

Forensic Expert Evaluation of Microcar Driver Actions in Case of Traffic Collision

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Actions microcar drivers (electric unicycle, electric scooter, etc.) were analyzed with the aim of developing new regulatory approaches to conducting forensic research and providing a forensic expert conclusion on a traffic collision involving the person driving such a vehicle. The lack issue of a regulatory framework for operation of such means of transportation as unicycles on public roads is outlined, as well as the issue associated with the use of unicycles in public areas (in parks, playgrounds, sidewalks, etc.). The design of the unicycle is presented, the methods of its control are systematized, and a detailed list of equipment necessary for ensuring road traffic with microcar participation is offered. As an example, a part of the author's expert research on criminal proceedings to establish whether an electric scooter belongs to the category of vehicles in accordance with requirements of traffic codes in force in Ukraine is presented. This article purpose is to supplement the legislative framework of Ukraine with conditions and rules for driving microcars, as well as to determine functions of a person driving a unicycle while traffic collision. To achieve this goal, general scientific and special methods (formal logic (analysis, synthesis, deduction, induction, analogy, abstraction), special legal, system analysis) were used.

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Keywords: *microcar; electric unicycle; motorized scooter; road user; traffic codes; traffic collision; forensic expert; road accident analysis.*

Research Problem Formulation

When traveling on the public roads of our country (this especially applies to large cities of Ukraine: Kharkiv, Kyiv, Dnipro, Odesa, etc.), today in the flow of traffic you can often see people moving at a fairly high speed along the roadway on a one-wheeled device, namely: a unicycle (in particular, those who have not reached the age of majority: namely: children). Such means of transportation are extremely mobile, even compared to a motorcycle, let alone a regular car. The unicycle is capable of rapid acceleration and sideways maneuvering without giving any warning signs/gestures. Such actions of persons driving a unicycle provoke dangerous situations on the highways, which can even cause physical injuries to road users, and sometimes, unfortunately, fatalities. Currently, there is no legal regulation regarding the movement of people on a unicycle on the roadway. There is no mechanism for bringing such persons to responsibility (administrative, criminal) in case of their involvement in a traffic accident (hereinafter referred to as traffic collision).

In view of the above, it is now necessary to identify such persons as belonging to a certain category of road users (from technical positions), submitting

proposals for appropriate changes in the legislative framework, the which documents in Ukraine regulate road traffic and the rights of its participants. There was also an urgent need to change the expert approaches to the examination of accident with participation of the person who driving microcar (electric unicycle, electric unicycle, etc.).

It is worth remembering Ukrainian active progress towards full membership in the European Union, and one of the strategic and long-term directions of the EU development is environment preservation and protection. For example, Sustainable and Smart Mobility Strategy of the EU ¹ (SSMS), adopted by European Commission in 2020, provides for reduction of greenhouse gas emissions from transport: the development of public transport, micromobility, replacement of air transport and intercity bus services by rail, optimization of freight transportation and creation of transport hubs. It is clear that adapting the Sustainable and Smart Mobility Strategy of the EU in Ukraine is extremely necessary not only for joining the EU, but also for the sustainable development of our state. In addition, Ukraine is already paving the way to securing and preserving the environment: in 2021, the National Economic Strategy for the period until 2030 ² was approved,

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- 1 Sustainable and Smart Mobility Strategy / European Commission. URL: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12438-Sustainable-and-Smart-Mobility-Strategy_en (date accessed: 02.06.2022).
 - 2 Національна економічна стратегія на період до 2030 року : затв. Постановою КМУ від 03.03.2021 р. № 179 (зі змін. та допов.). URL: <https://zakon.rada.gov.ua/laws/show/179-2021-%D0%BF#n25> (date accessed: 02.06.2022).

according to which our state should become, in particular, climate neutral by 2060. This means that each of the sectors of the economy, in particular, transport should emit no more greenhouse gases into the atmosphere than natural ecosystem³. can absorb. Therefore, it is appropriate to predict an increase in the number of microcars (and therefore environmentally friendly) means of transportation on domestic roads in the coming years which movement, unfortunately is not yet regulated by the regulatory and legal acts of Ukraine.

Analysis of Essential Researches and Publications

Unfortunately, the issue of determining belonging microcar users to a certain category is not new.

Chinese scientists Sh.-Ch. Fang, I-Ch. Chang i T.-Yi Yunote: *“At present, there are approximately 3,500 electric scooters in the Penghu region. The government has set up 332 charging columns at 27 key locations*

to facilitate the charging of these scooters. <...> This study also classifies users into one of three types: “one-time charging,” “repeat charging,” and “high-frequency charging”»⁴.

In Europe, there are some issues with definition of functions of a person driving a microcar. Examining this problem in Norway, M. Pazzini, L. Cameli, C. Lantieri, V. Vignali, G. Dondi and T. Jonsson note: *“Some local governments are not yet ready to integrate e-scooters into their transport systems. Indeed, the legislation is unclear as it is not easy to determine whether the e-scooter is more like a bicycle or a vehicle. Moreover, it is difficult to predict the impact of e-scooters on road traffic, as well as the type of road infrastructure chosen by e-scooter drivers or the possible interaction of such vehicles with weak road users, such as pedestrians or cyclists”⁵.*

This issue was addressed in research papers of: G. Underwood⁶; S. Lin, M. He, Yo. Tan⁷; S. G. Hosking, Ch. C. Liu and M. Bayly⁸; T. Bellet and A. Banet⁹; K. Bassil, H. Rilkoff, M. Belmont, A. Banaszewska,

- 3 Як українським містам скорочувати викиди парникових газів від транспорту / Екодія. 16.07.2021. URL: <https://ecoaction.org.ua/iak-mistam-skorochuvaty-vykydy.html> (date accessed: 02.06.2022).
- 4 Fang Sh.-Ch., Chang I-Ch., Yu T.-Yi. Assessment of the behavior and characteristics of electric scooter use on islands. *Journal of Cleaner Production*. 2015. Vol. 108. Part A. Pp. 1193—1202. DOI: [10.1016/j.jclepro.2015.07.095](https://doi.org/10.1016/j.jclepro.2015.07.095) (date accessed: 02.06.2022).
- 5 Pazzini M., Cameli L., Lantieri C., Vignali V., Dondi G., Jonsson T. New Micromobility Means of Transport: An Analysis of E-Scooter Users' Behaviour in Trondheim. *International Journal of Environmental Research and Public Health*. 2022. Vol. 19. Is. 12. DOI: [10.3390/ijerph19127374](https://doi.org/10.3390/ijerph19127374) (date accessed: 02.06.2022).
- 6 Underwood G. Visual attention and the transition from novice to advanced driver. *Ergonomics*. 2007. Vol. 50. Is. 8. Pp. 1235—1249. DOI: [10.1080/00140130701318707](https://doi.org/10.1080/00140130701318707) (date accessed: 02.06.2022).
- 7 Lin S., He M., Tan Yo. Comparison Study on Operating Speeds of Electric Bicycles and Bicycles: Experience from Field Investigation in Kunming, China. *Transportation Research Record*. 2008. Vol. 2048. Is. 1. Pp. 52—59. DOI: [10.3141/2048-07](https://doi.org/10.3141/2048-07) (date accessed: 02.06.2022).
- 8 Hosking S. G., Liu Ch. C., Bayly M. The visual search patterns and hazard responses of experienced and inexperienced motorcycle riders. *Accident Analysis & Prevention*. 2010. Vol. 42. Is. 1. Pp. 196—202. DOI: [10.1016/j.aap.2009.07.023](https://doi.org/10.1016/j.aap.2009.07.023) (date accessed: 02.06.2022).
- 9 Bellet T., Banet A. Towards a conceptual model of motorcyclists' risk awareness: A comparative study of riding experience effect on hazard detection and situational criticality assessment. *Ibid*. 2012. Vol. 49. Pp. 154—164. DOI: [10.1016/j.aap.2011.10.007](https://doi.org/10.1016/j.aap.2011.10.007) (date accessed: 02.06.2022).

M. Campbell ¹⁰; S. Bernardi and F. Rupl ¹¹; R. Aldred ¹²; L. Abend ¹³; E. Bahk ¹⁴; Ch. Teh and T. T. Wei ¹⁵; V. Choudhary, M. Shunko, S. Netessine and S. Koo ¹⁶; W. E. Marshall and N. N. Ferenchak ¹⁷; S. O'Hern and J. Oxley ¹⁸ et al. ¹⁹.

In Ukraine (similarly to Norway), the legal status of persons driving microcar has not yet been defined, their qualifications

are lacking in accordance with requirements of traffic codes ²⁰ and the legal framework for the operation of such vehicles has also not been approved. on public roads.

Article Purpose

Highlight the issues of operating such a means of transportation as a unicycle

- 10 Bassil K., Rilkoff H., Belmont M., Banaszewska A., Campbell M. Pedestrian and Cyclist Safety in Toronto. *Toronto Public Health*. June, 2015. DOI: [10.13140/RG.2.1.4477.1680](https://doi.org/10.13140/RG.2.1.4477.1680) (date accessed: 02.06.2022).
- 11 Bernardi S., Rupl F. An Analysis of Bicycle Travel Speed and Disturbances on Off-street and On-street Facilities. *Transportation Research Procedia*. 2015. Vol. 5. Pp. 82–94. DOI: [10.1016/j.trpro.2015.01.004](https://doi.org/10.1016/j.trpro.2015.01.004) (date accessed: 02.06.2022).
- 12 Aldred R. Inequalities in self-report road injury risk in Britain: A new analysis of National Travel Survey data, focusing on pedestrian injuries. *Journal of Transport & Health*. 2018. Vol. 9. Pp. 96–104. DOI: [10.1016/j.jth.2018.03.006](https://doi.org/10.1016/j.jth.2018.03.006) (date accessed: 02.06.2022).
- 13 Abend L. Cyclists and E-Scooters are Clashing in the Battle for Europe's Streets. Time. August 27, 2019. URL: <https://time.com/5659653/e-scooters-cycles-europe/> (date accessed: 02.06.2022).
- 14 Bahk E. Electric scooter accidents on the rise. The Korea Times. December 6, 2019. URL: <https://m.koreatimes.co.kr/pages/article.asp?newsIdx=277033> (date accessed: 02.06.2022).
- 15 Teh Ch., Wei T. T. E-scooter that knocked into cyclist in fatal Bedok accident should not have been used on public paths: LTA. The Straits Times. Sept 26, 2019. URL: <https://www.straitstimes.com/singapore/transport/e-scooter-that-knocked-into-65-year-old-cyclist-in-fatal-accident-was-not> (date accessed: 02.06.2022).
- 16 Choudhary V., Shunko M., Netessine S., Koo S. Nudging Drivers to Safety: Evidence from a Field Experiment. INSEAD Working Paper. No. 2020/28/TOM. 51 p. DOI: [10.2139/ssrn.3491302](https://doi.org/10.2139/ssrn.3491302) (date accessed: 02.06.2022).
- 17 Marshall W. E., Ferenchak N. N. Why cities with high bicycling rates are safer for all road users. *Journal of Transport & Health*. 2019. Vol. 13. DOI: [10.1016/j.jth.2019.03.004](https://doi.org/10.1016/j.jth.2019.03.004) (date accessed: 02.06.2022).
- 18 O'Hern S., Oxley J. Pedestrian injuries due to collisions with cyclists Melbourne, Australia. Accident Analysis and Prevention. 2019. Vol. 122. Pp. 295–300. DOI: [10.1016/j.aap.2018.10.018](https://doi.org/10.1016/j.aap.2018.10.018) (date accessed: 02.06.2022).
- 19 Yao L., Wu Ch. Traffic Safety for Electric Bike Riders in China: Attitudes, Risk Perception and Aberrant Riding Behaviors. *Transportation Research Record*. 2012. Vol. 2314. Is. 1. Pp. 49–56. DOI: [10.3141/2314-07](https://doi.org/10.3141/2314-07) (date accessed: 02.06.2022) ; Xu C., Li Q., Qu Zh., Tao P. Modeling of speed distribution for mixed bicycle traffic flow. *Advances in Mechanical Engineering*. 2015. Vol. 7. Is. 11. Pp. 1–9. DOI: [10.1177/1687814015616918](https://doi.org/10.1177/1687814015616918) (date accessed: 02.06.2022) ; Guthold R., Stevens G. A., Riley L. M., Bull F. C. Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1.6 million participants. *The Lancet*. 2020. Vol. 4. Is. 1. Pp. 23–35. DOI: [10.1016/S2352-4642\(19\)30323-2](https://doi.org/10.1016/S2352-4642(19)30323-2) (date accessed: 02.06.2022) ; Hawkins A. J. Lime's electric scooters will be able to tell when you're too drunk to ride / Talking scooters and safety with co-founder Brad Bao. *The Verge*. Apr 17, 2019. URL: <https://www.theverge.com/2019/4/17/18411127/lime-brad-bao-electric-scooter-drunk-detection-vergecast> (date accessed: 02.06.2022).
- 20 Правила дорожнього руху : затв. Постановою КМУ від 10.10.2001 р. № 1306 (зі змін. та доп.). URL: <https://zakon.rada.gov.ua/laws/show/1306-2001-%D0%BF#Text> (date accessed: 02.06.2022).

on public roads. Propose to supplement the legal framework of Ukraine with conditions and rules for driving microcars, as well as to determine status, rights and responsibilities of a person who was driving a unicycle as a road traffic participant during an accident. Draw attention to issues arising for investigators, forensic experts and judges, if necessary, to provide an assessment of a similar traffic situation within the limits of their competence, as well as to the issues of providing a legal assessment by the relevant authorized person (body) and the legal qualification of a specific situation in the case.

Research methods

For achieving his goal, this research paper used general scientific and special methods that made it possible to optimally take into account the specifics of the object and the subject of research, in particular: methods of formal logic (analysis, synthesis, deduction, induction, analogy, abstraction) for detailed clarification the content of the issues under consideration; special legal methods (first of all, comparative law) while analysis of substantive and procedural law norms, scientific categories, definitions and approaches; the method of system analysis in the context of determining areas of activity to improve the application of specific expertise while forensic examination of traffic collisions involving microcars.

Main Content Presentation

In the European Union, in particular in France, vehicles such as a mono-wheel are moved in accordance with the approved legislative norms with appropriate restrictions. So, in France, movement on monowheels is allowed only on bicycle paths with a speed limit of up to 25 km/h or on roads where the maximum speed does not exceed 50 km/h, it is forbidden to drive on the sidewalk, carry passengers and use headphones while driving ²¹.

In Germany, movement of sidewalks using electric unicycles is strictly prohibited. It is allowed to move exclusively by bicycle paths, and in their lack to go to the carriageway. Under German law, the speed limit for microcars, which electric unicycle to, within the city limits should not exceed 20 km/h ²².

In Spain, the use of an electric unicycle is allowed on bike lanes and streets, where the speed of transport is limited to 30 km/h. In three cities (Madrid, Barcelona and Valencia), different rules apply to use of microcars. Electric unicycle drivers must wear helmets and give way to other road users, primarily pedestrians ²³.

In Japan, it is generally forbidden to move freely on electric unicycles and other ultramodern means of transportation. It is a bicycle country.

Let us consider in more detail how the issue of movement of microcars on public roads, in parks and other places is regulated in Ukraine.

21 Code de la route, partie réglementaire, version consolidée au 8 septembre 2011. *Légifrance* : Journal officiel de la République Française (JORF). URL: https://www.legifrance.gouv.fr/codes/texte_lc/LEGITEXT000006074228/2023-02-09/ (date accessed: 02.11.2022).

22 Straßenverkehrs-Ordnung (Deutschland) : der ab 01.04.2013 gültigen / STVO.de. URL: <https://www.stvo.de/strassenverkehrsordnung> (date accessed: 02.11.2022).

23 Normas de tráfico. Todo lo que necesitas saber para conducir en España / Just Landed. URL: <https://www.justlanded.com/espanol/Espana/Guia-Espana/Ocio-Viajes/Normas-de-traffic> (date accessed: 02.11.2022).

In addition to trucks and cars, buses and fixed-route vehicles, agricultural machinery and bicycles in domestic traffic rules, following vehicles are defined:

- **“Wheelchair is a specially designed wheelchair** designed for the movement on the road of persons with disabilities or persons belonging to other groups of people with limited mobility. The wheelchair has at least two wheels and is equipped with an engine or is driven by the muscular force of a person”²⁴. Consequently, wheelchair can move both with the help of the engine and with the help of force of the person on;
- **“motor vehicle** means a vehicle propelled by an engine. This term applies to tractors, self-propelled machines and mechanisms, as well as trolleybuses and vehicles with an electric motor with a capacity of more than 3 kW”²⁵. This category includes most of the vehicles in operation on the territory of our State;
- **“moped is a two-wheeled vehicle** that has an engine with a working volume of up to 50 cubic cm or an electric motor with a capacity of up to 4 kW”²⁶;
- **“motorcycle** is a two-wheeled power-driven vehicle, with or without a side-trailer, having an engine with a displacement of 50 cm or more. Motorcycles are equated to motor scooters, motorcycle sidecars, tricycles and other motor vehicles,

*the permissible maximum mass of which does not exceed 400 kg”*²⁷. These vehicles are mostly two-wheeled, designed to carry usually one passenger, do not have a body and are unstable during operation in winter.

According to terminology of the traffic codes, **“vehicle is a device designed to transport people and (or) cargo, as well as special equipment or mechanisms installed on”**²⁸.

Therefore, taking into account the above definitions of traffic codes, electric unicycle can be considered a vehicle, since it transports one person.

At the same time, according to the traffic rules, **“road user is a person who is directly involved in the process of driving on the road as a pedestrian, driver, passenger, animal driver, cyclist, as well as a person moving in a wheelchair”**²⁹. In this definition, there is no mention of persons driving microcars (electric unicycle, motorized scooter, etc.). It is not consistent with the term “vehicle” of these same traffic codes.

Analysis of the above definitions indicates that means of transportation such as a unicycle, having an electric drive of less than 3000 W, correspond to only one of the above terms, “vehicle”. However, a unicycle does not fall under any of the qualifications specified in requirements of traffic rules, thus, this vehicle cannot be defined as belonging to any of categories provided for by the traffic rules. Because of this, operation

24 Правила дорожнього руху URL: <https://zakon.rada.gov.ua/laws/show/1306-2001-%D0%B-F#Text> (date accessed: 02.06.2022).

25 Ibid.

26 Ibid.

27 Ibid.

28 Ibid.

29 Ibid.

of a unicycle does not make it possible to consider it a road traffic participant in accordance with the term specified in the traffic rules. At the same time, some microcars, such as *InMotion V10F (Black)* unicycle, have a power of 2000 W and a speed of up to 40 km/h. This speed of travel is well above the conventional wisdom of pedestrian speeds in places where pedestrian traffic is allowed, and is currently not very significant compared to the speeds of vehicles on public roads.

Taking into account the above, we systematize a range of issues related to the use of such transportation means as unicycles on public roads of Ukraine:

- lack of an appropriate legislative framework for regulating participation of microcars in road traffic;
- lack of legal mechanisms for bringing person driving electric unicycle to responsibility, as well as determining the degree of such responsibility in case of traffic collision involving the electric unicycle and its driver;
- injury or even death of traffic collision participants caused by the electric unicycle driver and/or malfunction of this electric unicycle;
- danger inevitability of further operation of the monowheel in case of its collision with an obstacle (hitting a pit it slows down and does not have time to compensate for driver inclination, causing him to fall from the monowheel, that is capable of causing bodily harm;
- sudden shutdown of the electric unicycle in case of its use at

maximum speed (working at the limit of its capabilities, electric unicycle is not technically able to reach even more power and is not able to warn about the lack of driver power), which result is driver can fall off the electric unicycle and suffer bodily injuries.

Consequently, the use of an electric unicycle as a microcar on the territory of Ukraine primarily requires regulation at the legislative level, that is, making appropriate changes to domestic legislation, namely, to Law of Ukraine: On Traffic ³⁰ (hereinafter referred to as the *Profile Law*) and to traffic codes.

In our opinion, it is appropriate to consider as drivers of mechanical vehicles all those who drive a unicycle (motorized scooter, self-balancing scooter); thus, we consider it appropriate: to add part 2 of Art. 14: *Road users* of the relevant Law and para. 25 paragraph 1.10 of traffic codes with a mention of persons who move on unicycles, electric scooters, self-balancing scooters and other microcars n), and point 1.10 of the traffic codes defining the terms *microcar* and *unicycle*.

In addition to the mentioned, it is extremely important to determine the minimum age that gives the right to drive a unicycle from 16 years. Such a restriction is due to the fact that being responsible for one's own actions on the road, being fully aware of the extent of possible danger associated with the operation of a microcar, correctly understanding the behavior of other road users and reacting to it in a timely manner may not be before the age of 16.

Mandatory requirements for the driver equipment when traveling on a unicycle must also be made regarding the presence

30 Про судову експертизу : Закон України від 25.02.1994 р. № 3353-XII (зі змін. та допов.). URL: <https://zakon.rada.gov.ua/laws/show/3353-12#Text> (date accessed: 25.11.2022).

of: a protective helmet, gloves, elbow pads and knee pads, and in the dark and/or in conditions of insufficient visibility (for timely detection by other road users) reflective elements (tape, stickers, vest, etc.) or clothing already equipped with reflective elements. Clause 2.3 of traffic codes must be supplemented with such mandatory requirements.

In addition, electric unicycle driver should receive appropriate training on the rules of movement of carriageway in general use, confirmed by a certificate for the right to drive a vehicle of the appropriate category. For this purpose, in paragraph 2.13 of traffic codes, such road users should be added to category A1.

Timely detection of microcars on the roadway by other road users will contribute

to limiting the speed on a mono-wheel to 30 km/h, which needs to be supplemented by paragraph 12.9 of the traffic codes with the corresponding norm.

Let us illustrate the above proposed additions to the traffic codes and the relevant Law with a detailed consideration of a typical design of a unicycle. The basic element of a unicycle is, of course, a wheel (diameter of the wheels can vary) with a closed housing made of polymer materials. At the top are the handle, control panel and display or status indicators. On the sides there are stands that can be lowered or raised. Inside the case, there is not only a wheel, but also an electric motor, a battery, a center of gravity, magnets, gyroscopes, that maintain balance and participate in steering.

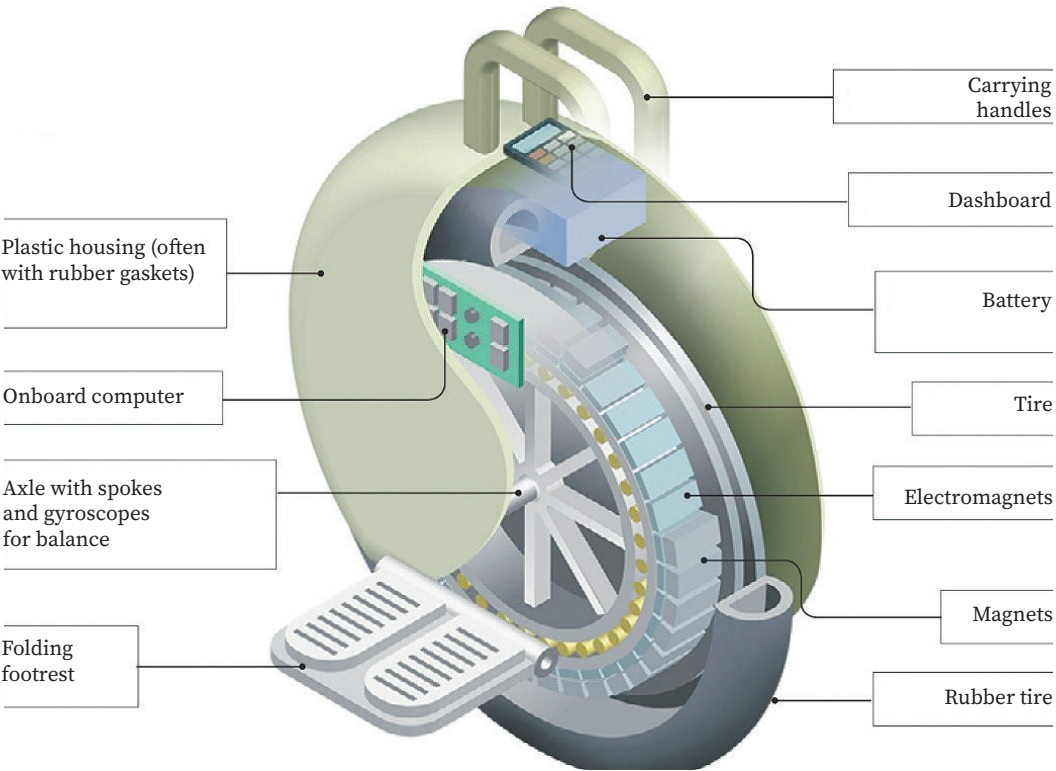


Fig. 1. Unicycle in section

Electric unicycle works on the principle of calculating position of the one who controls it with the help of gyroscopes. The engine start buttons are located on the control panel. Under influence of electromagnetic induction, motor rotor starts electric unicycle, forcing it to move from its place. When the driver, being on electric unicycle, leans forward or backward, electric unicycle moves in the direction chosen by the driver; when the driver leans sideways, the electric unicycle turns.

Let us consider the actions of driver when moving on electric unicycle and its driving, since the actions of this person depend on his own safety, safety of others, as well as road safety. When tilting the torso forward, the driver makes more effort to the front of the pedals and accelerates the movement of the unicycle, leaning back and increasing the force on the rear of the steps, the driver slows down this movement: gyroscopes fix the change in the position of the center of gravity, trigger the electromagnetic field and combine the poles of the magnets (the same poles: forward movement, different: backward movement). The larger and stronger the inclination of the torso to the side during turns, the greater the turn will be. If the gyroscopes are working, then it is enough for the driver to keep the balance for lateral collapse: the same skill is required for driving on the road.

The above design features of the monowheel confirm our opinion about the need for careful training for its controlling. Such training should begin with the formation of a sense of the gyroscopic system, gradually mastering the efforts on the pedal first with one foot, remembering the movement and the degree of pressure, then with both feet. Standing on a unicycle

with both feet at the beginning of training, you should stick to a person or a wall.

The design features of the unicycle are unique and are designed to protect the life and health of the driver: in the case of acquiring a very sharp angle of inclination of the body by the manager, the gyroscopes instantly give the command to electric motor of the unicycle to accelerate, driving under driver and preventing it from falling.

Bicycle has the same balance characteristics as a unicycle. However (unlike a person who drives a microcar, such as a unicycle) clause 1.10 of the Traffic codes contains a definition of the terms *bicycle*, *cyclist* (as well as *bicycle path*, *bicycle lane* and *bicycle crossing*), and section 6 of the traffic codes requirements for the cyclist himself (his clothing and age, equipment with reflective elements) and for his movement on the territory of Ukraine.

Since the movement of a bicycle depends on muscular strength of a person, and movement of a unicycle is ensured by operation of an electric motor, the unicycle driver (unlike a cyclist) must receive appropriate training for moving on public roads, that is, obtain a certificate for the right to drive a vehicle of appropriate category.

For this purpose, paragraph 7 of clause 2.13 of traffic codes that specifies vehicles that belong to category A1 (mopeds, scooters and other two-wheeled vehicles that have an engine with a working volume of up to 50 cm³ or an electric motor with a capacity of up to 4 kW), should be added a single-wheeled vehicle, namely: electric unicycle.

In order to streamline the movement of persons driving microcars, in particular unicycle, on the territory of Ukraine, it

is necessary to add such road users to category A1 or equate them.

Currently, the norms proposed by us are absent in both the traffic codes and the profile Law, which provokes ambiguous approaches to the technical and legal assessment of the actions of the person who, at the time of the accident, was driving a micro-mobile vehicle: in one case, this person is qualified as a pedestrian, in the other as a driver. If we consider the manager a pedestrian mono-wheel, then during an accident with a mono-wheel hitting another pedestrian and injuring the latter, it is impossible to classify this event as an accident: after all, *such technical analysis contradicts the term “traffic collision” is an event that occurred during the movement of the vehicle, as a result of which people were killed or injured or material damage was caused*³¹, given in clause 1.10 of the traffic rules.

Similar issues arise for investigators during investigation of criminal proceedings involving such a microcar as an electric scooter. Let us look at some examples from expert practice.

Example 1. To National Scientific Center «Hon. Prof. M. S. Bokarius Forensic Science Institute» (hereinafter referred to as NSC «Hon. Prof. M. S. Bokarius FSI») from the Department for Investigation of Crimes in the Field of Transport of Investigative Department of the Main Directorate of the National Police in the Kharkiv region received a decision of investigator on the appointment of a forensic engineering and transport examination for criminal proceedings, as well as a certified photocopy of the operating instructions for the *Like.Bike Titan* electric scooter on 10 sheets.

Questions put to the decision of forensic examination:

- “Based on specifications of the *Like.Bike Titan* motorized scooter, does it belong to the vehicle category; if so, to which vehicle category?”;
- “Is it possible to use the *Like.Bike Titan* electric scooter on public roads?”

Circumstances of traffic collision. 02.10.2021, at about 21:00, near the house № X on the street. I.v. in Kh. there was a collision of a bus of BASES on S.I. Petrov, who was driving a motorized scooter *Like.Bike Titan*. As a result of this traffic collision, s. Petrov with bodily injuries was taken to the hospital (from the decree on appointment of examination).

Input data:

- maximum speed of the *Like.Bike Titan* electric scooter is 60 km/h, engine power is 2×1000 W (from a photocopy of vehicle license of the *Like.Bike Titan* motorized scooter);
- In accordance with the instructions for use of the *Like.Bike Titan* motorized scooter, the motorized scooter is not a vehicle and a road user, it cannot be used on public roads, highways (in particular, of state importance). Persons under 16 years of age are not allowed to use the electric scooter without adult supervision, and you should wear a helmet during use (from photocopies of the instructions for use of the *Like.Bike Titan* motorized scooter).

31 Правила дорожнього руху URL: <https://zakon.rada.gov.ua/laws/show/1306-2001-%D0%B-F#Text> (date accessed: 02.06.2022).

The result of performed researches. Forensic expert found out that the motorized scooter *Like.Bike Titan*, on which S.I. was moving, Petrov, designed for operation by adults and equipped with two electric motors with a capacity of 1000 watts each. In addition, according to the instructions for use of the *Like.Bike Titan* motorized scooter, the *Like.Bike Titan* electric scooter is not a vehicle and a road user, it cannot be used on public roads.

Since there is no definition of the term *motorized scooter* in domestic traffic laws (instead, it is stated that vehicles are devices designed to transport people and/or cargo, as well as special equipment or mechanisms installed on it, and mechanical vehicles are those that drive in motion with the help of an engine or electric motor with a power of more than 3 kW), the expert came to the conclusion that the electric scooter *Like.Bike Titan*, driven by S. I. Petrov, belongs to non-mechanical vehicles (the total power of its electric motors is 2000 W, i.e. less than 3 kW stipulated in Clause 1.10 of the traffic codes). Current traffic regulations do not outline a place for the movement of electric scooters, and the instruction manual for the operation of the *Like.Bike Titan* motorized scooter states that this means of transportation is not intended for operation on public roads, therefore, S. I. Petrov did not have the right to use the *Like.Bike Titan* motorized scooter on public roads.

Example 2. To NSC «Hon. Prof. M. S. Bokarius FSI» from the Investigative Department of the Main Department of the National Police in Vinnytsia region from the senior investigator for forensic examination received a resolution on the appointment of an examination and a photocopy of the criminal proceedings

on the fact of hitting a MAZ car (driver V. S. Shevchenko) on minors D. A. Korzhov and V. K. Kryzhanova, who were moving on an electric scooter *Like.Bike One*.

Questions put to the decision of forensic examination:

- “Is motorized scooter (traffic collision participant) a vehicle (in accordance with the technical requirements of traffic codes of Ukraine)?”;
- “Is motorized scooter a mechanical vehicle (in accordance with the technical requirements of traffic codes of Ukraine)?”;
- “Is it possible to equate an electric scooter in these road conditions to a bicycle (in accordance with the technical requirements of the traffic codes of Ukraine)?”;
- “Is it possible to equate the movement of an electric scooter with a bicycle path and a roadway in these road conditions to pedestrian traffic (in accordance with the technical requirements of the traffic codes of Ukraine)?”.

Circumstances of traffic collision. 28.04.2021, at about 17:25, the driver V.S. Shevchenko, driving a MAZ car and moving D. in the city of V., during the execution of the turn to the right maneuver on the D. A. Korzhova and V. K. Kryzhanova, who crossed the roadway on the *Like.Bike One* motorized scooter, were hit by minors. D. within the right-to-left bike lane relative to the MAZ vehicle direction of travel. As a result of this accident, V.K. Kryzhanov died on the spot from his injuries (from decree on the examination appointment).

Initial data: dimensions of the motorized scooter *Like.Bike One*: height from the road surface 116 cm, length from the front to the rear dimension 110 cm,

length from the axle of the front wheel to the axle of the rear: 90 cm, height from the road surface to the top of the footrest: 16 cm (from the decree on the examination appointment).

The result performed researches. According to vehicle license of motorized scooter *Like.Bike One*, forensic expert compiled table. 1 *Technical characteristics of the motorized scooter: Like.Bike One.*

Table 1

Technical characteristics of motorized scooter Like.Bike One

Parameter	Value
Model	Electric scooter: <i>Like.Bike One</i>
Designation	For adults
Dimensions	1200 × 430 × 500 (folded), 1200 × 430 × 1140 (unfolded)
Battery Capacity	216 W × g
Charge time	3 h.
Wheel diameter	8 inches
Brake	Rear, disk
Wheelbase	1200 mm
Maximum load	80
Maximum speed	25 km/h
Capacity	250W

In accordance with technical characteristics of motorized scooter *Like.Bike One* is equipped with an electric motor with a capacity of 250 watts and is designed for operation by adults. Data sheet states that the *Like.Bike One* electric scooter is not allowed on the public road.

The conducted research and analysis of the provided materials of the criminal proceedings made it possible to establish

that the *Like.Bike One* electric scooter, on which minors D. A. Korzhov and V. K. Kryzhanova were riding, is not a bicycle (since a bicycle is a “vehicle, except for wheelchairs, which is set in motion by the muscular power of the person sitting on”³²⁾ and does not belong to pedestrians (since a pedestrian is, in particular, “person who participates in road traffic outside of a vehicle”³³⁾). In other words, according to

32 Правила дорожнього руху URL: <https://zakon.rada.gov.ua/laws/show/1306-2001-%D0%B-F#Text> (date accessed: 02.06.2022).

33 Ibid.

the current traffic regulations, the *Like.Bike One* electric scooter with a 250 W electric motor, on which the minors D. A. Korzhov and V. K. Kryzhanova were riding, cannot be equated with a bicycle, and the movement of the *Like.Bike One* electric scooter with a bicycle path or roadway cannot be equated to pedestrian traffic.

In addition, currently in reference literature there are no parameters for the stable deceleration of a technically serviceable motorized scooter, motorized scooter and microcar on the road surface in an accident (data on the delay time of the brake drive and on the growth time of deceleration). The lack of this information leads to provision of incomplete conclusions by forensic experts and inability to resolve the issue of the presence or absence of an motorized scooter, gyro board or other microcars, the technical ability to prevent a traffic collision, as well as to find out presence or absence of inconsistencies in the actions of the driver with the requirements of traffic rules, which from a technical standpoint would be in causal connection with the occurrence of traffic collision in question.

In view of the above, there is also an urgent need to find out the technical characteristics of Ukrainian microcars, determine the parameters mentioned above experimentally, as well as to develop forensic expert methods for studying such traffic collisions.

Conclusions

Since the number of microcars (for example, electric unicycle, motorized scooters and gyroboards) on the territory of our state will increase permanently, their safe use needs to be regulated in

the current legislation of Ukraine (in particular, traffic codes and Specialized Law).

In view of the above, we propose:

- 1) Part 2 of Article 14 "Participants of road traffic" of the relevant Law shall be worded as follows:

"Road users include drivers and passengers of vehicles, pedestrians, persons moving in wheelchairs, monowheels, electric scooters, gyroboards and other microcars, cyclists, animal drivers";

- 2) paragraph 25 of clause 1.10 of traffic codes shall be amended as follows:

"driver is a person who drives a vehicle and has a driver's license (tractor driver's license, temporary permit for the right to drive a vehicle, temporary coupon for the right to drive a vehicle) of the appropriate category, or a person who drives a mono-wheel, electric scooter, gyro-board, other microcars. The driver is also a person who teaches driving while in the vehicle."

- 3) supplement clause 1.10 of the traffic rules with the definition of the terms:

"microcars mean an electric or self-balancing or mechanical vehicle intended for one person";

"electric unicycle is electric microcar, self-balancing unicycle "(monocycle), with one wheel and feet located on both sides of the wheel, designed to move one person".

- 4) determine the minimum age from which the right to drive an electric unicycle comes from 16 years;
- 5) supplement paragraph 2.3 of the traffic codes with the following mandatory requirements for the driver of any microcars: during the movement should be worn in a protective helmet, protective gloves, elbow pads and knee pads; and in the dark and in conditions of insufficient visibility (for timely detection by other road users) use light-reflecting elements (tape, sticker,

vest, etc.) or be in clothes that have light-reflecting elements;

- 6) add drivers of any microcar to category A1 of road users (paragraph 2.13 of the traffic codes) with the corresponding rights and obligations;
- 7) add to clause 12.9 of the traffic codes the requirements for limiting the speed of a micro-mobile vehicle to 30 km/h.

Експертне оцінювання дій керувальника мікромобіля в разі дорожньо-транспортної пригоди

Павло Хоробрих

Проаналізовано дії учасників дорожнього руху, які керують мікромобільними засобами пересування (моноколесом, електросамокатом та ін.), із метою виробити нові нормативні підходи до процесу виконання експертних досліджень і надання висновку експерта за дорожньо-транспортною пригодою, у якій брала участь особа, що керувала таким засобом. Окремлено проблему відсутності нормативної бази щодо експлуатації на дорогах загального користування таких засобів пересування, як моноколесом, а також проблему, пов'язану із використанням моноколес на територіях загального користування (у парках, на дитячих майданчиках, тротуарах та ін.). Наведено конструкцію моноколеса, систематизовано прийоми керування ним, запропоновано докладний перелік оснащення, необхідного для забезпечення дорожнього руху за участі мікромобільного транспортного засобу. Як приклад презентовано частину виконаного автором експертного дослідження за кримінальним провадженням зі встановлення належності електросамоката до категорії транспортних засобів згідно з вимога-

ми чинних в Україні Правил дорожнього руху. Метою статті є доповнити законодавчу базу України умовами та правилами керування мікромобільними засобами пересування, а також визначити функції особи, яка керує моноколесом, під час дорожньо-транспортної пригоди. Для досягнення цієї мети використано загальнонаукові та спеціальні методи (формальної логіки (аналіз, синтез, дедукцію, індукцію, аналогію, абстрагування), спеціально-правові, системного аналізу).

Ключові слова: мікромобільний засіб пересування; моноколесом; двоколісний транспортний засіб (електросамокат); учасник дорожнього руху; Правила дорожнього руху; дорожньо-транспортна пригода; судовий експерт; автотехнічна експертиза.

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Declaration of Competing Interest

Author declare no conflict of interest.

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