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ELECTRIC SCOOTERS, EXPERIENCE OF USE: ADVANTAGES AND DISADVANTAGES

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Abstract. *The experience of operating electric scooters, the advantages and disadvantages of their use are analyzed, measures to improve traffic safety are proposed in this article.*

Key words: *electric scooter, micromobility, traffic safety, experience of use, advantages, disadvantages, improvement of traffic conditions.*

Introduction.

Electric scooters, electric bicycles, hoverboards, and monowheels — these modes of transportation have long become a common sight on the streets of Ukrainian cities and have firmly integrated into our lives. These types of transport, like bicycles, can effectively be used to combat the reduction in traffic congestion, air pollution, the consequences of the global pandemic, and climate change on the planet.

Electric bicycles are operated according to the rules of cyclists, while hoverboards and monowheels are more suitable for the younger generation, considering the need to constantly maintain balance. Electric scooters, unlike them, have the potential to occupy a niche in personal electric transportation (PET) within cities, but the conditions for their convenient and safe use are not yet recognized at the legislative level. Therefore, analyzing the experience of their use and considering the advantages and disadvantages is important at this stage of micromobility means development.

Main text.

Electric scooters were initially perceived as a form of entertainment for the youth, but during the pandemic, people realized that they are not just toys but also a single-passenger means of transportation for distances of up to several kilometers at considerable speed. An electric scooter is typically a small, possibly foldable, vehicle powered by an electric motor. Designed for standing, although there are models with seats. They are most commonly used in cities and are intended for short-distance travel.

The following models of electric scooters are distinguished: light and heavy scooters. Light scooters, usually equipped with a small battery, are foldable,

convenient for carrying and transporting, but limited in range on a single charge. Scooters with heavy batteries have more weight, are less convenient to use, but allow for covering a greater distance. The experience of use shows that heavy electric scooters with long range on a single charge are usually used more often as rental vehicles, while light ones are more often used as individual use models.

Thanks to electric scooters, the term "micromobility" has gained popularity. Micromobility refers to a new type of urban mobility, primarily associated with the use of a variety of lightweight transportation modes designed for single-person travel. There is currently no universally recognized definition at the international level. Some countries introduce lists of permissible types of these vehicles; however, considering the emergence of new varieties every year, certain universal parameters such as maximum speed, weight, and power seem more important for defining electric micromobility devices [1].

In many countries, city authorities are actively promoting the spread of electric scooters, expanding rental stations, hoping to reduce traffic congestion, decrease the need for car parking spaces, and mitigate air pollution. Currently, rental electric scooter companies operate in nearly 100 cities worldwide.

It should be noted that the regulation of micromobility is influenced by the level of road safety and the level of economic development. A high level of economic development implies the availability of micromobility devices, thus necessitating their regulation. However, the issue of regulating micromobility devices is new to the world. European countries are only beginning to take their first steps in this matter.

In countries with a high level of road safety (such as Sweden, the United Kingdom, Denmark, the Netherlands, and Germany), regulations are introduced based on previous experience, relying on national programs and concepts (such as Vision Zero4) [1].

Despite the differences between countries, in many of them, it is prohibited to use sidewalks for transportation, and the speed of travel should not exceed 25-30 km per hour.

Let's analyze the operating conditions of electric scooters in various countries around the world. The popularity of electric scooters has sharply increased in many countries during the pandemic, prompting the authorities to consider rules for using this mode of transportation. Their decisions in this regard may vary significantly: in some countries, teenagers can ride them, while in others, only licensed drivers are allowed. In some places, riding on sidewalks may be permitted, while in others, it is only allowed on private property.

Experience of using electric scooters in different countries

In many countries, electric scooters have become widely used. For example, in France, demand for them increased by a third in 2020. However, in most Asian countries, they have not become popular due to strict rules and restrictions.

For instance, in Singapore, electric scooters have been practically banned since January 2020: they can only be used on bicycle paths, which are very few in the city-state. Violators face a fine of 2,000 Singapore dollars ($1,400) or up to three months in prison.

In the Netherlands, riding them is only allowed on private property - using

electric scooters on public roads is prohibited under the threat of a €360 fine and confiscation of the vehicle. Moreover, the kingdom has the strictest requirements for scooters - they are classified as "special mopeds" here, which must have two independent braking systems, a brake light, turn signals, and more. So far, no existing model meets the government's requirements, and they cannot be sold.

In the United Kingdom, the use of private electric scooters outside private property is also illegal - riding them on British roads is only allowed on those rented from a special station, of which there are still very few in the country.

In the United States, the movement of electric scooters is regulated only at the state, district, and even municipal levels. For example, they are allowed in the state of California, but the city of Beverly Hills has banned them [2].

With driver's license and license plates

In Japan, the main requirement is to have a driver's license allowing the operation of mopeds and scooters with engine capacities up to 50 cubic centimeters. Electric scooters need to be registered with the police and regularly pay vehicle taxes, equipped with license plates, rear-view mirrors, brake lights, and turn signals. The fine for violating these regulations can reach ¥50,000 ($450), and in certain cases, imprisonment for up to three months is possible. Wearing a helmet is recommended but not mandatory, and the speed limit is 20 km/h. Due to strict requirements in Japan, there have been no serious accidents involving electric scooters reported.

In Singapore, despite the limited areas where scooters are allowed, owners need to register them with the police. The weight of an electric scooter should not exceed 20 kg, and the speed limit is 25 km/h, with operation allowed only from the age of 16.

In the Republic of Korea, starting from May 13, 2021, only licensed drivers aged 16 and above can use electric scooters (previously allowed from the age of 13). Violators will be fined ₩100,000 ($89). Additionally, penalties are imposed for riding without a helmet (₩20,000) or while intoxicated (₩100,000 and license suspension) [2].

Age and speed restrictions

The European Union has yet to harmonize the rules for micro-mobility transport that apply in different countries, so even in neighboring countries, they can be completely different. For example, in France, electric scooters can be ridden from the age of 12, in Germany and Italy - from 14 (in the latter, up to 18 years old, wearing a helmet is mandatory).

The authorities of Istanbul have begun strict regulation of the use of electric scooters: riding them is only possible from the age of 15, not faster than 25 km/h, and only on roads and bike paths. Moreover, it is not allowed to transport more than one person on a scooter or to enter public transport with this means of transportation. Companies that rent them out must obtain a license for two years and equip special parking lots.

In the United States, as a rule, electric scooters can be operated from the age of 16 (in some states - from 12). State authorities also regulate permissible technical characteristics: power from 750 to 2.5 kW, maximum speed - 15-20 miles per hour (24 to 32 km/h). Generally, driver's licenses are not required (with exceptions such as

California), but special equipment is usually required, such as a helmet and clothing with reflective elements.

In China, residents do not use electric scooters, preferring bicycles, mopeds, and electric bicycles. To rent the latter, the driver must be over 16 years old. The rules for scooters in China are similar to those in other countries for scooters: restrictions on maximum speed (25 km/h), weight (55 kg), and engine power (400 W) [2].

Where and how to ride

In the United States, only some states distinguish electric scooters in traffic regulations as a separate mode of transportation. The most detailed regulations are considered to be in Michigan, where it is clearly explained that riders should travel as close to the right edge of the road as possible (usually on specially designated lanes) and lane changing is prohibited.

In Japan, within city limits, riding is only permitted on the roadway or near the edge, or - if there is appropriate marking - in bicycle lanes. However, for example, right turns at traffic lights are not allowed (traffic in the country is left-hand).

In Germany, since May 2019, electric scooters are allowed only on bicycle lanes, but practically everywhere this rule is violated and they ride on sidewalks. Due to the increasing number of accidents, some cities, such as Berlin and Cologne, have created zones where these vehicles are banned.

Although scooters with motors have not become widespread in Brazil, rules have been devised for them: riding on sidewalks is prohibited, but riding on the roadway where the speed limit is 40 km/h is allowed (with a maximum speed for scooters of 20 km/h), and parking should only be in specially designated areas. Violations can result in fines starting from 500 reais ($100). The power of the scooter's electric motor must not exceed 350 W, otherwise, they are equated to mopeds.

In the UK, a person on a scooter can be fined just like a regular driver: £50 for riding in a pedestrian zone, £100 for crossing the stop line on a red light.

Even stricter rules are in place in France - riding on the sidewalk will cost €135, and if the speed exceeds 25 km/h, then immediately €1,500. Within the city, it is recommended to travel on bicycle lanes, but it is also allowed to ride on the roadway if the traffic flow speed there does not exceed 50 km/h. In addition, it is not allowed to operate a scooter with headphones.

In Italy, for electric scooter enthusiasts, there are speed limits (25 km/h, in pedestrian zones - 6 km/h) and safety requirements - lighting devices on the vehicle itself, a reflective vest on the driver in the evening and at night. It is not allowed to carry other people or animals, and when crossing the road on a "zebra", one must dismount from the scooter [2].

Safety of movement

Let's analyze the experience of using electric scooters with a focus on traffic safety during trips. According to information analysis, at least five people in France have died as a result of electric scooter trips. In 2021, a 31-year-old Italian woman died after being hit by an electric scooter with two people on it. Thus, the Paris authorities held a referendum on banning the rental of electric scooters in their city, of which there are nearly 15,000. The official survey results showed that nearly 90%

of the votes were in favor of banning battery-powered devices. The referendum was called in response to the increasing number of people who were injured or killed on electric scooters in the capital of France. Concerns among the city's residents have grown regarding how some people operate scooters—looping through traffic, dodging pedestrians on sidewalks, and speeding up to 17 miles per hour (27 km/h). Electric scooter drivers often do not use helmets, and 12-year-old children had the opportunity to legally rent electric scooters. Criticism was also voiced that groups of parked electric scooters cluttered sidewalks [3].

Abandoned scooters have become a serious problem in the city, with many of them found in urban parks and squares. The ban on parking scooters on sidewalks has largely been overlooked, despite the threat of a €35 fine. Frustrated pedestrians sometimes throw rental scooters into the Seine River, prompting some companies to dispose of discarded scooters and try to recycle them where possible [4].

Also, according to the information review, in Ukraine, due to the high usage of e-scooters on the roads, the number of accidents is increasing. Riding electric scooters on the roadway simultaneously with other vehicles poses a threat to the safety of the scooter driver, while riding on pedestrian walkways or sidewalks poses a danger to pedestrians. In Ukraine, 16 road traffic accidents involving electric scooters have already been recorded.

In Ukraine, authorities have also started penalizing electric scooter drivers for violating traffic rules. Currently, there are already 16 cases related to accidents involving scooters recorded in the Unified Judicial Register, as reported by the state service Opendatabot [5]. Most accidents involving electric scooters are classified by courts as administrative offenses. Their number is constantly increasing, and fines are increasing as well—while violators paid 340 hryvnias in fines last year, now it's already 850 hryvnias. Typically, accidents occur due to the negligence of scooter drivers or other road users. Recorded accidents include those at pedestrian crossings, as well as during stops and exits from vehicles. However, three cases are classified as criminal, which is related to causing bodily harm in accidents [6].

Experience of using electric scooters in Ukraine

Let's take a closer look at the experience of using electric scooters in Ukraine. In 2021, scooter sharing systems were actively operating in Ukraine, and sales in this segment were increasing every day before the martial law. This is not surprising, as electric scooters are convenient, easy to use, and do not require any physical preparation. In addition, city residents are seeking alternative ways to commute to work due to the reduced number of public transport units and the increasing cost of fares.

In recent years, there has also been a growth in micro-mobility means in Kyiv. As of 2021, there were six scooter rental services operating in the capital. Among them are Bolt, Kiwi, Scroll, Zelectra, Bike Now, and Vzhooh. Many capital residents, especially young people, opt for unicycles to get around the city, which can reach speeds of up to 80 km/h. All this, along with the lack of bicycle infrastructure, significantly affects movement on sidewalks, posing a danger to pedestrians [7]. Furthermore, rental companies need to organize morning start points: 1,025 points across all districts of Kyiv need to be clearly designated for parking, and only

scooters from these points should start. This would help address the issue of scooters being left anywhere after recharging in the morning.

Meetings with representatives of electric scooter rental services were held to analyze the use of micro-mobility means in Ukraine. The discussions covered the general vision of micro-mobility development, particularly rentals, in Ukraine, foreign practices that would be desirable to implement, the situation of this type of transport in the city, user convenience, the ecological effect for the city, traffic safety, and measures to improve safety.

Among the obstacles hindering the spread of electric transport, leaders cited the lack of appropriate infrastructure and legislative regulation of this issue. All companies monitor global trends and strive to apply the best global practices. Practices of using scooters in Poland, Germany, and Estonia were considered the closest to Ukraine. Furthermore, the experiences of global industry leaders such as Lime, Bird, and others are constantly being studied.

A survey of micro-mobility users in Ukraine included a large number of open-ended questions covering road safety, infrastructure design and construction for micro-mobility, electric scooter rental services, and more.

More than half of the respondents have their own micro-mobility device, 23% have used rental electric scooters, 8.8% planned to purchase one in 2021, and 17.7% used rental scooters in 2021 (multiple answers were allowed). 9.7% have not used and do not plan to start using this type of transport. When asked "What are the advantages of using micro-mobility means compared to the type of transport you chose in the previous question?" 63% of respondents mentioned speed, mobility, the ability to bypass traffic jams, and independence from public transport. 21% indicated that it positively affects health. Responses about cost savings, comfort, environmental friendliness, etc., were also popular [7].

Obstacles in the electric scooter rental sector were identified as the lack of infrastructure, high cost of service, vandalism, chaotic parking (both cars and scooters were mentioned), insufficient quantity, coverage, and prevalence in the city, as well as risks for investors due to legislative unregulatedness.

For over a year, active discussions were held in Ukraine on how to define the rights of personal electric transport users and regulate the movement of micro-mobility devices. In many European countries, Personal Electric Transport (PET) is equated with bicycles in regulatory documents and is regulated similarly. This means that their users must adhere to the same rules as cyclists. Therefore, changes in traffic rules for them may also affect bicycle users.

Micro-mobility devices increase the demand for bicycle infrastructure because in countries where their movement is regulated, they are supposed to use bicycle infrastructure.

Personal electric transport has every chance of becoming part of sustainable urban mobility. This aligns with mobility priorities and enhances people's safety while moving.

It is important to understand that personal electric transport is determined by the level of speed or power: in European countries, the upper limit of power varies from 250 watts (Sweden) to 1 kilowatt (Estonia), and speeds range from 20-25 km/h. More

powerful and faster means of transportation do not fall into this category and require state registration and driver's license of the corresponding category. In spring 2021, Bogdan Lepyavko, a representative of the Kyiv Cyclists' Association, participated in the study "White Book of Micromobility" for the EU4Climate project, funded by the European Union and implemented by the UNDP. The study on micromobility made its contribution to the development of the National Bicycle Strategy [8].

The "White Book of Micromobility" analyzes the market, draws conclusions, and proposes micromobility policy recommendations for national and local levels in Ukraine.

Recommendations for the national level:

1. Provide a definition for micro-mobility devices. Devices not falling into this category should be equated with higher categories (mopeds, motorcycles, etc).

2. Equate users of Personal Electric Transport (PET) in rights and obligations with bicycle users. This will establish rules that are understandable and clear to all categories of road users, automatically implying responsibility in case of violations. It's worth noting that responsibility for violations of traffic rules by cyclists is established in the Code of Ukraine on Administrative Offenses. This approach also aligns with the experience of EU countries.

3. Develop strategic documents outlining measures for the development of infrastructure for micro-mobility, appropriate funding, and informational campaigns. An example of such a document could be the National Cycling Strategy, which would encompass the development of micro-mobility.

4. Develop rules for transporting bicycles and micro-mobility devices on public transport, both urban and intercity (primarily railways).

5. Enhance road safety by implementing practices such as:
   - Vision Zero - evidence-based policies on speed limits (including reducing the maximum speed in cities);
   - infrastructure solutions that enhance road safety;
   - automated traffic law enforcement systems;
   - pedestrian and cyclist-pedestrian zones in cities;
   - teaching road safety basics in educational institutions;
   - control over the use of lighting devices on bicycles and micro-mobility devices during dark hours of the day.

6. To reduce or even completely remove import duties on bicycles and micro-mobility devices for a certain period, stimulating local production of these devices.

7. Continue improving the state construction norms (DBN) and state standards of Ukraine (DSTU), including modern traffic calming and regulation devices in them [8].

Recommendations for the local level:

1. Create a cohesive and safe bicycle infrastructure.

2. Engage the public in decision-making and discussion of infrastructure projects and urban spaces.

3. Develop rules for transporting micro-mobility devices in public transport, consider the possibility of integrating bicycle and electric scooter rental services into a unified city transport ticket.

4. Create spaces that promote and encourage the use of micro-mobility devices, including: restricting car access to the city center, avoiding chaotic car parking, creating bicycle-pedestrian areas, and car-free streets.

5. Develop policies for the rental of electric scooters and bicycles, establish cooperation between local authorities and companies providing rental services.

6. Conduct informational campaigns to popularize sustainable modes of transport, highlighting their positive impact on the environment, health, and urban economy [8].

Currently, among all the recommendations for national and local levels, only the first recommendation at the national level has been implemented: providing a definition for micro-mobility devices. Other recommendations for national and local levels, as outlined in the Micro-Mobility White Paper, are still awaiting implementation in Ukraine.

In March 2023, electric scooters, unicycles, and other personal mobility devices in Ukraine were legislatively recognized as vehicles. This is the first step towards amending the Rules of the Road to regulate the use of such transportation, including prohibiting movement on sidewalks. This is stated in the Law of Ukraine "On Some Issues of the Use of Vehicles Equipped with Electric Motors, and Amendments to Some Laws of Ukraine Regarding Overcoming Fuel Dependency and Developing Electric Charging Infrastructure and Electric Vehicles" [9].

In the law, light electric vehicles are now divided into two categories:

- a light personal electric vehicle is a wheeled vehicle powered exclusively by electric traction motors (one or more) with a power rating of up to 1000 watts, equipped with an electric energy storage system (battery) capable of charging from an external source of electric energy, with one, two, three, or four wheels, having a maximum design speed of up to 25 kilometers per hour;

- a low-speed light electric vehicle is a wheeled vehicle powered exclusively by electric traction motors (one or more), equipped with an electric energy storage system (battery) capable of charging from an external source of electric energy, with two, three, or four wheels, having a maximum design speed that is less than or equal to 50 kilometers per hour and greater than 10 kilometers per hour, and an unladen mass not exceeding 600 kilograms [9].

Typically in Europe, vehicles from the first category are equated to bicycles, and those from the second category to mopeds.

Directive EU 168/2013/EC [10] clearly defines that based on power and speed, vehicles such as mopeds and electric scooters/electric bicycles are categorized differently — L1e and L1e-A. Category L1e-A, which includes electric scooters, has power restrictions of 1000 watts and a speed limit of 25 km/h. Additionally, according to Directive 2006/126/EC [11], this category is exempt from the requirement of having a driver's license, unlike low-speed mopeds.

However, the issue of where electric scooters and monocycles can be ridden (sidewalks, bike paths, roadways) is not yet regulated, and changes to the Ukrainian Road Traffic Rules are needed for this purpose.

Therefore, electric scooters, as micro-mobility vehicles, have the following advantages and disadvantages:

Advantages:

Ecological: Electric scooters do not emit harmful emissions into the atmosphere, making them an environmentally friendly mode of transportation.

Maneuverability: Electric scooters can navigate narrow streets and spaces with limited room, allowing them to bypass traffic jams and quickly reach their destination.

Economy: Electric scooters are significantly cheaper to use compared to private cars or public transportation. Moreover, they can be purchased at a reasonable price or rented.

Disadvantages of electric scooters as urban transportation:

Limited travel range: Electric scooters have a limited travel range, considering the battery charge, which may not be convenient for longer trips.

Weather conditions: Using an electric scooter in rainy weather may be uncomfortable, and it can be dangerous during snow and ice.

Infrastructure availability: In many cities, there are no dedicated bike lanes where safe electric scooter travel is planned, which may lead to collisions with other road users and injuries to the scooter rider or others.

Summary and conclusions.

Having analyzed the experience of electric scooter usage in other countries and within Ukraine, we conclude that as an option for urban personal transportation, electric scooters have the right to be used, especially considering the potential for micro-mobility for city residents provided by this mode of transportation. In our view, the use of electric scooters among people will only increase because of the numerous advantages, and people will choose this mode of transportation. However, to use electric scooters as private electric transport in urban areas on a large scale, it is necessary to first create appropriate infrastructure, develop a network of bike lanes for shared use by cyclists and electric scooter riders. Changes need to be made to the Road Traffic Rules of Ukraine. It is necessary to equate electric scooter users in rights and obligations to bicycle users. This will create rules that are understandable and obvious for all categories of road users and automatically provide for liability in case of violations. Only then can scooter riders significantly reduce their own risk of movement from traveling on the roadway alongside larger vehicles moving at higher speeds. It will also reduce the danger to pedestrians who are obstructed and endangered by electric scooter riders.

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