The use of electric scooters during COVID-19 lockdown in Kuwait: safety considerations

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Received 6 October 2024
Revised 13 January 2025
17 March 2025
5 April 2025
Accepted 8 May 2025

Abstract

Purpose – Standing electric motorized scooters (e-scooters) have grown in prominence as an alternate method of mobility since their debut in 2017. Despite the numerous advantages, such kind of transportation is dangerous due to the risk of accidents and consequent injuries. Kuwait banned the usage of electric scooters on public roads in 2020. Thereby, an alternate solution was proposed in this research. This paper aims to study the implementation of electric scooters in Kuwait, their advantages & disadvantages and challenges they might face to be adopted as a sustainable mode of transportation in the society.

Design/methodology/approach – To select the best solution, a survey of 20 questions was created and analyzed. Besides, logistic regression has been used to identify the factors that have an impact on the probability of an accident.

Findings – As a result, age, usage of scooters, opinion about safety and presence of another party all had a significant impact on the probability of an accident. Based on the results of the survey, the solution for creating a special lane for electronic scooters has been proposed. The solution was presented for two Kuwait areas: Sheikh Jaber Bridge and Salem Sabah Al-Salem Al-Sabah Street. The new plans were provided in the research. It is expected that the implementation of this solution will solve the problem of accidents as well as provide sufficient social distancing during the pandemic and reduce traffic jams.

Originality/value – This work presents a new trend in Gulf Cooperation Countries, taking Kuwait as an example, that depend mostly on car usage. Introducing environment-friendly modes of transportation such as scooters will bring many benefits to the society such as pollution reduction and enhancing physical activity in the community. This will add also to the literature in this domain as almost no similar studies can be seen in the literature for this region of the world.

Keywords E-scooter, COVID-19, Lockdown, Survey, Logistic Regression, Road, Accidents

Paper type Case study

The author would like to thank Eqbal Alshammari, Fatma Alfadhli, Zainab Asiri and Nour Alenezi for their collaboration in this research work.

Compliance with ethical standards: Disclosure of potential conflicts of interest: None.
Research involving human participants and/or animals: None.
Informed consent: Not applicable.
Conflict of interest: None.
Data availability: All data used in this work appears in the submitted paper.

Urbanization, Sustainability and Society
Vol. 2 No. 1, 2025
pp. 310-337
Emerald Publishing Limited
2976-8993
DOI 10.1108/USS-10-2024-0058

1. Introduction

Shared stand-up electric motorized scooters (e-scooters) were introduced to the market a few years ago, in November 2017 (Badeau *et al.*, 2019). They are now available for short-term rental in numerous locations and are promoted as a solution for short-distance transportation. They are also available in Kuwait. Stand-up electric scooters are designed to carry riders over short distances in urban areas, using a small electric engine and a platform on which a single rider stands. Ride-sharing companies are deploying fleets of these scooters to metropolitan areas, allowing users to rent them for short periods. They are easily controlled via smartphones and have become one of the most cost-effective forms of urban mobility compared to other modes of transportation. Communities are increasingly adopting them due to their low cost, zero emissions and minimal environmental impact. Although they provide a practical and cost-effective means of addressing transportation shortages, they have also introduced a new public safety issue for communities and health-care professionals to deal with.

These scooters, which are barely inches off the ground and can reach speeds of up to 15 miles per hour, consist of only a thin, flat piece of metal between two small rubber tires, leaving riders highly vulnerable to catastrophic injury on major roads (Choron and Sakran, 2019). The venture-backed e-scooter companies, some of which are now valued at over two billion dollars, have developed a system that allows them to sell first and prioritize safety later (Burke and Kaplan, 2019). Manufacturers have established guidelines and rules that should be followed to reduce injuries, which include wearing a helmet while riding, being at least 18 years old, riding only on streets (not sidewalks), avoiding riding with another person and not obstructing public walkways when parking the scooter.

Health issues related to riding e-scooters have been thoroughly discussed by researchers. There have been alarming reports of an increase in the number of riders and pedestrians visiting emergency rooms due to injuries caused by e-scooters. One such report is based on data from the USA, where e-scooters were legalized in September 2017, and the first scientific studies on this subject are already available. According to these data, most of those injured were scooter riders, with only about 10% being pedestrians (Trivedi *et al.*, 2019). Craniocerebral trauma affected nearly 40% of patients, while fractures of the limbs were the second most common injury (31%) (Trivedi *et al.*, 2019; Ishmael *et al.*, 2020). Although the research included a limited number of cases, another American study found a significant increase in e-scooter-related injuries, including severe craniocerebral damage (Badeau *et al.*, 2019). These findings are consistent with a survey conducted in New Zealand, where scooters have been registered since September 2018. This study also documented a significant rise in major injuries, primarily to the extremities but also to the axial skeleton (Mayhew and Bergin, 2019). In addition, similar studies have been conducted using data from Germany (Störmann *et al.*, 2020) and Australia (Royal Australasian College of Surgeons, 2019).

According to published official statistics for Kuwait (Statista, 2023), a steady annual growth rate (The Compound Annual Growth Rate 2023–2028) of 1.98% is expected, resulting in a projected market volume of US$2.57m by 2028. It is estimated that unit sales in the scooter market will reach 0.53k motorcycles by 2028 (Statista, 2023). The popularity of electric scooters is rapidly growing in Kuwait as residents seek greener and more efficient transportation options (Statista, 2023). Despite this increase, research on e-scooter deployment and safety in Kuwait remains scarce and poor, highlighting critical limitations and gaps in the literature. The problems related to e-scooter deployment align with broader urban mobility issues, where prediction methods, such as machine learning and statistical techniques to estimate travel time, have been studied to better transportation planning (AlRukaibi *et al.*, 2019). Understanding these methods and models can help to enhance managing the traffic and safely integrate e-scooters with urban networks.

Despite the rise of e-scooters worldwide, there are significant obstacles to their deployment that restrict their popularity and safety. Some user-related problems, such as helmet violations, insufficient rider training and issues with pedestrians, remain unresolved (Mehranfar and Jones, 2024). Additionally, road conditions, parking facilities and dedicated lanes are among the infrastructure issues that raise the probability of accidents (Lee *et al.*, 2024). Furthermore, environmental issues that impact the long-term durability of batteries include the severe heat in Kuwait and worries about battery sustainability (Campisi *et al.*, 2024). More challenges were studied in other transportation infrastructure sectors in Kuwait, such as sustainable port management, where some strategies and plans for efficient processes and environmental sustainability have been discovered and introduced (AlRukaibi *et al.*, 2020).

As seen in the literature, there is a lack of studies based on Kuwaiti data, which makes this research highly significant. This study aims to provide a comprehensive analysis of e-scooter-related accidents and injury patterns in Kuwait by determining the significant causes and proposing solutions to reduce risks. This research is performed to introduce valuable suggestions that can help policymakers and urban planners in enhancing e-scooter safety and rules. In this study, a survey was created and conducted to analyze the patterns of accidents and injuries related to e-scooters, identify their causes and propose solutions to address these issues. This was achieved through a series of procedural steps. First, a review of the theoretical and empirical literature was presented to provide a comprehensive understanding of the research field. The methodology of the study was then developed, and the results were described and discussed. Based on the conclusions and findings, a proposal was presented to address the problem of frequent e-scooter accidents, aimed at being implemented by the Kuwaiti Government.

To achieve this, a structured research methodology was used, beginning with a review of existing theoretical and empirical literature. The study then presents its findings and discusses their implications, culminating in a set of policy recommendations designed to enhance the safe and efficient integration of e-scooters within Kuwait's urban transport ecosystem. These findings will provide valuable insights for policymakers, urban planners and micromobility service providers to develop sustainable and safety-conscious deployment strategies.

2. Literature review

2.1 Electric scooter definition and implementation

Electric scooters with no docking stations or e-scooters, are a comparatively new mode of transportation. It is quickly transforming the way of travel to and from work or university, delivery services and other short trips. Electric scooters have become a common form of transportation in both the USA and Europe over the past three years (Hardt and Bogenberger, 2019). The first appearance of standing electric scooters was in Santa Monica, CA, in September 2017, when Bird Rides, Inc., a micromobility startup, distributed hundreds of scooters across the city (Hall, 2018). Riders flocked to these scooters almost immediately, owing to their simplicity of use, convenience and low price. The driving experience in many metropolitan areas has shifted because of this popularity.

If we consider Kuwait specifically, the residents of the country have already taken up a new activity: riding electric scooters, particularly in residential areas. Individuals of all ages use scooters to inhale cold air in the evenings, and some of them even use them to visit cooperative societies in the vicinity or public parks, according to the Al-Qabas daily newspaper. Electric scooters range in price from approximately KD 50 to KD 140 [1]. The price of a scooter might rise to KD 300 for those who can travel long distances. The engine power varies depending on the type of scooter. Some of them can go 45 km at a top speed of 15–20 miles per hour. Some models have engines that produce less than 250 watts and go

only 20 km. Scooter pricing is determined based on the speed options and engine power. Most of them are pollution-free and ecologically beneficial (Vorina *et al.*, 2019).

Some nations pass regulations governing the use of electric scooters that are similar to bicycle legislation to manage the large number of scooters on their streets and minimize the risks that may emerge as a result of scooters crowding out vehicles. Kuwait is one of the countries that has enacted such regulations. In response to previous complaints, Kuwait has prohibited the usage of electric scooters on public roadways, according to local media [2]. The restriction was imposed by the Ministry of Interior, which cautioned that riding unregistered motorcycles on public highways is illegal and dangerous to people's lives. Since this problem has occurred, some solutions need to be implemented to prevent the banning of electric scooters.

2.2 Studies related to electric scooters

There is a scarcity of literature on e-scooters, with most research focusing primarily on the situation and growth in China and the USA, where these vehicles are common among city dwellers. As a result, there is a lack of studies related to this mode of transportation in Kuwait. Therefore, a general overview of the current literature on scooters is provided in this section, which is studied from different aspects. This section provides a cross-section of the existing scientific literature related to the theme.

Weinert *et al.* (2008) offered one of the first analyses of e-scooters and their use. According to this study, there were various problems which forced the government to support electric-powered two-wheelers or ePTWs. These issues included the cost efficiency of such transportation and their role in worsening air pollution and the traffic environment. Thus, a scooter became a preferable method of transportation in comparison with cars, public transport or bikes. In turn, Cherry and Cervero (2007) conducted a more usage-focused study of eBikes and e-scooters in Chinese cities based on a survey of bike, eBike and scooter users. As a result, people with above-average schooling and household incomes use e-bikes and scooters as their preferred mode of transportation in their everyday lives, according to the findings. Similarly, in Kuwait, using e-scooters – if properly regulated and integrated into the existing highway infrastructure – can help reduce traffic congestion and associated environmental problems.

E-scooters have been investigated from the perspective of sharing (ESS or electric scooters sharing) as well since they can be rented by people. Mathew *et al.* (2019) studied anonymized big data from ESS rides and found that individuals ride ESS for around 8 min for 0.7 miles at a speed of 5.23 miles per hour. According to the data from their study, ESS might be a viable method of last-mile transportation. Between dock-based bike-sharing and ESS ridership, McKenzie (2019) discovered substantial disparities in geographical and temporal dimensions. Eccarius and Lu (2020) used a PLS-SEM model using the planned behavior theory to study behavioral factors of travelers' intention to use ESS. The perceived compatibility of ESS has a substantial overall influence on usage intention, according to the researchers. Younes *et al.* (2020) used large data from ESS providers' APIs to investigate the temporal drivers of ESS rides. According to the results of their negative binomial model, ESS ridership varied between weekdays and weekends, with no change between AM and PM. In a similar study, a multinomial logit model was used to predict the choice of transportation way by Christoforou *et al.* (2021). The current focus on ESS has been on the adaptive control method and algorithm to achieve self-balancing and yaw control for the machine itself (Tsai *et al.*, 2010). It is an important topic about ESS safety dynamics for maneuvering, whereas its crash safety in traffic accidents remains blank due to the lack of reported and recorded accident cases. The ESS concept can also be easily implemented and

tested in Kuwait, as millions of expats work in the country and are expected to use such a mode of transportation once it is introduced at reasonable prices.

Recent literature showed great demand for micromobility devices such as e-scooters (Abduljabbar *et al.*, 2021; Lee *et al.*, 2021; Tuncer *et al.*, 2020). This mainly contributed to their role in improving mobility in urban areas with limited transit service (Javadinasr *et al.*, 2022). The importance of e-scooters increased considerably during the Corona period due to the shift from mass transit options to single transit options to avoid being affected by the virus. A study in Australia showed a huge rise in the usage of micromobility devices versus the usage of public transportation (Lock, 2020). Another study in San Antonio, TX, by Jobe and Griffin (2021) showed that people had a higher intent to use micromobility devices post-COVID-19. A study in New York City for older adults affected by COVID-19 showed that the increase in adoption of micromobility during the pandemic was not as significant as among younger groups (Gao *et al.*, 2023).

Literature showed that during COVID-19, micromobility services were used for longer distances compared to before the pandemic (Abdullah *et al.*, 2020; Li *et al.*, 2021). Research in Austin, TX, revealed that low-income regions with the immense existence of e-scooters witnessed a lower drop in e-scooter trips, distance and duration during the pandemic (Tuli *et al.*, 2023). The trend is also clear in Asia as well. Recent works in Metro Manila, Philippines, proved that the pandemic had increased the awareness of environmental problems caused by excessive use of cars, which led to a major attitude shift toward the usage of e-scooters (Gaspar *et al.*, 2023). Many other studies in the literature highlighted the clear effect of a pandemic on the attitudes of people toward the usage of micromobility devices such as e-scooters due to many reasons related to environmental considerations, better accessibility, healthy lifestyle […] etc. (Yang and Lewis, 2023; Tan *et al.*, 2023).

In terms of Kuwait, very few studies/sources can be seen in the literature that analyze the specific conditions in Kuwait, such as social perceptions of scooters or the current regulatory framework. Among these is a recent study (AlKheder and Albaghli, 2024) had identified the barriers and benefits of shared e-scooters in promoting sustainability in Kuwait using Delphi and force field analysis methods. This research investigated the main opportunities and barriers to adopting this technology in Kuwait from three sides, which are social, environmental, economic and safety aspects, taking into consideration the travel behavior and urban infrastructure sides. Results show that from the urban infrastructure side, e-scooter adoption was favorable from all aspects except the economic aspect. It was recommended to regulate more laws in Kuwait to ensure road users' safety. In the current study, the logit model was the preferable one since it allows predicting the probability of the event based on the binary dependent variable.

2.3 Accidents involving electric scooters

Even though e-scooters are an accessible and cost-effective way to travel short distances in congested areas (Choron and Sakran, 2019), recent reports have raised safety concerns. A study on accidents and risk factors associated with rentable, dockless e-scooter use was conducted by the Austin Public Health Department and Centers for Disease Control and Prevention (Austin Public Health, 2019). They discovered that the majority of the injuries were to the rider's head (48%) and that only one out of every 190 riders was wearing a helmet. Over the span of a year, a second report on e-scooter accidents from Southern California reported 249 injuries associated with e-scooter use (Trivedi *et al.*, 2019). It was discovered that 80% of cyclists were hospitalized as a result of a crash, and just 10 out of 249 riders were wearing a helmet (only 4% of all riders). Many other studies worldwide in the literature have focused on the safety issues of using e-scooters (Ishmael *et al.*, 2020; Badeau *et al.*, 2019; Mayhew and Bergin, 2019). Safety

related to using e-scooters in Kuwait, along with their associated accidents, needs to be studied. This will help in implementing the proper bylaws to regulate the usage of such new modes of transportation to reduce the risk and enhance safety levels.

2.4 People and purposes of electric scooter usage

There are numerous studies, that aim to identify the profile of a scooter rider and the purposes for the scooter driving (Fitt and Curl, 2019). Travel surveys offer fascinating information about user profiles that may be used to develop policy recommendations and improve users' travel experiences. Mobility profiling is commonly used to target certain road users, such as scooter riders. Eccarius and Lu (2020) explored the factors that impact university students' propensity to use a scooter-sharing service. According to the study, understanding of e-scooter sharing services, environmental ideals and a young age (below 20) all had a part in developing a favorable desire to use them. Gitelman *et al.* (2017) presented a study to learn more about the demographics, health conditions, walking/cycling habits, attitudes about scooter use and life quality of senior travelers who use mobility scooters.

The study of e-scooter geographical data and trajectories is another approach to getting information about user profiles. Moran *et al.* (2020) created geofence-based electric scooter users of Vienna, indicating the relevance of the built environment, population density and land use as determinants for e-scooter usage. Bicycles and e-scooters are parked more properly than vehicles, according to Brown *et al.* (2020). Jiao and Bai (2020) investigated the characteristics that were most linked with ES usage in Austin, TX, and found that population density, education level, proximity to the city center, multimodality and compact land use were all important. Bai and Jiao (2020) compared their findings to similar data from Minneapolis, MN, and found geographical and temporal parallels and differences between the two cities. This conclusion implies that profiling should not be only mode-specific but also city-specific in some situations. Similar studies are missing in Kuwait to gather information about user profiles.

The current research provided valuable insight into the people who were using the scooters and those willing to use them. However, their typical portrait may be different from country to country. Therefore, it was necessary to make a portrait of a typical scooter driver based on the data of Kuwait respondents, which can be generalized in terms of one country. The reasons for scooter usage are almost the same in every country. However, the percentages of people who use scooters for one or other purposes may vary. It can be concluded that questions on both reasons of scooters' usage and demographic characteristics of the scooters' drivers should be obtained by a survey, to be able to answer these two sets of questions, which will be reliable for the case of Kuwait.

3. Methodology

Figure 1 includes a data flow chart describing all methodological steps for the benefit of the reader.

3.1 Survey design

To conduct the current study, a structured survey was developed to achieve two main objectives: (1) to identify the frequency of e-scooter accidents within the sample and (2) to estimate the model that highlights the key determinants of these accidents. The survey consisted of 20 questions, formulated depending on a review of existing literature and expert consultations to ensure clarity. Before starting this study, the survey was applied in a pilot test with a small group of respondents to enhance the questions and improve comprehension. The survey was administered in both English and Arabic to ensure accessibility for all participants.

The survey was administered in both English and Arabic to ensure accessibility for all participants. The data collection process took place from May 6, 2021, to May 17, 2021,

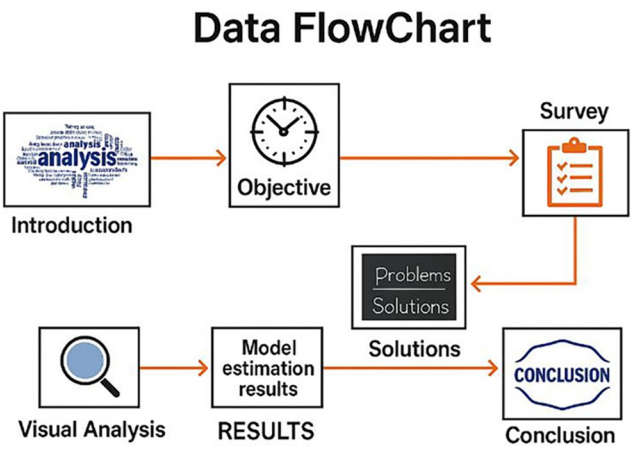

Figure 1. Methodological data flow chart
Source: Author's own work

through in-person interviews, allowing researchers to provide clarifications and ensure accurate responses. Interviewers were trained to maintain consistency and minimize response bias. A total of 736 responses were collected, covering a diverse sample of e-scooter users.

To enhance the methodological replicability of our study, we provide a clear framework for survey design, sample size determination and data collection procedures. The sample size was determined based on Kuwait's total population of 4,207,000, using the following statistical formula: [Include formula]. Researchers interested in analyzing e-scooter accident patterns in different contexts can adapt this approach by following similar sampling methods, survey design principles and data collection techniques.

All collected responses were translated into English and merged into a single data set to facilitate a standardized analysis. Our structured approach ensures that this methodology can be easily replicated in other regions to assess e-scooter safety trends and contributing factors. The sample size was determined based on Kuwait's total population of 4,207,000 using the following statistical formula.

Equation (1): Survey sample size (SS) calculation:

$$SS = \frac{Z^2 * p * (1-p)}{C^2} \tag{1}$$

where

- Z is a Z-score corresponding to a 95% confidence interval (1,96).
- p represents the assumed proportion of the population (0.5 by default).
- c is the margin of error in the sample.

Based on the provided formula above, the minimum number required for the sample size was calculated as 601. However, to be more accurate and robust in the study, 736 responses were collected. The survey results were then analyzed using Microsoft Excel for visual analysis.

3.2 Logistic regression

Since we were interested in the factors that had an impact on the probability of an accident for electric scooters, it was necessary to estimate the regression model. Most of the variables

were recoded into numeric ones, so the dependent variable was binary type (1 in case of an accident and 0 otherwise). Logistic regression was a good fit for such a model. Logistic regression is a statistical model that uses a logistic function to represent a binary dependent variable in its most basic form; however, there are many more advanced variants. Logistic regression is a technique for estimating the parameters of a logistic model in regression analysis (a form of binary regression). The model can be expressed in the following formula.

Equation (2): Logistic regression:

$$p = \frac{1}{1 + e^{-(b_0 + b_1 x_1 + \cdots + b_n x_n)}} \tag{2}$$

4. Results

4.1 Visual analysis

The first set of questions gave the demographic characteristics of the respondents, which were gender, age and educational level. These questions had been asked for a better understanding of the portrait of an average respondent. The gender of the respondents was considered at first. Most of the respondents were females (78% against 22% for males). Besides, half of the respondents belonged to the age group from 21 to 29 years old (51%), while the age group with the minimal number of respondents was 10–15 years old (1%). Respondents who were 16–20 years old also made up a large group, which took 36% of all the respondents. In turn, the most frequent educational level was university (88%). Some of the respondents attended high school (11%), while the number of people who studied in primary or intermediate school was just 1% of the sample. There were few uneducated people in the sample – less than 1%.

The usage of the electric scooters had been considered for the genders mentioned above separately (Figure 2).

Since there were more females in the data, we had more answers given by them in the graph above. As a result, many males and females had not used electric scooters. However, the difference between females, who answered "yes" and "no" was much bigger than that between the males. This can also be explained by the number of males and females in the sample. Some additional questions targeted only those people who had used electric scooters before and had a bad experience, while other questions were answered by all the respondents. The general questions regarding electric scooters were analyzed first. Respondents were asked about the time period when they had tried an electric scooter (Figure 3).

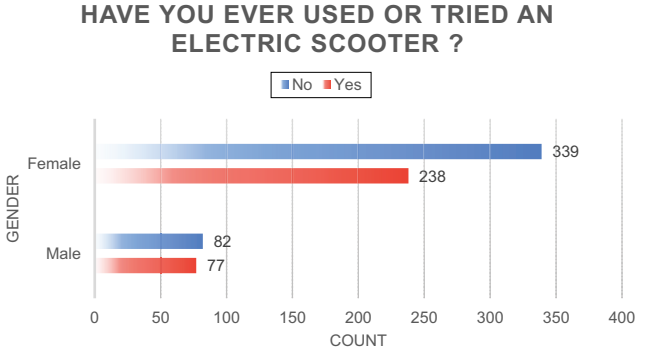

Figure 2. Usage of electric scooters by gender
Source: Author's own work

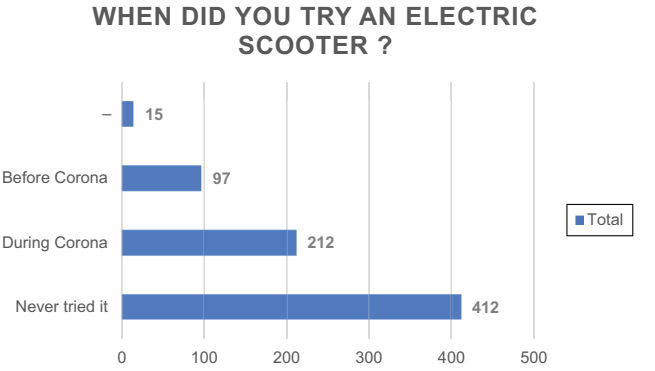

Figure 3. Period time when the respondents had tried electric scooters
Source: Author's own work

We can see that most of the respondents had not tried electric scooters, which supports the previous results. However, most of those who had ridden an electric scooter drove it during the coronavirus pandemic (212 out of 736 or 28.8% compared to 97 out of 736 or 13.2%). Fourteen respondents preferred not to answer this question. These results can be explained by people's desire to avoid public transportation during the spread of COVID-19 but still want to use some fast and convenient way to reach their destination. In this case, the usage of electric scooters during the pandemic was a good analogy for public transport or taxis. Respondents were also asked about the reasons for using electric scooters (Figure 4).

Most of the people used fun and entertainment as a reason to use electric scooters (420 out of 736 or 57.1%), while only 39 of them used delivery methods as a reason (5.3%). It can be explained by the inconvenience of using the electric scooter for such a purpose, as in most cases, the person was standing while driving. The couriers carry heavy bags, which make it inconvenient to deliver goods using an electric scooter. Spending free time and walking during times of partial curfew had almost equal number of responses (171 and 176, respectively). The penultimate place, in turn, was occupied by the reason (as a hobby), which had 44 responses.

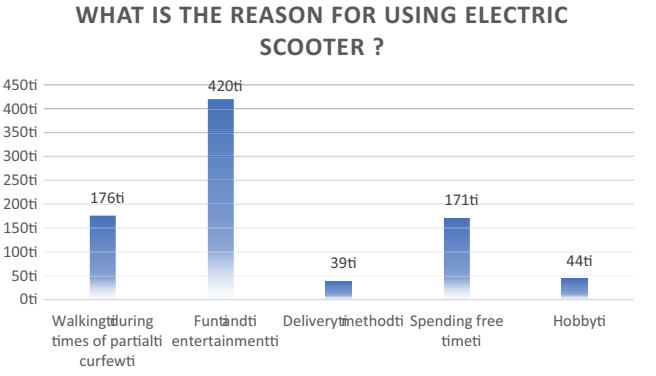

Figure 4. Reasons for using electric scooters
Source: Author's own work

We were also interested in the risk of electric scooters to the health of the user. Therefore, the next set of questions identified those people who already had some bad experience with electric scooters. The first question in this section was the accident experience. In total, 63% of the people did not have an accident while using the electric scooter, while 16% of them had this bad experience. In total, 21% of people did not respond to the question, which can be associated with the people who did not use the electric scooter. The cause of such an accident was another interesting topic (Figure 5).

If we exclude the people who had not used the scooters, most of the accidents were related to problems on the street surface (129 responses). The second reason by frequency was the inability to use the scooter (103 responses), while the third one was the role of other parties (82 responses). The less frequent reasons were related to the quality of the scooter. We have also been interested in the involvement of other parties in the accident (Figure 6). While there

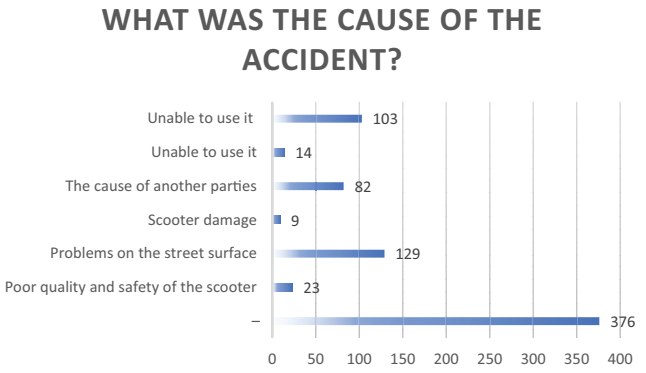

Figure 5. Reason for the accident
Source: Author's own work

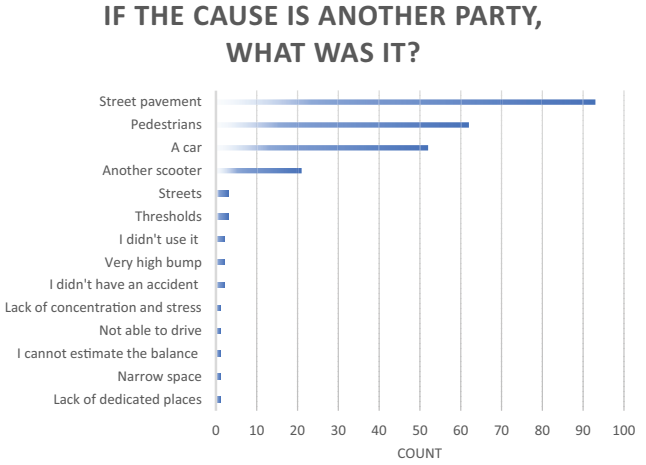

Figure 6. Other party involved in the accident
Source: Author's own work

were few options from which respondents could choose (car, another scooter, street pavement and pedestrians), they were also able to add their options.

Most of the scooter drivers could not handle the street pavement. Besides, the problem of accidents with pedestrians was obvious. As the electric scooter can reach a speed of 25 km/h, the accident at such speed can be fatal for pedestrians. Accident with a car was another problem. However, this problem can be fatal for the scooter's driver himself where the cars were driven at high speeds. Anyway, all these problems are related to the lack of space for electric scooter drivers: they either drive on sidewalks with pedestrians or on the road with cars. As a result, both of these accidents may occur. The extent of injuries was another question related to the accidents of electric scooters (Figure 7).

Most of the people did not have any severe injuries during the accident with an electric scooter. However, there were 27 respondents who had severe injuries. This was 3.7% from all the samples and 8.6% from those people who had tried the electric scooter. We cannot ignore this number, and the problem of accidents on electric scooters should be solved. Thereby, to solve this problem, we developed another set of questions, which were related to the advantages and disadvantages of electric scooters, their comparison with bicycles and the opinion of respondents about the suggested solution generated in the current research. We started with the question of possible usage of electric scooters in the future (Figure 8).

Most of the people were either willing to use the electric scooter in the future or they could not give an unambiguously positive answer. However, they did not deny the possibility of using it as well. So, we considered these respondents as somebody who can be categorized in the group of the risk of having an accident in the future. The reasons for using an electric scooter have been presented before. However, it is interesting to know what were the reasons that prevented respondents from using them (Figure 9).

Most of the respondents considered electric scooters as being not important and/or not useful. The second reason for frequency was being unsafe, which can be related to the danger of having an accident. The least frequent reason was difficulties in usage. In reality, electric scooters are as simple in usage as bicycles. We asked the respondents to choose between bicycle and electric scooter according to safety. The results are presented below (Figure 10).

For both questions, the respondents had chosen a bicycle over an electric scooter as a better one to use and as a safer one. To consider the reasons for this choice, the answers to the next question were presented (Figure 11).

For respondents, bicycles were crucial for sports activities (454 responses). Besides, they thought that bicycles were easier to use (281 responses) and easier to transfer between the

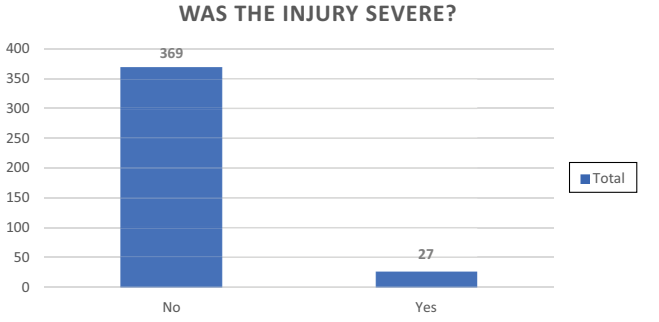

Figure 7. Respondents with severe injuries after the accident
Source: Author's own work

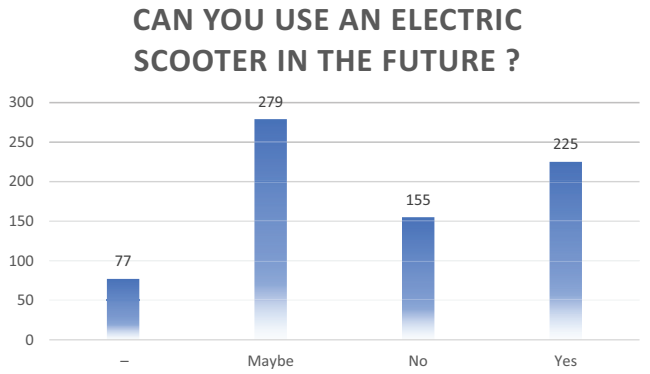

Figure 8. Possible usage of electric scooters in the future
Source: Author's own work

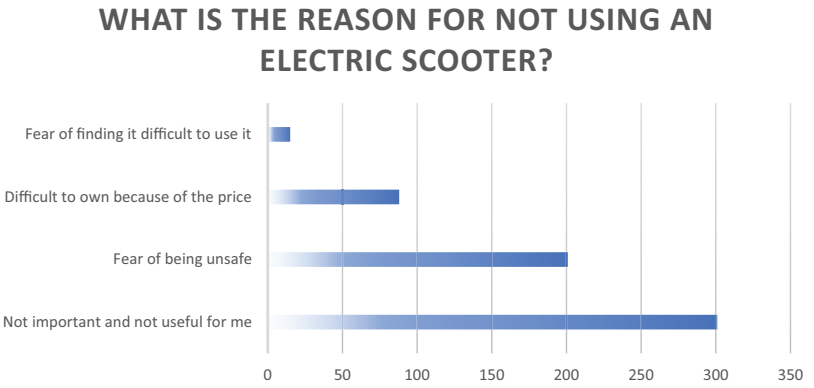

Figure 9. Reasons for not using an electric scooter
Source: Author's own work

street and sidewalk (224 responses). In general, these reasons were related to lack of activity while using electric scooters and less controllability over the electric scooter.

Respondents were asked to specify the advantages and disadvantages of using electric scooters. The results can be seen in the following figure (Figure 12).

Among all the advantages mentioned in this survey question, respondents estimated its easiness as the most important reason. However, previously, we had seen that bicycles were easier to use. So, the respondents compared electric scooters to other ways of transportation except for the bicycle. Another important advantage was the reduction of environmental pollution caused by cars. That is true for electric scooters as they work on electrical rechargeable batteries. The least important advantage was saving the money spent on refueling. Probably respondents were more interested in keeping the environment safe rather than saving money by using electric scooters.

However, most of the people did not consider electric scooters as a safe means of transportation (420 responses). Moreover, people were worried about the injuries that may

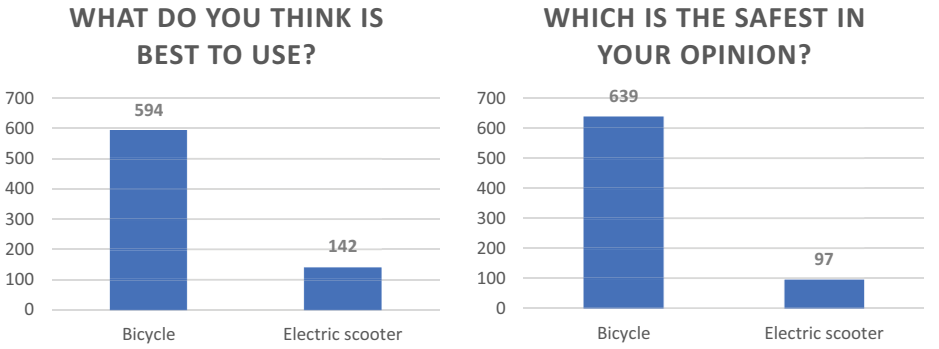

Figure 10. Comparison of bicycles and electric scooters
Source: Author's own work

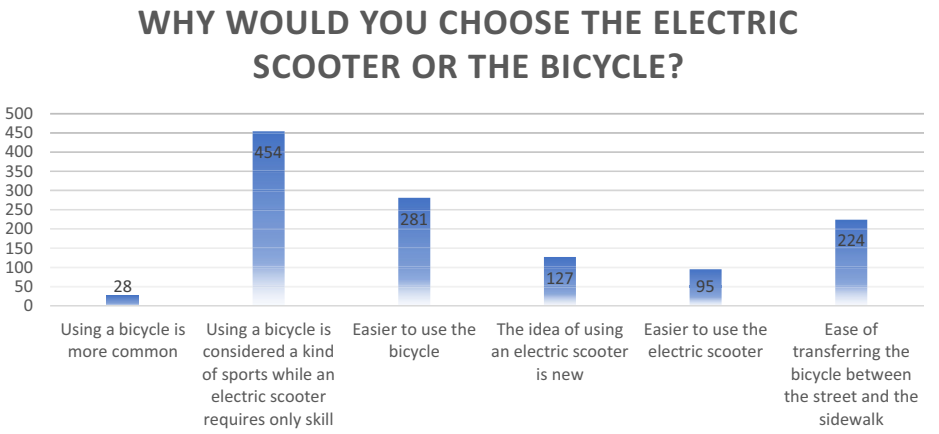

Figure 11. Reasons for choosing an electric scooter or bicycle
Source: Author's own work

arise during the accident. Both disadvantages are related to the number of accidents that happen to electric scooter drivers. We highlighted two main problems that people may face while using electric scooters during the curfew and asked for the respondents' opinions about that as well (Figure 13).

As a result, people were choosing the absence of eligibility on Kuwait streets for usage of electric scooters as a more important problem in comparison with the danger of using the scooters at night. The final question was about the solution to the disadvantages that had been mentioned before (Figure 14).

The best solution that was proposed by the respondents was the allocation of special lanes for electric scooters in the streets (670 responses out of 736). This solution will solve the problem of accidents with cars and pedestrians since electric scooters will not be driven either on sidewalks or on roads together with cars. This will increase the safety of the usage of electric scooters and solve the problem of injuries since fewer accidents will happen, which will probably just happen between two scooters.

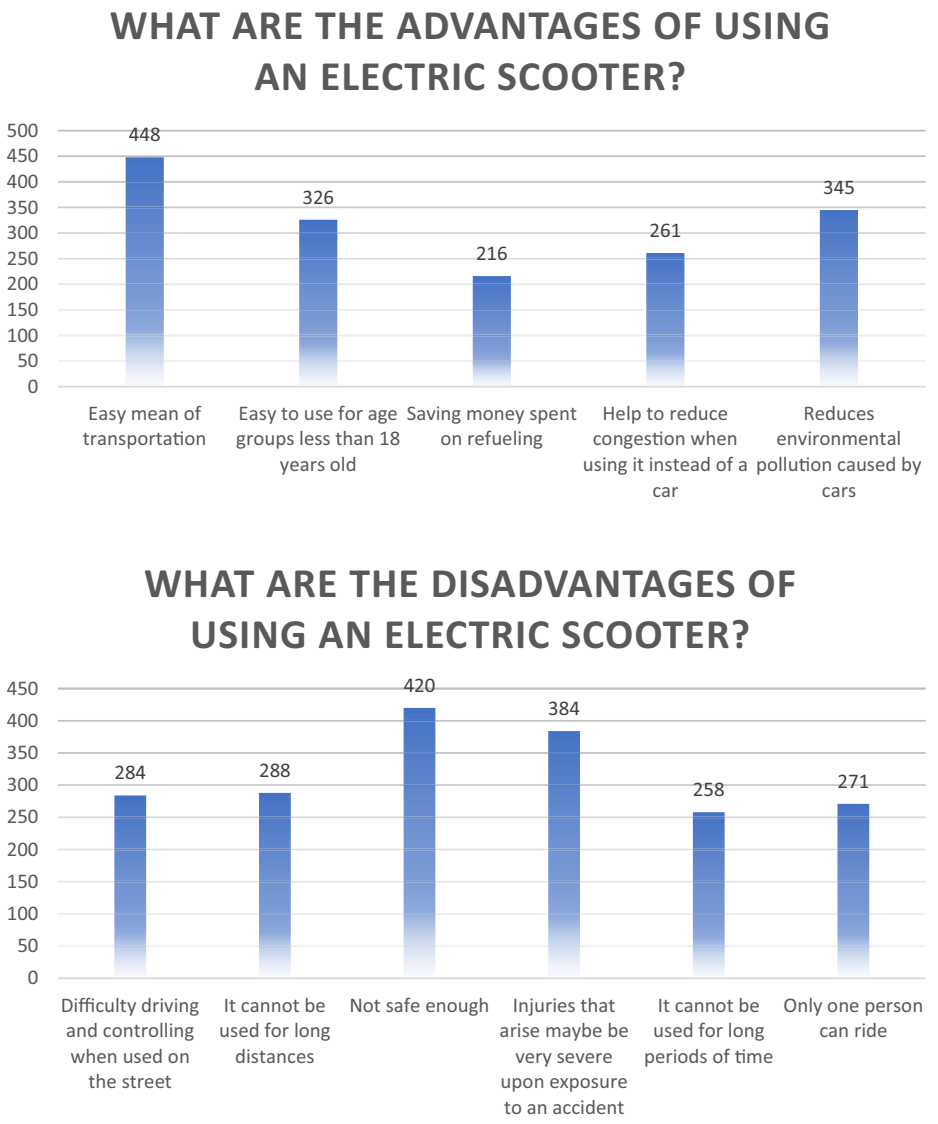

Figure 12. Advantages and disadvantages of electric scooters
Source: Author's own work

4.2 Model estimation results

Logistic regression has been used to identify the factors that have an impact on the probability of an accident. This is important for policymakers to understand the most relevant parameters to scooter transport safety in Kuwait to take proper actions to reduce the risk of crashes. First, all of the variables had been recoded into dummy ordinal numeric variables. The presence of

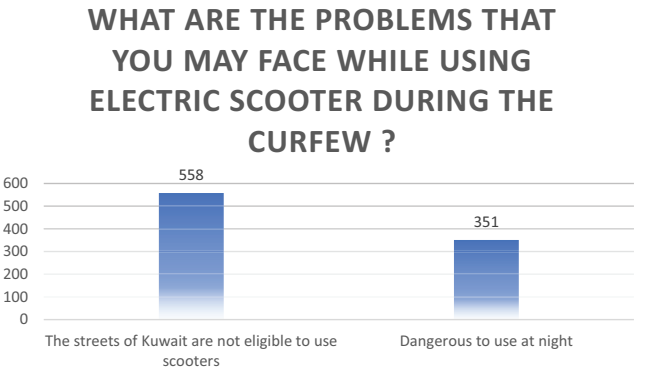

Figure 13. Problems that people may face while using electric scooters during the curfew
Source: Author's own work

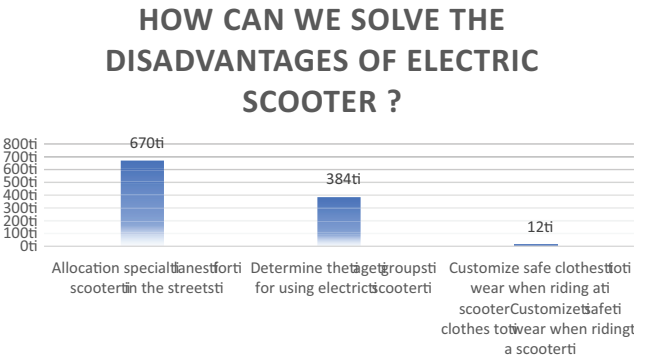

Figure 14. Solution for electric scooters' disadvantages
Source: Author's own work

an accident had been chosen as a dependent variable, while the independent ones were gender, age, education, whether the person had used an electric scooter and when, what the person had chosen as the best and safest means of transportation, and the cause of an accident. As a result, the estimation of the model looks as follows (Table 1).

Now, we can analyze the fitting of the model and interpret its results. First, we can see that only such variables as age, usage of the scooter, choice of safest means of transportation and reason for an accident, "the cause of another party," were significant, while other variables were insignificant in the model. As for the statistical significance of the variables, all of the mentioned variables were significant at a 1% significance level, except for the reason for the accident, which was significant only at 5%. Let's consider each of the significant variables separately. Age had a negative impact on the probability of an accident. The negative coefficient of −0.559 for this predictor suggested that all other variables were equal. Older people were less likely to have an accident. A unit increase in the age group reduces the log odds by 0.559. It was quite understandable since

Table 1. Model estimation results

Variable	Coefficient*
Intercept	−1.892
Gender	−0.182
Age	−0.559***
Education	0.349
Used the scooter	3.409***
When used	−0.131
Best use	−0.623
Safe use	0.999***
Reason of accident: problems on the street surface	0.043
Reason of accident: scooter damage	−0.890
Reason of accident: the cause of another parties	−1.357**
Reason of accident: unable to use it	−0.455
McFadden *R*-squared	0.342

Note(s): ***1% significance level; **5% significance level and *10% significance level
Source(s): Author's own work

older people had more experience in driving electric scooters compared to younger people, who were expected to have accidents more often.

The usage of scooters had a positive impact on the probability of an accident. The positive coefficient of 3.409 suggests that all other variables being equal, those people who had used an electric scooter were more likely to have an accident. This is a logical conclusion, as the person cannot have an accident without driving an electric scooter, only being hit by an electric scooter. Since it is a dummy variable, usage of the scooter increased the log odds by 3.409.

There was an unpredicted result for the choice of safe transport. This variable had a positive coefficient, which means that all other variables being equal, those people who had chosen an electric scooter as the safer option in comparison with a bicycle were more likely to have an accident. As it is a dummy variable as well, the choice of scooter being the safest transport increased the log odds by 0.999. So, we can doubt the safety of this kind of transportation. However, such results can be explained by common sense: those people who had chosen bicycles as the safest option probably did not drive electric scooters, so they did not have accidents on them.

Among all the reasons, one reason had been excluded from the model in order not to have a multicollinearity problem. Nevertheless, only one reason had a significant impact on the probability of an accident, which was the cause related to other parties. The negative coefficient of −1.357 suggests that all other variables being equal, those people who had an accident because of another party were less likely to have an accident. From this, we can conclude that the accidents with the inclusion and caused by another party were less likely to appear. In general, the model did not have a good predictive quality, since the McFadden *R*-squared was pretty low, which was 0.342. It was related to the statistically significant omitted factors that can be included in the model as well. However, our goal was to estimate the model based on the results of the survey, which had been successfully achieved.

5. Solution

The last question of the survey conducted in terms of this research was devoted to the solution that was necessary to be taken to solve the disadvantages of electric scooters. As a result, most of the respondents voted for the allocation of special lanes for electric scooters in

the streets. There were a few reasons that can be considered for the implementation of this solution. First of all, providing the external space for the e-scooters will make the businesses strive. Evidence suggests that people who use two-wheeled vehicles spend more money in local shops than users of most other modes of transportation, so no doubt improving town centers and high streets with special lanes for e-scooters can boost retail sales by up to 30% [3]. Moreover, such a solution may boost the e-scooter business itself. There is a high probability that the unsafety of this transport stops some people from renting electric scooters and driving them. With the appearance of special lanes, the issue of safety will move for the better, allowing people to be more secure in this kind of transportation.

Besides, the e-scooter lane allows more people to travel in less time while reducing traffic congestion. The inefficient use of road space caused by too many automobiles transporting one or two passengers has been worsening congestion in most of Kuwait with the steady increase of its population. Building e-scooter lanes to allow more people to substitute some vehicle trips with two-wheeled transport is the solution, not the cause, of traffic congestion. In the modern situation with the COVID-19 pandemic, the lane creation will also allow people to provide a new and safe method of transportation instead of public transport, providing social distancing in this case. It is crucial, especially because of the high demand for e-scooters after the beginning of the COVID-19 pandemic.

Despite all these reasons, the main reason to create the lane for e-scooters is the safety of both drivers and pedestrians. According to research titled *Route Infrastructure and the Risk of Bicyclist Injuries* [4], special lanes for bikes enhanced safety and reduced injuries by 89%. The same can be expected in terms of e-scooters. For those, who drive the scooter for the first time, it relieves one more stress when driving. Also, it can help alleviate road congestion by causing delays if an electric scooter has an accident. Unfortunately, there are no statistics about the number of accidents with electric scooters in Kuwait. However, the actions of the Kuwaiti Government to ban this kind of transport can tell us that the problem of accidents exists. Therefore, this solution should be taken.

For the creation of special lanes for electric scooters, two places were chosen. The first location was at Jaber Bridge (the full name is Sheikh Jaber Al-Ahmad Al-Sabah Causeway), on which the scooter lane will replace the right-hand safety lane. This bridge is located in Kuwait, in the Middle East. It is a super-sea-crossing bridge constructed in Kuwait's Gulf. Kuwait City and Madinat al-Hareer are connected by this construction. This bridge had been chosen due to the beautiful view and the location away from residential areas. Currently, the bridge looks as follows (Figures 15 and 16).

The total length of the bridge is 30.1 miles or 48.5 km. The bridge itself consists of two smaller bridges, which are 15 meters wide.

As can be seen, each bridge has three lanes of traffic in addition to the safety lane. Each lane has an approximate width of 3.2–3.7 meters. For the calculation of the new plan, the following numbers have been taken into account. The automobile lanes were taken as an average, which was 3.4 meters long, the safety lanes were 2.4 meters long and the barriers between the two-way streets were 0.6 meters long. There are six lanes for automobiles in total and four lanes for safety on the roadway. As a result, the overall width was calculated as follows.

Equation (3): Calculation of Jaber Bridge width:

$$3.4 * 6 + 2.4 * 4 + 0.6 = 30.6 \text{ meters} \tag{3}$$

Since there are four safety lanes, it had been assumed that one of them could be turned into a lane for scooters. If we divide the width of one safety lane, which is 2.4 meters, into two

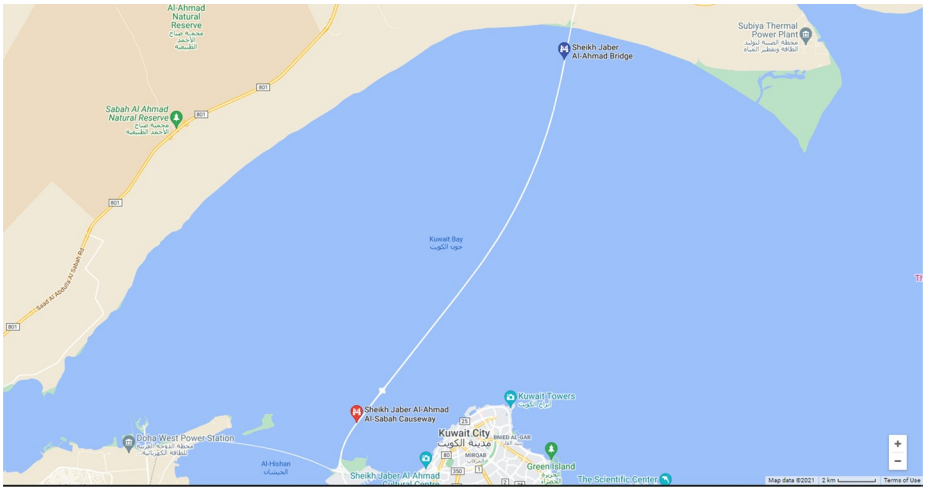

Figure 15. Jaber Bridge
Source: Google Maps

Figure 16. Jaber Bridge lanes
Source: Talal (2019)

sections for electric scooters to move back and forward, the width of one lane will be 1.2 meters, which is the minimum appropriate width for the bicycle lane. As we compare e-scooters to bicycles as analogies, the same rules may be implemented to scooters as well. As a result, the new plan with the inclusion of an electric scooter lane will look as follows (Figure 17).

As can be seen, the total width of the bridge, as well as the distance between bridges, remained the same. The number of traffic lanes on both sides remained the same as well. The lanes have been left untouched since the main purpose of this bridge is to ease the existing traffic congestion. The change can be seen on the right side of the diagram, where the electric scooters' lanes are shown. The green arrows are showing the direction of the movement.

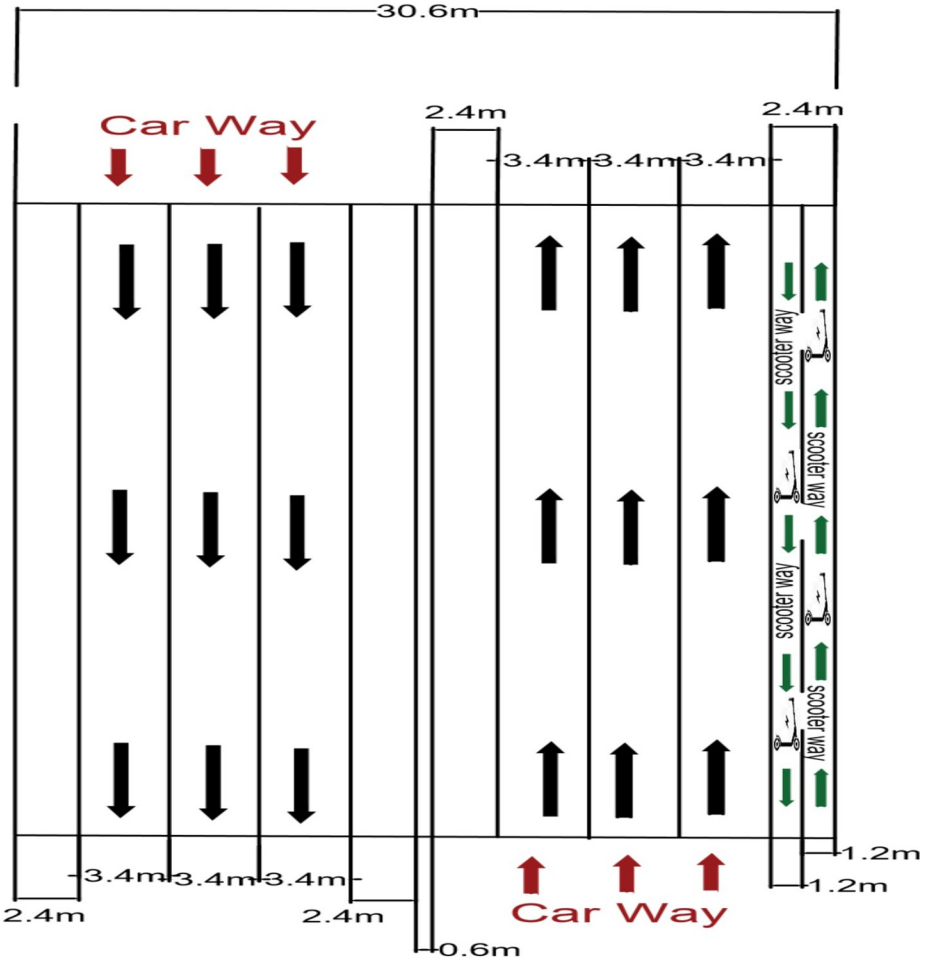

Figure 17. Jaber Bridge plan with inclusion of electric scooters' lane
Source: Author's own work

It is expected that such a change of the safety lane will not affect the safety of drivers and their passengers since one safety lane on this part of the bridge still exists. Besides, in cases of emergency, the drivers always give way to the ambulance, police, firemen and other services. In case of serious need, when the bridge is fully loaded and these services cannot pass the cars, cars will be able to enter the line for electric scooters. However, we do not see this as a necessity at the moment, because such congestion on the bridge has been met only once when it had been first opened. Following this situation, the General Traffic Department intensified vigilance to confront and punish lawbreakers, as well as to deal with the huge number of cars driving over the bridge or stopping and impeding traffic [5]. Therefore, the problem of full congestion should not arise.

Implementation of the above solution may also bring advantages to the economy of the country from tourists. This place can become a new sightseeing place for tourists who wish to rent an electric scooter and see the view from the bridge. However, the disadvantage is existing as well. Thus, the average electric scooter can ride 48 km or 30 miles with a full charge. Since the length of the bridge is 30.1 miles or 48.5 km, the full charge of the electric scooter will not be able to drive all this distance. Thereby, it is necessary to put a warning sign in the middle of the bridge or even two signs closer to the beginning and end of the bridge, which will warn about the full bridge length and the necessity to check the power of the electric scooter, so it is enough to return from the bridge.

The second place that had been chosen for the introduction of the electric scooter lane was an internal street, which was Salem Sabah Al-Salem Al-Sabah Street. We would like to replace the sidewalk between the two streets with a scooter lane with a sidewalk barrier on both sides to keep scooter riders safe from vehicles. Many restaurants, stores and business structures are located on this roadway. Electric scooters may be used for short distances, as the street is significant with its surrounding locations that suit the demands of the people.

We aim to apply the leasing concept in such streets, especially following the COVID-19 epidemic and the partial curfew in Kuwait, as well as the suspension of all recreational activities, scooter use has grown across all age groups. The pandemic has led to an increase in prices, as this idea is suitable for people who cannot afford scooters. Methods of creating electric scooter lanes suggest dividing scooter lanes from automobile lanes, as has been done by many nations across the world, to minimize the number of accidents. Besides, we would like to use a different surface than the street to avoid the problem of gravel flying in Kuwait, to prevent injuries to scooter riders and to minimize the number of accidents caused by street difficulties.

The characteristics of the streets were taken according to the following parameters. It was expected that the lanes would be 3.5 meters wide (this width had been taken from a search on Google about the lanes of Kuwait streets). Also, in reality, the distance between the two streets was 4 meters. Therefore, the total width of the street had been calculated based on the following formula.

Equation (4): Calculation of Salem Sabah Al-Salem Al-Sabah Street width:

$$3.5 * 6 + 3 + 0.5 * 2 = 25 \text{ meters} \tag{4}$$

Based on the above characteristics, the new plan for this street, with the inclusion of an electric scooter lane, is presented below (Figure 18).

So, the plan shows that the electric scooters' lane is located right in the middle of the street instead of the sidewalk that has been there before. The scooter lane had been assumed to be 3 meters wide on the street where the project was located, and 0.5 meters had been left in the scooter lane to separate it from the automobile lanes. This section can be equipped with

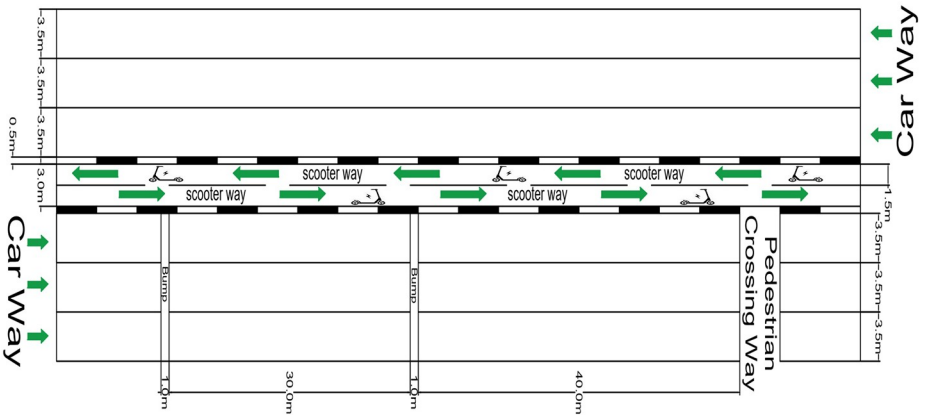

Figure 18. Salem Sabah Al-Salem Al-Sabah street plan with the inclusion of electric scooters' lane
Source: Author's own work

protective poles. When dividing these 3 meters into two lanes for different directions of movement, the width of one lane was equal to 1.5 meters, which was more than the minimum allowed width taken into consideration for Jaber Bridge. The direction of movement was shown with green arrows. Two bumps were placed at a 30-meter distance from each other for the cars to slow down before the pedestrian crossing way. A pedestrian crossing path 40 meters away from the hump had been created as well. The pedestrian crossing route was created to securely cross the street from the lease site to the scooter lane. Such a solution is expected to bring to the local shop additional sales, based on the arguments about the purchase behavior of e-scooter drivers presented before. Moreover, it will allow people to abandon public transport during the period of the COVID-19 pandemic to reach their favorite shops, restaurants and other places. For both implementations, it is necessary to consider the type of road surface and what materials it consists of to provide the safest area for electric scooters. Since an electric scooter is an analogy to a bicycle, the types of surfaces for bike lanes are discussed.

The classification of pavement type can be presented as follows:

- Unsurfaced granular.

An unsealed granular or gravel lane may be considered as the first stage of a route's development, particularly where: the volume of cyclists initially expected to use the bikeway is low; gradients are relatively flat (i.e. 3%); the area's environmental amenity may be reduced by a surfaced bikeway; and construction costs must be kept to a minimum. This option does not fit the required safety of the road; therefore, such pavement cannot be used.

- Granular with sprayed treatment.

Before applying a sprayed seal surface, one or more granular layers are put and compacted. Sprayed seals, while regarded as a viable surfacing option for bicycles, are less favored than concrete or asphalt because of their rougher or more changeable surface roughness.

- Granular with bituminous slurry surfacing.

Before priming and surfacing with a slurry or micro-surfacing, one or more granular layers are put and compacted. Surface cracking and loss of form in slurry and micro-surfacing can be triggered by soil movements, as well as temperature and aging impacts. In the case of a bridge, such a surface is not appropriate for long-term usage.

- Granular with asphalt.

Before priming and surfacing with hot mixed asphalt layers, one or more granular layers are put and compacted. Asphalt paths are also prone to surface cracking and loss of form as a result of soil movements, as well as temperature and age impacts, making them unsuitable for the suggested solution.

- Concrete.

A low-strength granular subbase layer supports a high-strength cement-bound base layer with a textured surface in these pavements. In Australia, there are several varieties of concrete road pavements, the most prevalent of which is a jointed unreinforced (plain) concrete pavement (PCP). In the eastern USA, a version of this with continuous mesh reinforcement within the concrete foundation slab is typical for bikeways. Both of these options are considered preferable ones in terms of electric scooter lanes since concrete with any type of reinforcement provides long-term performance.

- Concrete block pavers.

For a variety of road and path pavements, interlocking concrete block pavers of various kinds are used. They are frequently chosen for their visual appeal and put in high-traffic local recreational areas. Because of the chamfered edges, concrete block pavers are typically inappropriate in this situation.

- Colored pavements.

The use of oxides and pigments added to the topping mix can be used to color concrete pavements for a restricted spectrum of colors. This option can be used as well to have a visually colorful road, but it is not necessary and adds additional costs to the solution. Based on the types presented above, it can be concluded that the best option for surface construction is the use of concrete with either reinforcing bars or reinforcing mesh. Since the location of one of the lanes will be on the bridge, which is located above the water, there is a high probability of corrosion of metal reinforcement inside of the concrete. The analogy of steel reinforcement is fiberglass reinforcement, which is lighter than metal but has better tensile strength and noncorrosive characteristics. This material will be the best fit for the surface of the bridge.

Even though the introduction of the special lanes was the result of the survey during the COVID-19 lockdown, the need for such lanes in the postpandemic period is even more important. This is evident from our experience in the field where the extensive traffic congestion that came after the reopening of sectors after Corona on roads represents a major risk to scooter users. This also can be touched by our interviews and talking to scooter users where their intentions and preferences regarding the existence of such special lanes after the Corona period.

6. Discussion

The usage of e-scooters as a regular mode of transportation in Kuwait still needs a lot of work to reach the level of usage in developed countries. Many obstacles still face the adoption of

such flexible transport services. Among these is the development of infrastructure (highways, special lanes, signage, charging stations […] etc.) to allow safe usage of scooters. The unprecedented daily traffic jams on Kuwait roads make using such transport methods dangerous. Furthermore, the development of traffic regulations related to the usage of scooters on highways is also needed. Much awareness is also needed for the public on the proper usage and where to use such devices, as sometimes you can see some users driving scooters on freeways. Benefiting from regional and international experiences in using scooters can also help in enhancing the situation in Kuwait. Encouraging certain types of businesses to use scooters for delivery of short-distance requests can help reduce car usage and indirectly encourage people to use them.

7. Conclusions

This research studied the implementation of electric scooters in Kuwait, their advantages and disadvantages, problems that may occur concerning them and possible solutions to such problems. Throughout the study, various theoretical and empirical works were analyzed to understand the topic and identify gaps in the research field. In the literature review section, the definition and implementation of electric scooters were discussed globally and particularly in Kuwait, as well as the profile of electric scooter drivers, the reason for using them and the occurrence of accidents and injuries. Based on the literature analysis, it was decided to create a survey to analyze reasons, opinions and demographic characteristics related to e-scooter usage. Additionally, logistic regression was chosen as the model to analyze the collected data, with a binary dependent variable indicating whether an accident occurred with an electric scooter. As a result, the survey counted 20 questions, which were presented in both English and Arabic languages. A total of 736 responses were collected.

From the visual analysis, several conclusions were made. Regarding the demographic characteristics, most of the respondents were females (78% compared to 22% for males), with half of the respondents belonging to the age group from 21 to 29 years old (51%). The most frequent educational level that was met in the data was university (88%). Most males and females had not used the electric scooters. In turn, those who had tried the scooters drove it during the COVID-19 pandemic. Most of the people used fun and entertainment as a reason to use electric scooters (420 out of 736 or 57.1%), while only 39 of them used delivery methods as a reason (5.3%). In total, 16% of respondents had experienced an accident while using an electric scooter. Most of these accidents were related to problems on the street surface. In total, 27 respondents suffered severe injuries. Since many respondents were either willing to use e-scooters in the future or undecided, the target audience for proposed solutions remains significant.

Those people who did not use the scooters explained it by the absence of importance and usefulness. For both better and safer usage, the respondents chose bicycles over electric scooters and explained the necessity to do sports while going with this way of transportation. Advantages and disadvantages of electric scooters have been discussed with respondents as well. Thus, among all the advantages mentioned in this survey question, respondents estimated its easiness as the most important reason, while unsafety had been mentioned as a disadvantage. To choose the solution implemented in this research, respondents were asked two more questions. Of the problems that appeared due to e-scooters, people chose the absence of eligibility on Kuwait streets for usage of electric scooters as a more important problem in comparison with the danger of using the scooters at night. Finally, among all the offered solutions, respondents had chosen the allocation of special lanes for electric scooters in the streets as the best one, which after that had been proposed by this research.

Additionally, by using logistic regression, the determinants of accident probability were identified. As a result, age, usage of scooters, opinion about safety and presence of another party had a significant impact on the probability of an accident. However, the quality of the estimated model was quite low.

The proposed solution for the introduction of specified lanes for scooters has been discussed in detail. The solution was suggested to be implemented in two areas: Sheikh Jaber Al-Ahmad Al-Sabah Causeway due to its sightseeing view and Salem Sabah Al-Salem Al-Sabah Street due to the location of restaurants, shops and businesses on this street. For both areas, new plans with the inclusion of an electric scooter lane have been presented. Since there were four safety lanes on Jaber Bridge, it had been assumed that one of them could be turned into a lane for scooters. For the Salem Sabah Al-Salem Al-Sabah Street, the sidewalk between the two streets was proposed to be replaced with a scooter lane with a sidewalk barrier on both sides to keep scooter riders safe from vehicles. Regarding the surface of these lanes, concrete with reinforcement had been chosen as the best option among all the variants of pavement surface. These solutions were profitable for the economics of Kuwait and disadvantages can be solved with them.

To better enhance sustainable mobility and ensure safe e-scooter adoption, different plans should be taken into consideration. One of these plans is Infrastructure improvements like improving designated e-scooter lanes, enhancing roads and merging micromobility with local transport can enhance wider adoption between people. Also, some of the regulations, such as speeding limits, wearing helmets and riding restrictions, can help mitigate safety risks. A safer environment for e-scooters can also be achieved through rider awareness programs that emphasize road-sharing manners and rider education. By implementing some of these measures alongside the proposed dedicated lanes, e-scooters can be developed into a practical and secure mode of transportation, which would help Kuwait create a more sustainable urban mobility framework.

While this study provides valuable insights into e-scooter usage and accidents in Kuwait, it has some limitations. The logistic regression model applied in this research had a few numbers of predictors, which could have influenced the model's overall explanation power. Additionally, due to some restrictions on resources and time, this research is especially interesting to study in the urban areas of Kuwait, possibly neglecting differences in accident rates between suburban and rural locations.

For future research, individual factors can be analyzed separately and selected more carefully to enhance the model. This approach could improve both the model's accuracy and the significance of the contributing factors. Also, future research could be expanded to have a data set including more comprehensive factors, such as road conditions, weather variables and traffic patterns. Besides, the demographic analysis of the research showed that the distribution of different age groups, education levels and genders was not evenly spread. Therefore, another potential direction for future research could be the collection of more normally distributed data with better control over the data collection process.

Despite the above-mentioned limitations, the purpose of the research was achieved. The study successfully analyzed e-scooter usage to identify accident cases, determined the factors influencing the likelihood of an accident, and proposed a solution to address the issue where accidents are a significant concern. The proposed solution can be implemented by the Government of Kuwait to lift the ban on electric scooters, allowing their use while promoting safety. This could benefit both businesses related to the electric scooter industry and Kuwait's economy.

Our future work focuses on collecting more data on scooter usage, operations, potential benefits, challenges and risks in Kuwait, as well as using advanced statistical tools for

analysis to draw robust conclusions and recommendations for this promising industry. Additionally, it may be useful to categorize the data based on time periods – such as before, during and after COVID-19 – using either the same or different variables to create three separate models. This approach may provide a clearer understanding of how key factors have evolved over these distinct periods.

Notes

1. Use of electric scooters – the latest trend in Kuwait. Available at: www.zawya.com/mena/en/life/story/Use_of_electric_scooters__the_latest_trend_in_Kuwait-SNG_188716299/
2. Kuwait bans electric scooters on public roads. Available at: https://gulfnews.com/world/gulf/kuwait/kuwait-bans-electric-scooters-on-public-roads-1.74972848
3. Six reasons to build cycle lanes. Available at: www.cyclinguk.org/article/six-reasons-build-cycle-lanes
4. Four benefits of adding protected bike lanes that may surprise you. Available at: www.terracastproducts.com/4-benefits-adding-protected-bike-lanes-may-surprise/
5. Traffic Department increases vigilance on Jaber Bridge. Available at: www.arabtimesonline.com/news/traffic-department-increases-vigilance-on-jaber-bridge/

References

Abduljabbar, R.L., Liyanage, S. and Dia, H. (2021), "The role of micro-mobility in shaping sustainable cities: a systematic literature review", *Transportation Research Part D: Transport and Environment*, Vol. 92, p. 102734.

Abdullah, M., Dias, C., Muley, D. and Shahin, M. (2020), "Exploring the impacts of COVID-19 on travel behavior and mode preferences", *Transportation Research Interdisciplinary Perspectives*, Vol. 8, p. 100255.

AlKheder, S. and Albaghli, Z. (2024), "Identifying barriers and benefits of shared e-scooters in promoting sustainability in Kuwait using Delphi and force field analysis methods", *Journal of Engineering Research*, doi: 10.1016/j.jer.2024.02.010.

AlRukaibi, F., AlKheder, S. and AlMashan, N. (2020), "Sustainable port management in Kuwait: Shuwaikh port system", *The Asian Journal of Shipping and Logistics*, Vol. 36 No. 1, pp. 20-33.

Alrukaibi, F., Alsaleh, R. and Sayed, T. (2019), "Applying machine learning and statistical approaches for travel time estimation in partial network coverage", *Sustainability*, Vol. 11 No. 14, p. 3822.

Austin Public Health (2019), "Dockless electric scooter-related injuries study", Austin, TX: Austin Public Health, available at: www.austintexas.gov/sites/default/files/files/Health/Web_Dockless_Electric_Scooter-Related_Injury_Study_final_version_EDSU_5.14.19.pdf

Badeau, A., Carman, C., Newman, M., Steenblik, J., Carlson, M. and Madsen, T. (2019), "Emergency department visits for electric scooter-related injuries after introduction of an urban rental program", *The American Journal of Emergency Medicine*, Vol. 37 No. 8, pp. 1531-1533.

Bai, S. and Jiao, J. (2020), "Dockless E-scooter usage patterns and urban built environments: a comparison study of Austin, TX, and Minneapolis, MN", *Travel Behaviour and Society*, Vol. 20, pp. 264-272.

Brown, A., Klein, N.J., Thigpen, C. and Williams, N. (2020), "Impeding access: the frequency and characteristics of improper scooter, bike, and car parking", *Transportation Research Interdisciplinary Perspectives*, Vol. 4, p. 100099.

Burke, S. and Kaplan, M. (2019), "The product is banned in some cities. The company is valued at $2 billion. 2018", available at: www.money.cnn.com/2018/07/09/technology/bird-valuation/index.html (accessed 11 January 2019).

Campisi, T., Kuşkapan, E., Çodur, M.Y. and Dissanayake, D. (2024), "Exploring the influence of socio-economic aspects on the use of electric scooters using machine learning applications: a case study in the city of Palermo", *Research in Transportation Business and Management*, Vol. 56, p. 101172.

Cherry, C. and Cervero, R. (2007), "Use characteristics and mode choice behavior of electric bike users in China", *Transport Policy*, Vol. 14 No. 3, pp. 247-257.

Choron, R.L. and Sakran, J.V. (2019), "The integration of electric scooters: useful technology or public health problem?", *American Journal of Public Health*, Vol. 109 No. 4, p. 555.

Christoforou, Z., Gioldasis, C., de Bortoli, A. and Seidowsky, R. (2021), "Who is using e-scooters and how? Evidence from Paris", *Transportation Research Part D: Transport and Environment*, Vol. 92, p. 102708.

Eccarius, T. and Lu, C.C. (2020), "Adoption intentions for micro-mobility–insights from electric scooter sharing in Taiwan", *Transportation Research Part D: Transport and Environment*, Vol. 84, p. 102327.

Fitt, H. and Curl, A. (2019), "E-scooter use in New Zealand: insights around some frequently asked questions", Retrieved August 21, 2020.

Gao, J., Lee, C.D., Ozbay, K., Zuo, F. and Chippendale, T.L. (2023), "Understanding the travel challenges and gaps for older adults during the COVID-19 outbreak: insights from the New York city area", *Transportation Research Interdisciplinary Perspectives*, Vol. 19, p. 100815.

Gaspar, R.M., Prasetyo, Y.T., Mariñas, K.A., Persada, S.F. and Nadlifatin, R. (2023), "Exploring consumers' intention to use bikes and E-Scooters during the COVID-19 pandemic in the Philippines: an extended theory of planned behavior approach with a consideration of Pro-Environmental identity", *Sustainability*, Vol. 15 No. 6, p. 5193.

Gitelman, V., Pesahov, F., Carmel, R. and Chen, S. (2017), "Exploring the characteristics of potential and current users of mobility scooters, among older people in Israel", *Transportation Research Part F: Traffic Psychology and Behaviour*, Vol. 46, pp. 373-389.

Hall, M. (2018), "Bird scooters flying around town", Santa Monica Daily Press, available at: www.smdp.com/bird-scooters-flying-around-town/162647, Published 26 September 2017 (accessed 13 September 2018).

Hardt, C. and Bogenberger, K. (2019), "Usage of e-scooters in urban environments", *Transportation Research Procedia*, Vol. 37, pp. 155-162.

Ishmael, C.R., Hsiue, P.P., Zoller, S.D., Wang, P., Hori, K.R., Gatto, J.D., … Bernthal, N.M. (2020), "An early look at operative orthopaedic injuries associated with electric scooter accidents: bringing high-energy trauma to a wider audience", *Journal of Bone and Joint Surgery*, Vol. 102 No. 5, p. e18.

Javadinasr, M., Asgharpour, S., Rahimi, E., Choobchian, P., Mohammadian, A.K. and Auld, J. (2022), "Eliciting attitudinal factors affecting the continuance use of e-scooters: an empirical study in Chicago", *Transportation Research Part F: Traffic Psychology and Behaviour*, Vol. 87, pp. 87-101.

Jiao, J. and Bai, S. (2020), "Understanding the shared E-scooter travels in Austin, TX", *ISPRS International Journal of Geo-Information*, Vol. 9 No. 2, p. 135.

Jobe, J. and Griffin, G.P. (2021), "Bike share responses to COVID-19", *Transportation Research Interdisciplinary Perspectives*, Vol. 10, p. 100353.

Lee, M., Chow, J.Y., Yoon, G. and He, B.Y. (2021), "Forecasting e-scooter substitution of direct and access trips by mode and distance", *Transportation Research Part D: Transport and Environment*, Vol. 96, p. 102892.

Lee, C., Lee, S., Sizemore, M., Jung, I., Jang, B.J. and Huh, J. (2024), "Micromobility sharing's effects on economic activities for sustainable development: accessibility, mobility, and connectivity. mobility, and connectivity".

Li, A., Zhao, P., Haitao, H. and Axhausen, K.W. (2021), "Understanding the variations of micro-mobility behavior due to COVID-19 in Switzerland", *100th Annual Meeting of the Transportation Research Board (TRB 2021), IVT, ETH Zurich*.

Lock, O. (2020), "Cycling behaviour changes as a result of COVID-19: a survey of users in Sydney, Australia", *Findings*.

McKenzie, G. (2019), "Spatiotemporal comparative analysis of scooter-share and bike-share usage patterns in Washington, DC", *Journal of Transport Geography*, Vol. 78, pp. 19-28.

Mathew, J.K., Liu, M. and Bullock, D.M. (2019), "Impact of weather on shared electric scooter utilization", *2019 IEEE Intelligent Transportation Systems Conference (ITSC), IEEE*, pp. 4512-4516.

Mayhew, L.J. and Bergin, C. (2019), "Impact of e-scooter injuries on emergency department imaging", *Journal of Medical Imaging and Radiation Oncology*, Vol. 63 No. 4, pp. 461-466.

Mehranfar, V. and Jones, C. (2024), "Exploring implications and current practices in e-scooter safety: a systematic review", *Transportation Research Part F: Traffic Psychology and Behaviour*, Vol. 107, pp. 321-382.

Moran, M.E., Laa, B. and Emberger, G. (2020), "Six scooter operators, six maps: spatial coverage and regulation of micromobility in Vienna, Austria", *Case Studies on Transport Policy*, Vol. 8 No. 2, pp. 658-671.

Royal Australasian College of Surgeons (2019), "Australian injury prevention network. Joint response between RACS and the AIPN to the national transport commission issues paper: barriers to the safe-use of innovative vehicles and mobility devices", available at: www.surgeons.org/

Statista (2023), available at: www.statista.com/outlook/mmo/motorcycles/scooters/kuwait (accessed December 2023).

Störmann, P., Klug, A., Nau, C., Verboket, R.D., Leiblein, M., Müller, D., Schweigkofler, U., Hoffmann, R., Marzi, I. and Lustenberger, T. (2020), "Characteristics and injury patterns in electric-scooter related accidents-a prospective two-center report from Germany", *Journal of Clinical Medicine*, Vol. 9 No. 5, p. 1569, doi: 10.3390/jcm9051569, PMID: 32455862; PMCID: PMC7290505.

Talal (2019), "Sheikh Jaber causeway: a bridge towards Kuwait's bright future - Talal, Kuwait times", available at: www.kuwaittimes.com/sheikh-jaber-causeway-a-bridge-towards-kuwaits-bright-future/

Tan, S., Fang, K. and Lester, T.W. (2023), "Post-pandemic travel patterns of remote tech workers", *Transportation Research Interdisciplinary Perspectives*, Vol. 19, p. 100804.

Trivedi, T.K., Liu, C., Antonio, A.L.M., Wheaton, N., Kreger, V., Yap, A., Schriger, D. and Elmore, J.G. (2019), "Injuries associated with standing electric scooter use", *JAMA Network Open*, Vol. 2 No. 1, p. e187381, doi: 10.1001/jamanetworkopen.2018.7381, PMID: 30681711; PMCID: PMC6484536.

Tsai, C.C., Huang, H.C. and Lin, S.C. (2010), "Adaptive neural network control of a self-balancing two-wheeled scooter", *IEEE Transactions on Industrial Electronics*, Vol. 57 No. 4, pp. 1420-1428.

Tuli, F.M., Nithila, A.N. and Mitra, S. (2023), "Uncovering the spatio-temporal impact of the COVID-19 pandemic on shared e-scooter usage: a spatial panel model", *Transportation Research Interdisciplinary Perspectives*, Vol. 20, p. 100843.

Tuncer, S., Laurier, E., Brown, B. and Licoppe, C. (2020), "Notes on the practices and appearances of e-scooter users in public space", *Journal of Transport Geography*, Vol. 85, p. 102702.

Vorina, A., Čakš, G. and Županec, J. (2019), "Green transport – the usage of electric scooter for public transport in towns".

Weinert, J., Ogden, J., Sperling, D. and Burke, A. (2008), "The future of electric two-wheelers and electric vehicles in China", *Energy Policy*, Vol. 36 No. 7, pp. 2544-2555.

Yang, Y. and Lewis, R. (2023), "Sustaining multimodal choices: examining travel behavior for non-work trips beyond COVID-19".

Younes, H., Zou, Z., Wu, J. and Baiocchi, G. (2020), "Comparing the temporal determinants of dockless scooter-share and station-based bike-share in Washington, DC", *Transportation Research Part A: Policy and Practice*, Vol. 134, pp. 308-320.

Further reading

Cycling UK (2025), "Six reasons to build cycle lanes. Six reasons to build cycle lanes", available at: www.cyclinguk.org/article/six-reasons-build-cycle-lanes

Ramadan Al Sherbini, C. (2020), "Kuwait bans electric scooters on public roads", Kuwait – Gulf News, available at: www.gulfnews.com/world/gulf/kuwait/kuwait-bans-electric-scooters-on-public-roads-1.74972848

TerraCast Products (2021), "4 Benefits of adding protected bike lanes that may surprise you", available at: www.terracastproducts.com/4-benefits-adding-protected-bike-lanes-may-surprise/

Times, A. (2019), "Traffic department increases vigilance on Jaber Bridge", ARAB TIMES - KUWAIT NEWS, available at: www.arabtimesonline.com/news/traffic-department-increases-vigilance-on-jaber-bridge/

ZAWYA MENA Edition "Use of electric scooters – the latest trend in Kuwait", available at: www.zawya.com/mena/en/life/story/Use_of_electric_scooters__the_latest_trend_in_Kuwait-SNG_188716299/

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