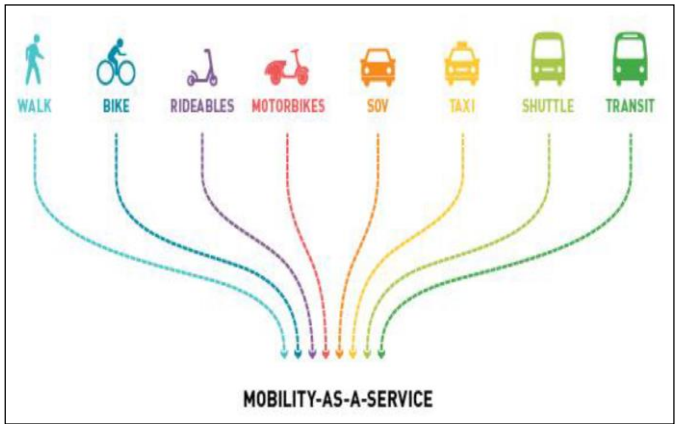

Figure 5. Micromobility as a MaaS

This analysis can also help the decision-makers to better understand micromobility and the effect of micromobility on users and cities. Results of conducted SWOT analysis are represented in Table I.

According to SWOT analysis one can see that micromobility have many advantages and opportunities. While weaknesses and threats are caused mainly due to a rapid and booming usage of micromobility that did not

followed with rapid changes in space allocation and regulation.

Important strengths, previously explained in this paper, are directed to reduction of car traffic and reduction of parking congestion. In the era of green and urban mobility biggest strengths of micromobility are: air quality improvement, noise reduction, reduction of climate change and better land use. All of mentioned strengths have, as the main product, urban space improvement.

Significant opportunities are related to social equity, eco mobility and shared mobility. With targeted strategic actions, there is strong opportunity for reduction in number of parking lots and number of traffic lanes for cars, which could consequently unburden the main city areas.

Weaknesses and threats are mostly focused on the aspects that are previously explained in this paper: traffic safety, lack of regulation and legislative framework, enforcement measures, weather conditions and terrain conditions.

Table I. SWOT analysis of micromobility – e-scooters

Strengths
• Reduction of car traffic • Reduction of parking congestion • Generation of revenues • Air quality improvement • Reduction of noise • Reduction of climate change • Urban space improvement • Better land-use
Weaknesses
• Traffic safety • Lack of regulation
Opportunities
• Social equity • Eco mobility • Shared mobility • Can reduce number of parking lots • Can reduce number of traffic lanes for cars
Threats
• Legislative framework • Enforcement measures • Weather conditions • Terrain conditions

VI. Conclusion

The established trends and expansion of new transportation modes within the concept of micromobility ask for the change of the previous attitudes and perceptions of the traffic system as a component of the city. The most recent representative of this concept – e-scooter – has shown that certain countries and cities are not prepared for the abrupt changes that this transportation mode brings.

Although certain countries have started to change and improve their traffic and legal systems, this process is long-lasting and requires considerable effort in order for the first significant results to be noticed. So far, Serbia has not taken any measures in dealing with these new changes. Therefore, it will have to actively and seriously address this issue. The first and most important step in dealing with this issue is the improvement of legislation in order to form a basis for taking further actions. A good example is set by Germany, France, Singapore, Poland, etc. In their legislation, these countries have defined or classified a new vehicle category. This can be a good starting point for defining domestic laws and by-laws.

The amendments to the law enable the incorporation of this new transportation mode into the existing traffic system; they offer the possibilities of arranging and constructing the required infrastructure, and sanctioning of improper behavior of traffic users. The examples seen around the world offer the solution of using shared spaces or part of the infrastructure, which requires all users to make certain concessions. Therefore, the improvement of the legislation and traffic system makes the solid basis which will provide equal conditions to all participants in traffic.

Lastly, micromobility, with its notable strengths and opportunities, could play an important role as a part of MaaS. This integration can significantly reduce our environmental footprint, save money, increase efficiency, increase population health and improve land use. With mentioned advantages and adequate implementation measures micromobility will progressively shape the future of traffic system.

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