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# ATTITUDES OF ELECTRIC SCOOTER DRIVERS REGARDING THE CHOICE OF THE SAFEST MOVEMENT SURFACE AND OTHER ASPECTS OF SAFE TRAFFIC PARTICIPATION

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**Abstract:** The modern development of cities induces a need for greater mobility of the population, and especially for the fast and easy change of locations of people and goods during the day. As a response to these needs, micromobility vehicles have appeared, representing a huge potential in solving these problems. Due to their characteristics, electric micro-vehicles, i.e. electric scooters, have particularly stood out in application as flexible, economical, and ecologically sustainable vehicles. The untimely harmonization of valid legal regulations with the intensive increase in the participation of electric scooters in traffic has led to a series of problems regarding their status and the issue of safe inclusion into the existing traffic system. In practice, in many cities, the infrastructure is not adapted to their movement, which has led to their movement on all available surfaces. As a consequence, there has been an increase in the number of conflict situations between different categories of traffic participants, which leads to the question of the justification of moving electric scooters on pedestrian and other surfaces used by vulnerable traffic users. In order to determine the justification of driving electric scooters on pedestrian and bicycle surfaces, a survey research was conducted, which pointed to the complexity of solving this problem and safely including scooter drivers into the traffic system. The results indicate that there are statistically significant differences in the perception of safety depending on the type of movement surface (roadway, bicycle, or pedestrian surface). It was concluded that riding electric scooters on pedestrian surfaces is not justified as a permanent solution, but exclusively as a temporary measure in the absence of dedicated infrastructure.

**Keywords:** Micromobility, electric scooters, pedestrian paths, traffic safety, speeds

## 1. INTRODUCTION

The increase in traffic volume in cities has resulted in the creation of significant congestion and traffic jams, which has slowed down and hindered the performance of daily activities in the usual ways. This has also resulted in prolonged travel times and reduced comfort in fulfilling daily life needs, all of which caused the need to find alternative ways of conducting daily activities in cities. Traffic jams, congestion, and the prolonged and unreliable time required for routine daily activities, in addition to causing losses, have also negatively influenced the creation of stress among traffic participants, making the performance of daily activities uncomfortable overall.

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In step with the described problems, new vehicles of smaller dimensions and with performance features that can more adequately respond to the daily demands of users have appeared on a mass scale in the Republic of Serbia, with the electric scooter emerging as the most efficient vehicle among them. Small dimensions, independent propulsion, and a satisfactory operating range have made this vehicle a prime candidate as the best replacement for other vehicles previously used, as it provides an acceptable travel time, enables easy and efficient movement, and does not require large spatial areas for parking. On one hand, it is an adequate response to existing demands, while on the other hand, it represents a significant source of traffic insecurity and a cause of casualties among traffic participants.

When analyzing the negative impact of the increased presence of scooters in traffic, the increased vulnerability of pedestrians, scooter riders, and cyclists particularly stands out, making it necessary to conduct adequate expert assessments regarding the choice of surfaces on which scooters should move, in order to prevent an increase in traffic casualties. As an indicator of the extent to which electric scooters affect pedestrian safety, as well as how pedestrians affect the safety of electric scooters, it is necessary to examine the frequency and presence of electric scooters on pedestrian paths, pedestrian zones, and sidewalks in countries and cities where their presence on these surfaces is permitted, as well as where it is prohibited. According to a study by Badeau et al. (2019), the highest number of injuries in accidents involving scooters, as much as 58%, occurred on sidewalks, while 23% of injuries occurred on roads. Riders injured on roads had twice the odds of sustaining moderate or severe injuries compared to those injured on sidewalks, likely due to higher speeds, but on the other hand, injuries on sidewalks were more frequent but generally less severe. Cicchino et al. (2021) showed in their research that the most common causes of injury were falls resulting from infrastructure issues such as potholes or cracks, and only 13% of injuries occurred in collisions with other motor vehicles. Sidewalk riding also posed a risk to pedestrians, although incidents of direct collisions with electric scooters were relatively rare. In this study, as well as in the study by Badeau et al. (2019), only 2% of electric scooter riders reported wearing a helmet, which could have been the cause of more frequent, extensive, and severe head injuries among users. The conclusions of these studies suggest that banning the movement of electric scooters on sidewalks can reduce the number of accidents involving pedestrians, but increase the severity of injuries for electric scooter riders if appropriate infrastructure is not available to them.

Šucha et al. (2023) conducted analyses in five countries where the use of electric scooters is regulated differently (where in Belgium and Sweden, riding electric scooters on pedestrian surfaces is prohibited; in the Czech Republic and Norway, it is permitted; and in Australia, it is permitted with specific restrictions), and the results showed that about 20-30% of electric scooter riders reported riding on sidewalks, regardless of whether it is legally permitted. Consequently, half of the surveyed electric scooter riders committed at least one traffic violation, and 10% experienced a traffic accident. The same authors showed that other categories of traffic participants also perceive scooters as unsafe and "irritating" traffic participants.

Antić et al. (2020) determined on which surfaces scooter users are noticed faster and more frequently (more easily) and showed that in 58% of cases, scooters are noticed on the sidewalk, while they were noticed on the roadway in 42% of cases, indicating that they are more easily and better noticed on sidewalks. Regarding the age structure of the respondents, drivers stated that in 87% of cases they notice younger electric scooter riders, while in 13% of cases they noticed older electric scooter riders. Like the previous one, this study also showed that 58% of drivers believe that electric scooter riders obstruct their movement (forcing them to adjust their speed and manner of travel), while 42% of drivers stated that electric scooter riders do not obstruct them. 51% of drivers stated that the appearance of electric scooters off the roadway distracts them by their very presence, primarily due to their unusual appearance and uncommon manner of movement.

Furthermore, the results show that 74% of respondents stated that the appearance of electric scooters on the roadway significantly distracts their attention, and as many as 90% of surveyed drivers believed that electric scooters are not adequately illuminated, while 77% of drivers do not notice electric scooters well enough in nighttime conditions.

Cubells et al. (2023) showed that in countries like Spain, where riding scooters is prohibited on pedestrian paths and sidewalks, users preferred routes with bicycle lanes, greenery, and lower traffic volume, making it the primary route for 44,2% of them, followed by pedestrian streets. The study concluded that the built environment and sociodemographic factors significantly influence the route choices of electric scooter riders and cyclists. Urban planning that prioritizes safe, accessible, and visually appealing infrastructure can enhance the micromobility experience and increase adoption, highlighting the need for inclusive, user-oriented transportation design.

An analysis of differences in risky behavior between shared and private electric scooter riders and cyclists in downtown Brisbane, Australia, revealed that illegal and risky behaviors are more frequent among shared electric scooter users, with shared electric scooter riders showing a higher rate of not wearing helmets (38,6%) compared to private ones (12,2%) (Haworth et al. (2021)). Similarly, shared bicycle riders also demonstrated higher rates of not using helmets compared to private cyclists. The same study showed that more than 90% of electric scooters, about half of shared bicycles, and about a quarter of private bicycles were ridden on a pedestrian path, and about 40% at a distance of less than 1 m from at least one pedestrian.

The results of a study conducted in Gothenburg showed that the safety of electric scooters in urban environments is influenced by several factors, with rider experience and distracting factors such as mobile phone use—which usually implies riding one-handed—standing out as the most significant (Pai & Dozza (2025)). Additionally, a survey study with scientific observation conducted in Dresden and Berlin showed that many riders choose to ride on the sidewalk because they feel safer and find it more convenient than riding on the roadway or bicycle lanes, particularly in urban environments. Although many electric scooter riders were aware of regulations prohibiting the use of sidewalks for their movement, their behavior was often driven more by the immediate practicality of avoiding traffic or finding smoother surfaces for travel, rather than intentional and targeted rule-breaking. Factors such as traffic congestion, road conditions, and the availability of safe infrastructure had a significant impact on the choice of path taken by electric scooter users (Anke et al. (2023)).

Jasiūnienė & Tumavičė (2022) reached results indicating that accidents involving electric scooters occur with all categories of traffic participants – pedestrians, cyclists, motor vehicles, other electric bicycle riders, and even among themselves, and are usually caused by sudden, unexpected maneuvering by traffic participants. However, the highest number of accidents occurred with vehicles, particularly at intersections or during turns into or out of side streets. Interestingly, during the study period, accidents involving bicycles increased, while accidents involving pedestrians decreased, which can also be linked to higher movement speeds of the participants, i.e., the difference in movement speeds.

Summarizing the various described and cited experiences in the use of electric scooters, it is not possible to reliably determine which surface would be the safest for the movement of scooter users, as different hazards exist under different circumstances. Since this is a new category of traffic participants in the Republic of Serbia, it is primarily necessary to examine the attitudes and behaviors of existing electric scooter users, as well as other traffic participants, regarding acceptability and co-functioning in the traffic system with electric scooters.

## 2. METHOD AND MATERIAL

A review of the legislative regulations relating to the use of electric scooters was conducted in this paper, starting from the definition of an electric scooter, through the surfaces on which they are allowed to move, to the persons who can use them. This enabled an insight into the current frameworks within the Republic of Serbia, inside of which measures for improving the safety of electric scooter users and other traffic participants must be defined.

In order to perceive the current state and the magnitude of the problem, an analysis of traffic accidents involving electric scooters and an analysis of casualty trends in accidents involving electric scooters were performed. The publicly available database of the Road Safety Agency of the Republic of Serbia was used for the accident analysis.

Subsequently, a survey research was conducted regarding the knowledge, attitudes, and behaviors of electric scooter users, as well as other traffic participants, concerning the safe participation of electric scooters in traffic. The attitudes of all surveyed categories were also specifically examined with respect to defining certain preventive measures aimed at electric scooter users.

### 2.1. Legislative Framework

In the Republic of Serbia, guided by various global practices and experiences, the legislator first defined what belongs to the category of light electric vehicles (Article 7, Paragraph 1, Item 31a), as this is the basis for defining all regulations and norms, and provided the following definition:

"A light electric vehicle is a motor vehicle with at least two wheels, with a mechanical steering wheel, without a seating position, whose continuous nominal power of the electric motor is not greater than 0.6 kW, whose maximum design speed does not exceed 25 km/h, and whose unladen weight does not exceed 35 kg."

The legislator also specified the surfaces on which these vehicles are allowed to move (Article 92a, Paragraph 1), with two exceptions (Article 92a, Paragraphs 2 and 3): "The driver of a light electric vehicle is obliged to use a bicycle lane, a pedestrian-bicycle path, or a bicycle lane for movement."

In doing so, it clearly defined that riding this category of vehicles while crossing the roadway is prohibited (Article 92v, Paragraph 1), except at the crossing of a bicycle lane and a pedestrian-bicycle path over the roadway.

### 2.2. Safety Analysis of Electric Scooter Users in Traffic

To analyze the state of safety for electric scooter users, the period from July 1, 2023, to December 31, 2024, was analyzed, during which a total of 144 traffic accidents were recorded. Out of this number, 39 accidents were recorded in the second half of 2023, while as many as 105 accidents were recorded during 2024. In the analyzed period, a total of 132 persons suffered casualties, of which 36 persons were in the second half of 2023 and 96 persons during 2024.

This trend indicates a gradual increase in the frequency of traffic accidents over the observed period, which may be a consequence of more intensive use of electric scooters, increased mobility of traffic participants, or insufficient adaptation of infrastructure to new forms of movement in urban environments. It is observed from the data that the highest number of traffic accidents was recorded in the category of accidents involving injuries, with continuous growth over the observed period (from 37 in the second half of 2023 to 53 in the second half of 2024).

The number of accidents with material damage is low, all of which indicates that the majority of incidents resulted in injuries to the participants involved. Accidents with a fatality were recorded only in the final phase of the observed period, with exactly 1 case. This can be considered statistically negligible data and a statistical error, but it carries high weight in the context of traffic safety and casualties of electric scooter users in traffic.

Based on the conducted analysis, it is observed that the highest number of traffic accidents occurs on the roadway, with a continuous increase in each subsequent period. This trend indicates a dominant exposure to risk precisely on roadways, where the interaction of different categories of participants is most intense. Pedestrian crossings represent the second most common category, with minor fluctuations in the number of accidents (6, 3, and 5). Although numerically less frequent, these events are the most critical from a safety perspective, as they involve a direct collision between pedestrians, light electric vehicle riders, and vehicles. Bicycle surfaces record a moderate growth, from one accident in the second half of 2023 to five in the second half of 2024, which may indicate an increased use of bicycle paths and lanes. Pedestrian areas have the lowest number of recorded accidents (2–3 per period), but their existence confirms that risk is present even in zones primarily intended for the safe movement of pedestrians.

Since September 15, 2023, when the Law on Amendments and Supplements to the Law on Road Traffic Safety („Službeni glasnik RS", ", No. 76/23) entered into force, prohibiting the movement of light electric vehicles on pedestrian surfaces while simultaneously allowing their movement on bicycle and roadway surfaces, visible changes have occurred in the spatial distribution of traffic accidents. The analysis shows a clear trend of decreasing numbers of accidents on pedestrian surfaces in 2024. On the roadway, 103 accidents with injuries, 10 with material damage, and 1 with a fatality were recorded, which unambiguously indicates that the roadway is the riskiest zone in the traffic system. At pedestrian crossings, 13 accidents with injuries were recorded, on bicycle surfaces 8 accidents with injuries and 2 with material damage, and on pedestrian surfaces 5 accidents with injuries.

The conducted analysis points to the fact that large differences in the specifics of individual categories of traffic participants, along with a significant variance in movement speeds, most frequently result in the most severe injuries. This has also been demonstrated by various foreign studies, which is consistent with different practical experiences, namely the fact that as kinetic energy increases in a collision, the consequences increase as well.

## 3. ANALYSIS OF KNOWLEDGE, ATTITUDES, AND EXPERIENCES REGARDING THE SAFETY OF ELECTRIC SCOOTER USE IN TRAFFIC

In order to collect data on the knowledge and attitudes of traffic participants and scooter users regarding the justification of electric scooter use on pedestrian areas, a survey research was conducted, structured into two thematic units. The first part was intended for electric scooter drivers, with questions related to their driving habits, compliance with regulations, perception of safety, and participation in traffic on pedestrian areas, while the second part was focused on other traffic participants. The research was conducted via social networks and thematic internet groups that gather drivers and micromobility enthusiasts. A total of 366 survey questionnaires were collected, of which 218 respondents belonged to the group of electric scooter drivers, and 148 to the group of other traffic participants. From the sample, 35 survey forms that did not meet the data quality criteria were eliminated.

In the structure of respondents, male scooter users were represented with 89%, which also reflects the most common structure of scooter users. The largest number of respondents belongs to the age group from 14 to 17 years, followed by 38 to 46 years.

Also, the level of education indicates that electric scooters are most commonly used by persons with completed secondary education (40,4%) and university degrees (30,7%), while

persons with higher education (college) make up 18,3% of those surveyed. The smallest share is occupied by persons with primary education (10,6%). In summary, the structure shows a clear urban dominance in the use of electric scooters, confirming that this form of mobility represents primarily a phenomenon of modern cities, conditioned by the dynamics of life, traffic jams, and the need for environmentally friendly solutions for short distances.

Regarding the knowledge and level of information of the respondents concerning traffic participation rules, 67,9% of respondents stated that they know the legal regulations, 27,1% that they partially know the legal framework, and 5,0% that they do not know the legal framework at all. The results show that electric scooters are increasingly moving beyond the scope of a "fun" or occasional means of transport and are becoming a stable segment of urban mobility. Also, a significant percentage of users cover more than 3 km per ride, indicating their growing importance in daily traffic. 61,5% of respondents use these vehicles for daily activities, 21,6% for recreation purposes, and 17% for minor grocery shopping, which points to the possibility of meeting various needs with this category of vehicles, contributing to their greater presence. A larger number of electric scooter owners (62,4%) do not possess a sticker issued by the Road Traffic Safety Agency.

Regarding the attitudes of scooter drivers, the largest part (45%) believes that it is safe to move on the roadway within a width of up to 1 m from the right edge of the roadway, while 39,4% consider this way of driving unsafe. An additional 15,6% of those surveyed stated that they are not sure ("I don't know"), which may indicate insufficient experience in driving a scooter or insufficiently clear regulations defining where scooters are allowed to move.

A convincing majority of electric scooter drivers (63,3%) believes that current regulations do not stimulate the use of this mode of transport. This result points to the general impression that the legal framework, instead of supporting the development of micromobility, rather has a limiting effect. On the other hand, only 13,3% of respondents stated that regulations nevertheless have an encouraging character. These data show that the existing regulatory framework is not perceived as a factor that encourages the use of electric scooters.

Out of the total number of surveyed scooter users, as many as 77,7% are in traffic in the role of car or truck drivers, which shows that the largest number of those surveyed represent active traffic participants, which is significant because they most frequently share traffic space with electric scooter drivers. Pedestrians are present with 10,1% of respondents, and other categories with less than 5%.

The attitudes of other traffic participants towards electric scooter drivers indicate a noticeable level of irritation and intolerance, although not completely negative. The largest part of respondents, 37,2%, stated that the appearance of electric scooter drivers sometimes irritates them. Such attitudes may be the result of situational factors, such as the unpredictable behavior of certain scooter drivers, movement through pedestrian zones, or insufficiently regulated infrastructure that forces scooter users to move on the same surfaces as pedestrians or drivers. On the other hand, a significant percentage, 35,1%, stated that electric scooter drivers irritate them extremely, which represents a worrying figure in the context of safety culture and mutual tolerance in traffic. While 27,7% of respondents stated that electric scooter drivers do not irritate them, which indicates the existence of a part of the population that shows a higher level of understanding and acceptance of this mode of transport. Viewed as a whole, the obtained results indicate that more than two-thirds of respondents (72,3%) to a lesser or greater extent experience electric scooter drivers as a factor causing discomfort or irritation in traffic. These data emphasize the need for stronger regulation, education, and infrastructure improvement in order to increase the level of mutual respect and reduce the degree of conflict between different categories of traffic participants.

The largest percentage of scooter drivers (48,6%) stated that they most frequently use the roadway, which is in accordance with legal provisions, and 41,2% state that they most frequently

see scooter drivers precisely on the roadway, indicating a growing awareness among scooter drivers of legal obligations. However, a significant part of drivers, even 16,1%, states that they use the scooter on the sidewalk, while as many as 3,1% of other participants point out that they most frequently see them precisely on those surfaces. When it comes to bicycle lanes, 21,1% of drivers state that they use them, while only 4,7% of other participants confirm seeing them there. Data on pedestrian-bicycle paths (12,8% of drivers and 11,5% of other participants) show a relative alignment in perception, and movement on pedestrian paths is the least represented, with 1,4% of drivers and 9,5% of observers, which indicates that this practice is limited, but not completely eliminated.

The results indicate that the roadway has become the dominant surface for the movement of electric scooters, which represents a positive step towards legal and safer participation in traffic. Nevertheless, a high percentage of movement on sidewalks and mixed paths shows that urban infrastructure is still insufficiently adapted to the new form of micromobility, requiring a systemic approach in planning and regulation.

Electric scooter drivers mostly highlight wearing a helmet (average score 3,65) as an action they frequently practice. This information may indicate an awareness of personal risk and the need for protection, but also a possible tendency to overestimate one's own responsibility. In contrast, other traffic participants rate this habit with a significantly lower score (1,94), suggesting that in practice, helmet use is not as widespread as drivers claim.

When it comes to wearing a reflective vest on the roadway, both groups agree that this measure is rarely applied (1,96 for drivers and 1,48 for other participants). Data on carrying another person show an opposite perception; while scooter drivers rate this action with a low score (1,5), other traffic participants believe that it occurs more frequently (2,43). This difference may be the result of individual observed cases that leave a strong impression on observers, even though they might not be frequent in the overall population.

For indicators of sidewalk use, differences are visible again; drivers estimate their own behavior at a moderate level (2,88), while other participants rate this behavior as significantly more frequent (3,43). This confirms the impression that scooter drivers often unconsciously or consciously encroach upon pedestrian space, which affects the perception of their safety culture and causes a negative public attitude.

The largest discrepancy was observed in the category of mobile phone use while driving – drivers themselves estimate this habit as almost non-existent (1,26), while other traffic participants give a score of 2,32. The analysis shows that there is a difference in the perception of risky behavior: electric scooter drivers tend to present themselves as more careful and responsible traffic participants, while other participants perceive them as a group that more frequently violates rules and endangers safety. These results indicate the need for systematic education and stricter control of behavior in order to reduce the gap between subjective and objective risk assessment and improve the general culture of traffic safety.

The majority of surveyed electric scooter drivers, as many as 65,2%, have never experienced a fall or a traffic accident, and similarly, 63,7% of other traffic participants stated that they have not witnessed such events. However, among those respondents who had an experience of a fall or accident, the largest number of incidents, according to both groups, occurred on the roadway, i.e., 13,1% of drivers and 14,6% of other participants state that they noticed or experienced such situations precisely on this surface. This confirms that the roadway, as the most dynamic and exposed traffic zone, is the place of highest risk for scooter drivers, while the sidewalk is in second place (10% of drivers and 13,4% of other participants). When it comes to pedestrian-bicycle paths, the percentages are similar, with 5% of drivers and 4,5% of other participants stating that falls or accidents were recorded on these surfaces.

A similar percentage (5%) of drivers stated that the accident occurred on a bicycle lane, while only 0,6% of other participants confirm witnessing such an event. The smallest percentage of

accidents was recorded on pedestrian paths, namely 1,8% of drivers and 3,2% of other participants, confirming that this surface is less frequently used for riding scooters, but also that risks exist in cases of non-compliance with the rules.

In order to examine the acceptability of preventive measures for improving the safety of scooter users, eight measures were defined, the acceptability of which was examined and the differences in attitudes between scooter users and other traffic participants were checked. The following measures were defined:

Measure 1 – It is necessary to limit the design speed of electric scooters to 25 km/h;
Measure 2 – The use of electric scooters on sidewalks should not be allowed;
Measure 3 – The use of electric scooters on sidewalks should be allowed without speed limits;
Measure 4 – It is necessary to limit the maximum unladen mass of an electric scooter to 35 kg for traffic safety reasons;
Measure 5 – It is necessary to limit the nominal power of the electric motor in an electric scooter up to 0.6 kW for traffic safety reasons;
Measure 6 – It is necessary to limit the speed of electric scooters on pedestrian-bicycle paths up to 10 km/h;
Measure 7 – It is necessary to limit the speed of electric scooters on the roadway up to 30 km/h for the age group of 14 to 18 years, i.e., up to 50 km/h for adults, and
Measure 8 – The use of electric scooters on sidewalks should be allowed with a speed limit.

**Table 1.** Mann-Whitney U test results

| Measure | Electric scooter drivers | Other traffic participants | Mann-Whitney U test |
|---|---|---|---|
| Measure 1 | 2,06 | 4,25 | U = 4753,5, z = -10,872, p < 0,001 |
| Measure 2 | 2,46 | 3,55 | U = 8663,0, z = -5.909, p < 0,001 |
| Measure 3 | 2,06 | 1,33 | U = 9579,0, z = -5.695, p < 0,001 |
| Measure 4 | 1,93 | 3,67 | U = 5801,5, z = -9.453, p < 0,001 |
| Measure 5 | 1,61 | 3,82 | U = 3800,0, z = -12.088, p < 0,001 |
| Measure 6 | 2,29 | 4,10 | U = 5366,0, z = -9.836, p < 0,001 |
| Measure 7 | 3,05 | 3,71 | U = 10896,0, z = -3.295, p < 0,01 |
| Measure 8 | 3,49 | 3,10 | U = 11896,0, z = -2.076, p < 0,05 |

All obtained results show a high level of statistical significance, confirming that the perceptions of the two groups systematically differ.

Electric scooter drivers have a more tolerant and liberal attitude towards restrictions, while other traffic participants emphasize the safety aspect and the need for stricter regulation.

In the following section, a binary logistic regression model was used to determine which factors influence the choice of surfaces used by electric scooter drivers and what influenced whether they were involved in a traffic accident as an electric scooter driver.

**Table 2.** Model describing factors that influence the use of different surfaces

| **Factors** | **Bicycle path** | **Roadway** | **Pedestrian-bicycle path** | **Sidewalk** |
|---|---|---|---|---|
| Socioeconomic | | | | |
| Gender (ref: male) | H | H | -0,996 | H |
| Age | H | H | H | H |
| Education | H | H | H | H |
| Place of residence (ref: up to 50,000) | | | | |
| From 50.000 to 200.000 | 0,470 | 0,677 | H | 0,000 |
| Over 200.000 | 1,265 | -0,997 | H | 1,208 |
| Measure | | | | |
| Measure 1 | H | -0,320 | 0,246 | H |
| Measure 2 | H | H | -0,540 | -0,333 |
| Measure 3 | H | H | H | H |
| Measure 4 | 0,249 | H | H | H |
| Measure 5 | H | H | 0,502 | H |
| Measure 6 | H | H | H | H |
| Measure 7 | H | H | H | H |
| Measure 8 | H | H | H | H |
| Behavior and rule compliance | | | | |
| ABS sticker | H | -0,742 | H | H |
| Knowledge of regulations | 0,667 | H | H | -1,163 |
| Wearing a helmet | H | -0,185 | 0,504 | -0,267 |
| Wearing a vest | H | H | -0,367 | 0,330 |
| Carrying another person | H | H | 0,374 | H |
| Use of the sidewalk | H | -0,723 | H | H |
| Mobile phone use | H | H | H | H |
| Nagelkerke $R^2$ | 0,068 | 0,304 | 0,239 | 0,227 |

The conducted analysis showed that drivers who support speed limits ride on the roadway less frequently, where they are in contact with faster vehicles, but use pedestrian-bicycle paths more often, which is in line with the more cautious profile of a driver who supports speed regulation. Drivers who are against riding on the sidewalk (i.e., in favor of a ban) use those surfaces less frequently (Measure 2). Drivers who support Measure 4 use bicycle paths more often. These are typically users who are aware of the technical and safety aspects of electric scooters and ride on safe and permitted surfaces. Finally, when speaking of Measure 5, drivers who support limiting the motor power are more inclined to moderate surfaces such as pedestrian-bicycle paths.

When it comes to behavior and rule compliance, almost all factors had an impact on the choice of at least one surface. A higher knowledge of regulations and possessing an ABS sticker is associated with a safer choice of surfaces. Those who know the rules and have a sticker choose bicycle paths for riding more often, and the roadway and sidewalk less frequently. Drivers who wear a helmet ride on sidewalks and roadways less often, but more frequently on pedestrian-bicycle paths. Such behavior may indicate a dangerous tendency where drivers who do not wear helmets often ride on surfaces where frequent conflicts with vehicles or pedestrians are possible. Another important result is that vests are worn more often by those moving on the sidewalk. When transporting two people, the pedestrian-bicycle path is used more frequently.

This may indicate problems typical for this movement surface. And finally, drivers who use the sidewalk rarely use the roadway as well.

## 4. CONCLUSIONS

Research on the justification of riding electric scooters on pedestrian surfaces has shown that this form of micromobility, although representing a modern, economical, and ecologically acceptable transport solution, requires a precise normative, infrastructural, and safety framework. Global experiences indicate that the key challenge in solving the safety problem of scooter users lies in balancing the need for accessible mobility and the protection of pedestrian space.

In most European and world cities, different solutions exist for the use of electric scooters, ranging from a complete ban on movement on sidewalks to controlled traffic with speed limits and mandatory use of protective equipment. All papers agree that the absence of clear regulations leads to an increase in the number of accidents and conflicts with pedestrians.

The legal framework in the Republic of Serbia has been significantly improved by the latest amendments to the Law on Traffic Safety, but the fact remains that in practice, a large number of electric scooters do not meet the prescribed structural conditions. The survey data shows that the percentage of electric scooters that exceed power and speed limits is high, which imposes a need to place such vehicles within legal frameworks as well, given their large participation in traffic. The introduction of a systemic registry and the Road Traffic Safety Agency (ABS) sticker represents a positive step, but insufficient without more rigorous enforcement.

Through the analysis of movement surfaces (roadway, bicycle, and pedestrian surfaces), it is concluded that each carries specific risks.

- On the roadway, the risk is highest due to the speed and mass of motor vehicles.
- On bicycle paths, the risk is moderate and depends on traffic density and the discipline of users.
- On pedestrian surfaces, the risk is lower for drivers but higher for pedestrians, leading to frequent conflicts and endangering the safety of more vulnerable participants.

The results of the analysis showed that the largest number of minor and moderate accidents occurs precisely on pedestrian surfaces, while the most severe consequences are characteristic of the roadway. Therefore, it is crucial that pedestrian surfaces remain a space free of motorized vehicles, except in cases where there is no alternative infrastructure and where clear speed limits (up to 6 km/h) and mandatory protective equipment are prescribed.

Based on the conducted analyses, it can be concluded that riding electric scooters on pedestrian surfaces is not justified as a permanent solution, but only as a temporary measure in conditions where a dedicated infrastructure for micromobility does not exist. In those cases, it is necessary to limit the speed, introduce the mandatory use of lighting markings and protective equipment, as well as the obligation of defensive riding and yielding the right of way to pedestrians. A sustainable approach implies the construction of dedicated bicycle-scooter paths that will physically separate pedestrian and motorized traffic, thereby preserving both the safety and functionality of the urban space.

Electric scooters in the Republic of Serbia represent a significant step toward the modernization of urban transport, but only with clear application and control of legal frameworks, education, and the development of adequate infrastructure. Without this, their movement on pedestrian surfaces endangers the primary function of those zones and leads to conflicts that violate the principle of "safety first."

Therefore, the justification of their riding on sidewalks can be accepted exclusively in exceptional conditions, under strict limitations, and with a clearly defined responsibility of the driver.

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