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Temporal Shifts in E-Scooter Rider Perspectives: A Longitudinal Investigation in Riyadh, Saudi Arabia

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Abstract: Shared electric scooters (e-scooters) have rapidly gained prominence as a first/last-mile mobility solution globally, with over 66,000 systems operating in 88 cities across 21 countries in 2019. While recognized for their flexibility, accessibility, and environmental benefits, concerns such as safety, parking issues, and infrastructural challenges accompany the operation of shared e-scooter systems. This research investigates the evolving perceptions of e-scooter users in Riyadh, Saudi Arabia, comparing pre-survey results with a recent study following the official deployment of e-scooters as a transportation mode in 2022. The analysis reveals significant shifts in user behavior, preferences, and perceptions. The findings indicate increased familiarity with e-scooters, heightened usage rates, and notable changes in domestic e-scooter use. Furthermore, the study identifies variations in willingness to use e-scooters across genders. A notable shift is observed in riders' perceptions, transforming from viewing e-scooters primarily as entertainment tools to embracing them as a reliable mode of transportation. The results show that the percentage of female respondents using e-scooters increased from 3% to 13%, representing over four times the post-survey numbers. Additionally, the percentage of individuals perceiving e-scooters as safe decreased from 28.2% in the pre-survey to 14.9% in the current survey (post-survey) among those who had used e-scooters. The regression analysis demonstrates a historical uptrend in the utilization of e-scooters, juxtaposed with a discernible decline projected for forthcoming usage (odds ratio [OR] = 0.74). Intriguingly, there is evidence indicating an enhancement of riders' confidence towards e-scooters, as reflected by an augmented perception of safety (OR = 1.48).

Keywords: riders' perspective; shared mobility; micro-mobility; public transportation

Citation: Almannaa, M.; Alyahya, A.; Ashqar, H.I.; Elhenawy, M. Temporal Shifts in E-Scooter Rider Perspectives: A Longitudinal Investigation in Riyadh, Saudi Arabia. *Sustainability* **2024**, *16*, 3759. https://doi.org/10.3390/su16093759

Academic Editors: Socrates Basbas and Andreas Nikiforiadis

Received: 22 January 2024
Revised: 19 April 2024
Accepted: 23 April 2024
Published: 30 April 2024

1. Introduction

Shared electric scooter (e-scooters) systems have extensively emerged as a first/last-mile mobility solution in many cities around the world. It was estimated that there were more than 66,000 shared e-scooter systems operating in 88 cities across 21 countries in 2019 [1]. Figure 1 shows a representative image of a shared e-scooter. As the demand for shared e-scooter systems is rapidly growing globally, various consecrations are correlated with operating these systems. On the one hand, shared e-scooter systems are considered to be flexible, accessible, convenient, environmentally friendly, sustainable, and relatively cheap [2–4].

On the other hand, there are various issues that accompany operating shared e-scooter systems in many areas, including safety concerns, parking e-scooters everywhere in dockless systems, insufficient storage spaces, no specific scooter lanes, and the redistribution problem of e-scooters [2,5].

Figure 1. Shared e-scooter [1].

Electric scooters can be frequently used for varied purposes such as recreational, commuting, and solving the first/last-mile problem, and shared e-scooter systems are associated with socioeconomic, demographical, and infrastructural factors [4,6–9]. Limited studies have been found that investigate the perception of shared e-scooter pilot systems in various cities and university campuses. The findings of these pre-surveys indicate that shared e-scooter pilot systems are intended to fill in a gap in the existing transportation supply sub-system [4,6–9]. Specifically, in [4], a pre-survey was conducted in 2020 to investigate the feasibility of introducing shared e-scooter systems as part of the transportation system in Riyadh, Saudi Arabia. Such systems may face challenges in Saudi Arabia, including the relatively high temperature, cultural barriers, insufficient infrastructure, and a lack of related polices and regulations that govern the use of e-scooters. The survey participants were asked several questions regarding social and demographic impact, experience evaluation, readiness to use and possible intention, safety of shared e-scooter systems, COVID-19 impact, and where preferably such systems can be used. The results indicated that about 73% of the respondents were willing to use shared e-scooter systems once they were introduced. Among them, 75% suggested that the most functioning places for electric scooters would be malls and open entertainment areas. The findings also indicated that insufficient infrastructure, safety, and high temperatures were the primary hindrances to introducing shared e-scooter systems. In terms of the COVID-19 effect, more than 50% of the respondents claimed that COVID-19 would have a negligible impact on their willingness to use such systems. Building on the abovementioned pre-survey, this study conducted a post-survey among riders and non-riders in the city of Riyadh, Saudi Arabia, to investigate their perception after deploying officially more than 25 shared e-scooter systems. The results of this study were compared with the pre-survey published in [4] to capture the changes in behavior and preferences after officially deploying electric scooters as an alternative transportation mode. The post-survey's sample was comparable with the pre-survey's sample, and it had 464 respondents. The analysis shows that the comparison of the two surveys reveals several notable shifts among respondents' perceptions in Riyadh. These shifts include increased familiarity with electric scooters, an increase in electric scooter usage, significant changes in domestic electric scooter usage, and variations in willingness to use electric scooters across genders. For example, the percentage of female respondents who had used electric scooters showed a significant increase from 3% to 13%, which is more than four times the post-survey.

2. Literature Survey

Most electric scooter studies have focused on one or more of the following various topics that are related to electric scooters:

1. Motivations for riding electric scooters, sociodemographic and perceptions of electric scooters, and riders and non-riders;
2. Route choice of electric scooter riders;
3. Travel behavior, safety concerns, and interactions with other road users;
4. Environmental impacts of electric scooter sharing systems.

To determine the obstacles and advantages of using electric scooters among professionals, Sanders et al. surveyed 1256 university workers in Tempe, Arizona, in the United States [3]. They found that electric scooters are preferred by both genders and people of all ages and races/ethnicities. Electric scooters are mostly praised for their comfort and capacity to travel farther than walking without using a vehicle; they are also typically seen as entertaining to ride. Few benefits were judged to vary considerably by sociodemographic group, indicating that electric scooters might help meet urban mobility needs. The study also discovered two main obstacles to using electric scooters. The first obstacle is the electric scooter availability problem, in terms of where they are available, when they are available, and where riders need them. The second obstacle concerns rider safety because of a lack of safe areas to ride, feeling shaky while riding, and worrying about being hit by a vehicle. Contrary to the anticipated advantages, there were gender differences in several barriers to using electric scooters, notably those that dealt with safety.

Kang, Seongmin et al. conducted a study in Seoul, Korea, that investigated how to improve convenience and safety in electric scooter sharing (ESS) services [10]. They used a latent class model to identify characteristics that affect consumers' decisions and willingness to pay (WTP) for particular features, such as real-time driving information and an exclusive e-scooter lane, with exclusive lanes significantly increasing WTP. The study emphasizes how sociodemographic factors influence the choice of ESS by affecting characteristics including maintenance, docking station parking methods, and service cost. The survey indicates that consumers are willing to pay more for items that improve convenience and safety. In order to finance these upgrades and increase effectiveness, user satisfaction, and the broader uptake of ESS systems, it suggests a model of public–private cooperation.

Laa and Leth's study in Vienna, Austria, examines the socioeconomic profiles and usage behaviors of e-scooter users, distinguishing between renters and owners [7]. Through online surveys and field observations, they find that e-scooter users in Vienna are predominantly young, male, highly educated residents. Importantly, the study highlights significant differences in usage between private scooter owners and users of sharing schemes, suggesting a potential shift from private car trips, particularly among owners. These findings underscore the importance of urban policies that prioritize safe and convenient cycling infrastructure to accommodate the growing demand for e-scooters while promoting sustainable and equitable urban transport systems.

Christoforou et al. defined micromobility and presented findings from a road survey of e-scooter users in Paris, revealing that they predominantly consist of young, highly educated men who seldom own their own e-scooters [11]. Despite not being less motorized than the general population, e-scooter users primarily use them for occasional trips, motivated by time savings, playfulness, and potential cost reductions, with a notable shift from walking and public transportation.

Nikiforiadis et al. conducted a study in Thessaloniki, Greece, involving 578 questionnaires to explore e-scooter usage patterns and user characteristics [12]. They employed a classification tree model to identify factors attracting people to e-scooters and a latent variable logit model to understand regular e-scooter users' attributes. The findings suggest that shared e-scooters primarily replace walking and public transport trips, raising questions about their environmental benefits, and reveal gender and geographical disparities in usage, providing valuable insights for urban policymakers.

Foissaud et al. analyzed the spatiotemporal dynamics of e-scooter trips across four European cities, Paris, Malaga, Bordeaux, and Hamburg, utilizing GPS data combined with user bank card registration information [13]. The findings reveal consistently low riding frequencies and vehicle turnover rates, with average trip distances of around 4.5 miles and durations of approximately 12 min. Tourists constitute a significant portion of e-scooter users, typically riding during the daytime over longer distances but at slower speeds, with peak usage observed in the afternoon across all cities, particularly in downtown and waterfront areas with accessible soft mobility infrastructure, indicating predictable usage patterns, notably for commuting purposes.

Lee et al. examined the factors influencing individuals' intention to use e-scooter sharing (ESS) services in Seoul, Korea, employing a latent class adjacent-category ordinal logit model [14]. The findings revealed two distinct groups of respondents: one preferring ESS for commuting and the other for first-mile and last-mile trips. The characteristics associated with each group indicated that younger, higher-income individuals less satisfied with public transportation tended towards commuting, highlighting the influence of trip purpose and public transportation quality on ESS usage preferences among various sociodemographic groups.

Campisi et al. explored participants' perceptions regarding factors influencing gender balance in e-scooter usage through an online survey conducted in Catania and Palermo, Sicily [15]. Utilizing an ordinal regression model, they identified age, occupation, and perceived safety of micromobility modes as key factors impacting gender equality. The study emphasizes the importance of considering gender perspectives in mobility planning and suggests that addressing safety concerns and tailoring services to accommodate diverse demographics can contribute to narrowing the gender gap in e-scooter usage. This research underscores the necessity of conducting gender impact assessments in transportation interventions and recommends coherent policy measures to promote gender equality in micromobility services.

Mura et al. integrated various aspects of e-scooter research into a cohesive framework, particularly focusing on safety, user preferences, and infrastructure considerations [16]. Through surveys and analyses, they found that e-scooters are generally perceived differently from bicycles, especially in natural light conditions, with younger individuals showing more awareness and preference for e-scooters. Additionally, the study highlights the need for further research to understand e-scooter dynamics, infrastructure interactions, and user behavior for the development of comprehensive policies and transportation systems.

A stated choice experiment (SCE) was created using a d-efficient strategy and given to students (n = 1968) at Portland State University (PSU) [17]. The survey discovered that electric scooters are not seen as the best way to solve the first-mile/last-mile issue.

Gössling examined the challenges surrounding the implementation of e-scooters in ten major cities by analyzing local media reports (n = 173) retrieved from various sources [18]. The study identified concerns expressed both before and after the introduction of e-scooters and contextualized them within evolving policy frameworks. The findings highlight the iterative nature of policy development in response to emerging issues, emphasizing the importance of implementing regulations regarding maximum speeds, designated infrastructure, parking regulations, and limiting the number of operators to mitigate negative public perceptions, ultimately suggesting that e-scooters have the potential to revolutionize urban transportation if managed effectively.

Zhang et al. collected data using GPS installed on electric scooters operating on Virginia Tech's campus. Then, they modeled 2000 randomly sampled electric scooter trajectories to understand riders' route choices [19]. The analysis revealed that electric scooter users prefer shorter and simpler routes. However, they are willing to travel long distances to ride on bikeways (59% longer), multi-use paths (29%), tertiary roads (15%), and one-way roads (21%). Furthermore, since electric scooters are powered by electricity, the road's gradient does not affect the chosen route.

Zakhem and Smith-Colin developed the Micromobility Guidance Tool (MGT) that aims to enhance e-scooter safety and compliance in urban settings by guiding users along optimal routes that prioritize safe infrastructure and nearest parking [20]. The tool was demonstrated in Dallas, TX, and effectively showed an increase in the usage of safer paths and reduced violations, showcasing a scalable solution for cities to manage shared e-scooter services more effectively.

Reck et al. presented a methodological framework for modeling and analyzing competition and mode choice in shared micromobility systems using accessible vehicle location data [21]. Their study, utilizing the largest shared micromobility dataset to date, identified nested mode choices primarily driven by distance and time of day, with docked modes preferred for commuting. They highlighted the importance of docking infrastructure to enhance micromobility as a viable alternative to private cars, particularly during rush hours, and revealed a relationship between fleet density and usage, suggesting opportunities for evidence-based regulation and fleet optimization by city authorities and service providers, respectively.

Kazemzadeh et al. thoroughly evaluated peer reviewed electric scooter safety studies, giving transportation the first consideration and medical research domains the secondary consideration [22]. Their findings indicate that studies are needed to understand how electric scooters interact with other road users and develop surrogate safety measures for electric scooters. Finally, they found that head and facial injuries are the most frequent injury categories for electric scooter riders.

Kleinertz et al. screened the electronic patient records of emergency department admissions in Germany for electric scooter-associated injuries between June 2019 and December 2021 [23]. They found 268 cases, most of which were riders, and 6% were involved in crashes associated with an electric scooter. They found that the majority of electric scooter riders' injuries occur in the head or face.

Kappagantu et al. found that common types of electric scooter-related head and neck injuries include the following [24]:

- Concussions;
- Skull fractures;
- Brain bleeds;
- Facial fractures;
- Lacerations.

Sandt et al. used data from emergency rooms in North Carolina, and an investigation of injuries from e-scooters showed clear demographic differences between e-scooter users and other users, like cyclists and walkers [25]. In order to determine the extent of e-scooter injuries among people in locations with e-scooter individuals aged 14 to 59, the study manually analyzed 487 emergency department visit records. For comparison, injury records from 1440 pedestrians and 1581 cyclists from the same places and times periods were looked at. The results demonstrated considerable differences in age, sex, race, and insurance type between e-scooter users and cyclists as well as between pedestrians. In contrast, there were no appreciable variations in terms of resident status or race. Injury cases involving e-scooters were less likely to involve drug or alcohol intoxication than those involving bicycles (6.5%) and pedestrians (10.3%). In addition, e-scooter users were less likely than users of other modes to be engaged in auto accidents, more likely to fall and become injured, less likely to need to be admitted to the hospital once an ambulance arrives, and more likely to pay for their own injuries out of pocket or through Medicaid.

In a retrospective analysis, Baca et al. evaluated the medical records of patients who were hospitalized between June 2021 and January 2022 to an emergency orthopedic department of a level three trauma center in Turkey due to fractures or dislocations [26]. According to the study, e-scooter accidents are more likely than other fracture types to result in severe fractures and dislocations that need surgical intervention. In particular, it was noted that e-scooter accidents are more likely to result in lower extremity injuries than falls, especially when they include collisions with moving or stationary objects. This

study emphasizes how important it is to have better safety protocols in place to reduce the possibility of serious accidents when using e-scooters.

In order to prevent accidents and injuries, Kazemzadeh et al. emphasized the urgent need for more research into the safety aspects of e-scooters [22]. They also stressed the significance of adopting safety measures, understanding interactions with other road users, and putting standard legislation in place. This implies that among e-scooter users engaged in crashes, head and facial injuries are the most frequent, highlighting the lack of uniform standards as a major obstacle to safe adoption. The results highlight the need for standardized safety equipment standards and steps to avoid operating an e-scooter while intoxicated in order to improve safety.

Janikian et al. reviewed the literature from 2017 to 2022 and summarized safety concerns about e-scooter use, concentrating on risky behaviors, environmental issues, and e-scooter dependability [27]. The lack of helmet use, the effects of alcohol, and other risky behaviors are highlighted, coupled with problems like poor lighting and mechanical breakdowns. The study promotes safety-enhancing measures, such as stronger laws governing the usage of helmets, addressing alcohol-related dangers, and enhancing the design of e-scooters and their riding environment to lessen injury risks.

Piatkowski, Timothy et al. conducted nineteen interviews with people who had gone to the emergency room because they had been injured in an e-scooter accident [28]. The study investigates the psychological effects of e-scooter injuries and finds that they cause major disruptions to life, alter people's perceptions of e-scooters as dangerous, and advocate for more safety regulations. In order to reduce the risks connected with alcohol use, participants recommended tactics such as safety education, pre-ride briefings, real-time guidance, and preventive measures like breathalyzers before use. The results emphasized the necessity of all-encompassing public health initiatives to encourage appropriate e-scooter use and improve overall public safety.

3. Methodology

3.1. Dataset

A digital survey was carried out in Riyadh, Saudi Arabia. This survey has 18 questions more than the pre-survey conducted in [4], and it is divided into two main areas, which are mobility and electric scooter perception (33 questions) and socioeconomic and demographic (10 questions), as shown in Table 1. Forty-three inquires were divided into the following four sections: Section one collects demographic data from respondents; Section two explores the past experiences of electric scooter riders; Section three delves into readiness to use and the possible purposes of new electric scooter riders; and Section four encompasses overall inquiries about the safety and challenges associated with electric scooter sharing systems, the influence of COVID-19, and possible locations for electric scooters in the Kingdom of Saudi Arabia. It also includes new questions regarding the interests of local authorities, which discuss the potential policies of electric scooter systems and new suggested regulations with regard to safety and efficiency.

Table 1. Survey.

No.	Section One
1	Citizenship
2	Marital Condition
3	Age
4	Sex
5	Place of residence in Riyadh *
6	Professional occupation
7	Monthly Income

Table 1. *Cont.*

8	Education background
9	How often do you workout?
10	Car ownership
11	Do you utilize cab-hailing apps? (Uber, Careem, etc.)?
12	Do you regularly ride a bicycle?
13	Do you regularly ride a motorcycle?
14	Have you ridden an electric scooter?
	Section Two (if answered "Yes" to Q.14)
15	Where did you utilize electric scooter?
16	What was the reason for using electric scooters?
17	Did you find any difficulties finding a shared electric scooter close to your location? *
18	Did you use it on the sidewalk or on the road? *
19	Approximately, how long was the trip on the shared electric scooter? *
20	Do you think it is necessary to allocate parking spaces for the sharing scooter instead of leaving it free to park? *
21	Have you experienced a close-call incident while riding an electric scooter?
22	Have you experienced a crash while riding an electric scooter?
23	Have you ever been more than one person on one scooter during a trip? *
	Section Three (if answered "NO" to Q.14)
24	In case if you come across an electric scooter, will you choose to use it?
25	What would be the intent behind using it?
	Section Four
26	Does it annoy you when you see the shared electric scooter parked on the sidewalk or pedestrian lanes? *
27	Does it annoy you when you see the shared electric scooter ride on the sidewalk or pedestrian lanes? *
28	Do you feel unsafe when walking or driving in areas where shared electric scooters are being ridden? *
29	Have you ever been involved in a collision with a shared electric scooter while walking or driving a vehicle? *
30	If the companies operating shared electric scooters provided helmets, would you wear them? *
31	Would you opt for a shared electric scooter for transportation, even if the cost of the trip is higher than utilizing cab-hailing apps?
32	Do you plan on purchasing a personal electric scooter for transportation? *
33	Based on your experience using shared electric scooters or watching the previous video, do you consider them to be safe?
34	What are the challenges faced by electric scooter sharing systems launched in Saudi Arabia?
35	Have you ever heard of the term geofence used to limit the movement of a shared scooter on a map? *
36	Do you support the idea of merging all scooter-sharing service applications into a unified platform with other public transportation? *
37	Which of the following payment methods do you prefer when using a shared scooter? *
38	Have you ever seen someone who you thought was under 18 ride a shared scooter? *
39	If personal insurance is offered as a package with additional fees that the shared scooter user can obtain through the application of the company providing the service, would you buy it? *
40	In light of the global spread of the new coronavirus, how does the impact of such transmissible sickness influence your decision to utilize electric scooters?
41	If the agencies managing electric scooters implement safety measures regarding COVID-19, do you believe it will alleviate concerns about using them?
42	**non-mandatory** question: What steps can operators of electric scooter systems implement to alleviate concerns related to infectious diseases?
43	**non-mandatory** question: Which locations would you recommend for the launch of electric scooter systems?

Note: * denotes new questions compared to the previous survey.

Respondents were initially requested to furnish demographic information before indicating their past encounters with electric scooters. Those with prior experience were automatically directed to Section two, while those without experience were directed to Section three. The ultimate section (Section Four) comprises general questions applicable

to all respondents. This study involved a comparable sample size of 464 respondents to the pre-survey's sample size, which was 439 [4]. The determined minimum sample size required to calculate the true population quantity is approximately 385, indicating that both studies had sample sizes exceeding the minimum threshold. This was performed using the following equation [29]:

$$\min \textit{required sample size} = \frac{N \times X}{X + N - 1}$$

where N is the population size (here is 4.7 million), $X = Z_{a/2}^2 \times p \times \frac{(1-p)}{MOE^2}$, $Z_{a/2}$ is the critical value of the normal distribution at $a/2$, MOE is the margin of error, and p is the sample proportion. We should highlight that this sample size is the same as the one obtained using Krejcie and Morgan's formula [30]. The data collection methods for this study remained consistent with the pre-survey ones, utilizing Google Forms and distributing the survey through oral communication and social media. Similar to the pre-survey study, no incentives were offered to participants. Both studies focused exclusively on responses from adults aged 18 and above, ensuring the consideration of responses from the target demographic. When comparing the main demographic characteristics of the respondents (nationality, gender, marriage status, and age) between the post-survey and the pre-survey results, several notable changes are observed (see Table 2). Firstly, the percentage of non-Saudi respondents has more than doubled in the new study. Secondly, the proportion of single respondents has increased by over ten percent compared to the married respondents. Additionally, there has been a decrease in the percentage of individuals aged 31–45 in the new study, which now stands at 33.8%. Conversely, the proportion of participants aged 46–60 has increased to 15.3%. Lastly, most other demographic characteristics remain relatively similar between the two studies.

Table 2. The socioeconomic and demographic traits of the survey participants: pre-survey vs. post-survey.

Category	**Subcategory**	**Percent (%)**	
		Pre-Survey	**Post-Survey**
Citizenship	Saudi	98.4	94.8
	Other nationalities	1.6	5.2
Sex	Man	66.7	68.5
	Woman	33.3	31.5
Martial state	Non-married	34.4	46.9
	Married	65.6	53.1
Age	18–30	48	48.1
	31–45	40	33.8
	46–60	10	15.3
	>60	2	2.8
Monthly income	SAR 3500 (SAR 933) or less	37	49.2
	More than SAR 3500 (SAR 933) and less than SAR 7000 (SAR 1866)	7	7.2
	More than SAR 7000 (SAR 1866) and less than SAR 13,000 (SAR 3466)	15	14
	More than SAR 13,000 (SAR 3466) and less than SAR 20,000 (SAR 5333)	25	13.6
	More than SAR 20,000 (SAR 5333)	16	16

Table 2. *Cont.*

Category	Subcategory	Percent (%)	
		Pre-Survey	**Post-Survey**
Educational background	High School	14	25.2
	Diploma	5	6.3
	Bachelor	55	50.6
	Master	14	10.1
	PhD	12	7.8
Professional occupation	Student	29.8	31
	Employed in the government	41.5	32
	Employed in the private agencies	8.7	15
	Self-employed	5.2	10
	Retired	3.2	5
	Not working	11.6	7
Physical exercise	Everyday	16.2	16.2
	Multiple times a week	36.2	36.4
	Every week	18.2	19.4
	Every month	14.8	12.3
	Never	14.6	15.7
Owns a car	Yes	72.9	75.5
	No	27.1	24.5
Usage of ride-hailing apps	Everyday	1.6	2.8
	Every week	8.0	6.5
	Every month	10.2	6.1
	Rarely	59.0	63.8
	Never	21.2	20.8
Bicycle usage	Regular bike usage	8.0	12.1
	Infrequent bike usage	92.0	87.9
Motorbike usage	Regular motorcycle usage	2.3	2.8
	Infrequent motorcycle usage	97.7	97.2

3.2. Area of Study

The focus of this post-survey is Riyadh city, selected because it corresponds to the city used in the pre-survey. Riyadh, the capital city of the Kingdom of Saudi Arabia, covers a total area of 3115 square kilometers and is elevated 600 m above sea level. Riyadh experiences a hot climate in the summer and a temperate climate in the winter. There are large temperature changes between day and night, According to the General Authority for Statistics Population Study conducted in 2022 (Saudi Census 2022), Riyadh has a population of 7,009,120 people, 21.2% of whom are under the age of 15, 74.7% are between the ages of 15 and 59, and 4.1% are 60 and older. Between 2004 and 2016, the city of Riyadh received around 276,000 internal migrants, the majority of whom came for work (75.4%). The majority of Saudi men typically wear the traditional Saudi garment, the Thobe, characterized by a loose-fitting white dress. However, many also opt for casual and sportswear clothing in non-work settings. Women in Riyadh commonly wear Abayas, loose-fitting garments that cover the body.

4. Results

In this section, we will present the findings of the post-survey, while also drawing a comparison with the results of the pre-survey conducted in 2020. By comparing the results of the post-survey with those of the pre-survey, we aim to identify any significant changes or trends in electric scooter usage and related factors over time. Table 3 presents a comparison of respondents' usage in Saudi Arabia in two surveys (namely pre-survey and post-survey), highlighting important observations. Overall, the comparison of the two surveys reveals several notable shifts in the respondents of electric scooter users. These shifts include increased familiarity with electric scooters, an increase in electric scooter usage, significant changes in domestic electric scooter usage, and variations in willingness to use electric scooters across genders. In particular, first, the percentage of respondents who had never seen an electric scooter decreased significantly from 40% to 10% in the post-survey compared to the pre-survey. In contrast, the percentage of respondents who were familiar with electric scooters but had never used them increased from 42% to 57%. Secondly, the percentage of respondents who had used an electric scooter at least once showed a doubling increase from 8% to 16%. Similarly, the percentage of respondents who had used an electric scooter several times increased from 10% to 17%. Regarding the location of usage, there was a significant shift between the two surveys. In the pre-survey, the majority of respondents (63%) primarily used electric scooters outside Saudi Arabia. However, in the post-survey, the trend reversed, with 59% of respondents primarily using electric scooters within Saudi Arabia. Consequently, the percentage of respondents who primarily used electric scooters outside Saudi Arabia decreased from 63% to 24%. On the other hand, the percentage of respondents who used electric scooters either inside or outside Saudi Arabia increased from 5% to 17%, which is more than three times that in the pre-survey. Furthermore, the percentage of respondents expressing willingness to use electric scooters decreased from 19% to 14%. Conversely, the percentage of respondents stating that they would never use electric scooters increased from 27% to 34%. The percentage of respondents indicating they may use electric scooters remained relatively consistent at 54% and 52% for the two surveys. When analyzing the data by gender, it was found that the willingness of male respondents to use electric scooters decreased from 53% to 38%. However, the percentage of male respondents who had used electric scooters increased from 20% to 30%. Similarly, the willingness of female respondents to use electric scooters decreased from 24% to 19%. However, the percentage of female respondents who had used electric scooters showed a significant increase from 3% to 13%, which is more than four times the pre-survey. These changes may be attributed to the proliferation of electric scooters in Saudi Arabia, particularly in Riyadh, where the number of service providers has expanded from two companies in 2020 to more than 25 companies. This discovery suggests that individuals who have not used electric scooters before are more eager to use them for possible purposes that need to be identified and executed by operating agencies. The subsequent sections delve into a thorough examination of the key findings from the results.

The two surveys in Saudi Arabia aimed to explore the possible purposes of electric scooter use. Respondents were instructed to select multiple answers to indicate the various reasons for their electric scooter usage. As a result, it is important to note that the response rates might not total 100% due to the possibility that respondents can choose multiple purposes. The summarized outcomes regarding the potential uses of electric scooters are presented in Figure 2, which reflects the comparison between the pre- and post-surveys. It is noteworthy that entertainment emerges as the predominant possible intention for using electric scooter sharing systems, as indicated by both the pre- and post-surveys. However, there has been a notable decrease in the percentages for entertainment in the post survey compared to the pre-survey. Specifically, for individuals who have used electric scooters multiple times, the percentage decreased from 93.2% to 51.1%. Similarly, for those who have used electric scooters once, the percentage decreased from 79.4% to 60.4%. Additionally, among individuals who have never used electric scooters but expressed willingness to do so, the percentage decreased from 68.7% to 44.6%. These data suggest

a shift in the perceptions of Saudi people regarding electric scooters, transitioning from primarily considering them as an entertainment tool to embracing them as a new mode of transportation.

Table 3. Previous and potential electric scooters' usage of respondents in Saudi Arabia.

Category	Subcategory	Percent (%)	
		Pre-Survey	Post-Survey
Use of electric scooters	Never encountered an electric scooter	40	10
	Not ridden an electric scooter but seen it	42	57
	Riden electric scooter at least one occasion	8	16
	Riden electric scooter multiple times	10	17
Country for previous usage of electric scooter	Saudi Arabia	32	59
	Other countries	63	24
	Saudi Arabia and other countries	5	17
Readiness to use electric scooter	Would use electric scooter	19	14
	Will not use an electric scooter	27	34
	Might use an electric scooter	54	52
Gender of electric scooter users and potential users	Male will use electric scooter	53	38
	Male used electric scooter	20	30
	Female will use electric scooter	24	19
	Female used electric scooter	3	13

4.1. Safety of Electric Scooters

To gain comprehensive insights into electric scooter safety, we included in both surveys four questions on crucial safety factors, such as near-miss collisions, electric scooter collisions while driving, feeling safe, and safety perception when walking or driving near electric scooters. The results revealed a slight increase in near-miss collisions, reported by 38% and 39% of respondents in the pre- and post-surveys, respectively. However, the percentage of respondents involved in electric scooter collisions while driving decreased from 19% to 14%, although there was an increase in electric scooter's usage in the post-survey. Additionally, the perception of feeling safe increased from 13.7% to 22.2%. In terms of the additional inquiries added for the post-survey, the majority of respondents (67.1%) rode electric scooters alone, while 32.9% rode with others. One of the additional inquiries explored safety perception when walking or driving near electric scooters, with 34.3% of respondents feeling unsafe, 39.2% uncertain, and 26.5% feeling safe. Collision involvement was relatively low, reported by 7.3% of respondents. Regarding helmet usage, 37.3% expressed willingness, 33.6% may consider it, and 29.1% stated they would not wear a helmet. These findings provide valuable insights into various aspects of electric scooter safety and can inform interventions to promote safe usage. Notably, there was a significant flip in safety perception associated with previous usage. The percentage of individuals who regarded electric scooters as safe decreased from 28.2% in the pre-survey to 14.9% in the post-survey among those who had used electric scooters. This shift in perception can be attributed to several factors such as reckless riding by others, lack of proper infrastructure and regularization, and a higher awareness of accidents and injuries which may have contributed to the increased proportion of respondents considering electric scooters to be unsafe. These findings highlight the need for further examination and research to address the evolving perceptions of electric scooter safety.

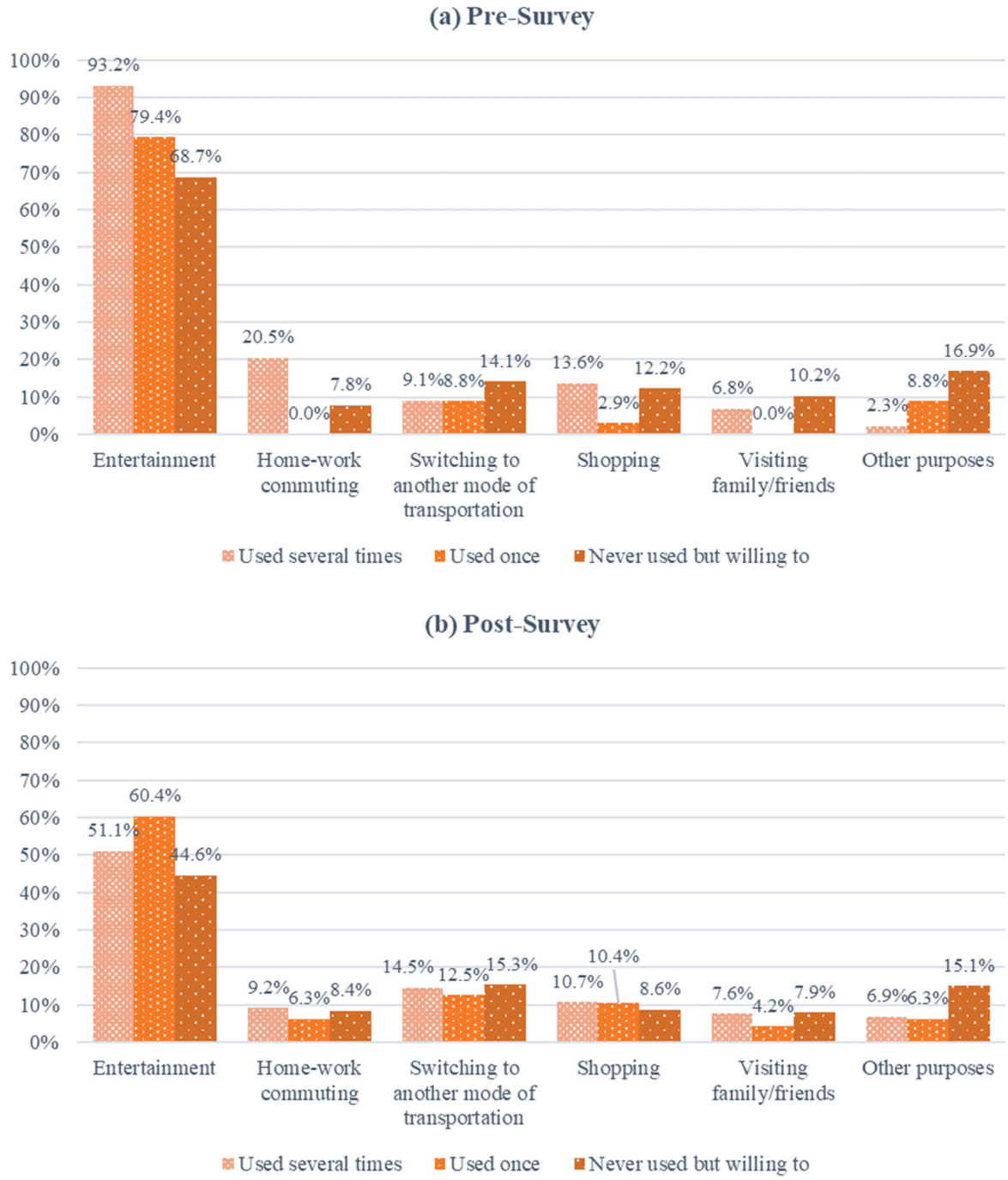

Figure 2. Possible purposes for using electric scooter sharing systems in Saudi Arabia for both surveys.

4.2. Challenges in Implementing E-Scooters

This article investigated the challenges that could hinder the implementation and usage of electric scooter systems. List questions were used to gather data, acknowledging that response rates might not sum up to 100% as respondents could choose more than one option. Both electric scooter users and non-users identified the same obstacles but with a different order. In the pre-survey, the obstacles ranked in the following order: (insufficient infrastructure, weather conditions, safety concerns, low speed, discomfort, satisfaction of needs, culture, and cost), while in the post-survey, the order was as follows: (insufficient infrastructure, weather conditions, safety concerns, discomfort, cost, culture, satisfaction of needs, and low speed) as shown in Figure 3. Additionally, non-users expressed similar expectations regarding these obstacles, albeit with varying response rates. Respondents

were also given the option to add other obstacles, leading to the inclusion of cultural factors such as wearing traditional dresses and the user's age. By comparing the results of the pre-survey conducted in 2020 with the post-survey (current study), it is evident that the major obstacles to the implementation and usage of electric scooters in Saudi Arabia have remained consistent. Insufficient infrastructure continues to be the primary obstacle, with response rates of 70.5% and 58.6% among users and non-users, respectively, in the pre-survey study. In the current study, the percentage of respondents identifying insufficient infrastructure as a major obstacle remained high, with response rates of 70.3% and 69.6% among users and non-users, respectively. This highlights the persistent challenge of inadequate infrastructure for electric scooter operations. While there have been some shifts in the perception of other obstacles, such as safety and cost, it is noteworthy that the infrastructure obstacle remains a significant concern. The comparison of the two studies emphasizes the importance of addressing infrastructure limitations to promote the successful deployment and usage of electric scooters in Saudi Arabia. Efforts should be directed towards developing suitable infrastructure, such as dedicated lanes, charging stations, and secure parking areas, to overcome this major obstacle and ease the integration of electric scooters into the transportation landscape. Moreover, the post-survey results revealed a significant shift in the perception of cost as an obstacle. Among e-scooter users, cost was ranked as the third obstacle out of the nine identified challenges. This finding suggests that as users gained more experience with e-scooters, their perception of cost as an obstacle became more prominent, highlighting its importance in influencing their acceptance and adoption of e-scooter systems. Furthermore, it is noteworthy that low speed has moved from the fourth obstacle in the pre-survey to the last obstacle in the post-survey. This shift indicates that respondents seemed to have a better impression of electric scooters after experiencing them or being exposed to e-scooter riders.

Respondents were not only asked about their usage preferences but also invited to recommend possible places for deploying electric scooter sharing systems. Table 4 provides a detailed breakdown of the recommended places. Interestingly, the table also compares the percentages of respondents for both the post- and pre-survey studies, revealing that the categories remain the same as in the previous study. These categories include open entertainment areas, shopping centers and malls, building complexes, residential areas and compounds, downtown cities, seasonal large events, and other locations like parking lots and stations.

The analysis of the data reveals several interesting findings when comparing pre- and post-survey studies on the perception and usage patterns of electric scooters in Saudi Arabia. The study indicates a shift in usage patterns, with an increased mention of shopping centers and building complexes as potential places for electric scooter usage in the current study likened to the post-survey. This suggests that electric scooters are being recognized as a convenient mode of transportation for accessing commercial and business areas. Additionally, there is a notable focus on downtown areas in the current study, indicating a growing interest in using electric scooters for commuting or exploring city centers. Furthermore, the increased mention of roads as potential places for electric scooter usage in the current study reflects the recognition of electric scooters as a viable means of transportation on urban roads. Notably, the "Other" category saw a significantly higher response rate in the current study compared to the pre-survey, suggesting a greater inclination among respondents to provide additional places beyond the predefined categories where electric scooters could be used. Overall, these findings highlight the evolving perception and increasing acceptance of electric scooters as a versatile mode of transportation across various settings in Saudi Arabia, as observed when comparing the current and pre-survey studies.

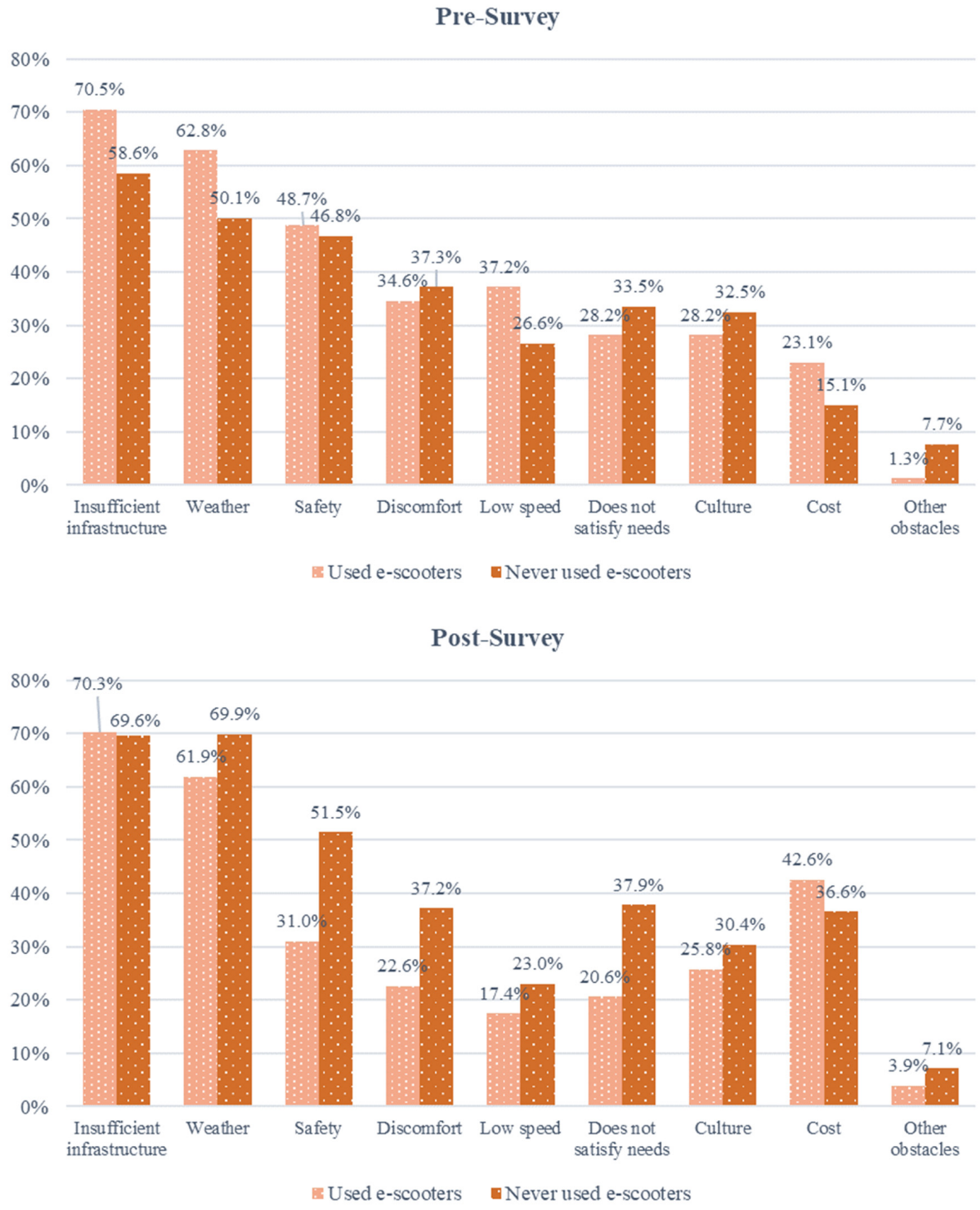

Figure 3. Challenges hindering the use of electric scooters in Saudi Arabia.

4.3. Electric Scooters and Ride-Hailing

This study also aimed to examine the association between ride-hailing apps and electric scooters in Saudi Arabia, building upon a pre-survey study. Consistent with the pre-survey study, approximately 82% of respondents who regularly use ride-hailing apps stated their inclination to utilize electric scooters if available. This indicates a strong preference for electric scooters among ride-hailing app users. However, there was a slight decrease in the willingness to use electric scooters among this group in the current study (post-survey), with around 80% expressing the same inclination. Furthermore, there were slight variations in the percentages for the infrequent usage of ride-hailing apps, with

roughly 77% in the pre-survey study and around 76.8% in the current study, suggesting a similar trend. Economically, the percentage of respondents willing to use ride-hailing apps, although they charge more, decreased significantly from 54% in the pre-survey study to approximately 11% in the current study. Conversely, the percentage of respondents willing to use electric scooters if they cost less increased substantially from 46% in the pre-survey study to around 89% in the current study. These findings highlight the evolving preferences towards electric scooters as a more cost-effective mode of transportation, emphasizing the need for policymakers and industry stakeholders to consider these changing dynamics in Saudi Arabia.

Table 4. Recommended locations for the implementation of electric scooter systems.

Category	Percentage (%)	
	Pre-Survey	**Post-Survey**
Entertainment areas	40.9	33.8
Shopping avenues	26.2	33.1
Residential compounds	21.5	28.8
Residential neighborhoods	12.8	10.8
Downtowns	11.4	17.3
Roads	8.1	12.9
Seasonal big events	4.7	6.5
Outlying areas	4.0	3.6
Other	5.4	13.7

4.4. Electric Scooters and the COVID-19 Effect

As the COVID-19 pandemic persisted and evolved into a deepening global crisis, the debate over the future of transportation remains ongoing. Micro-mobility, including the use of electric scooters, was not spared from the rapid and disruptive changes prompted by this sweeping pandemic. Within the context of Saudi Arabia, a pre-survey was conducted in 2020 during the peak of the pandemic to measure respondents' views of how the COVID-19 pandemic has affected the usage of electric scooters [4]. In this post-survey, the same questions were asked in 2022, and the results for both surveys are depicted in Figure 4. Regarding the effect of fear from COVID-19 on electric scooter usage, the figure reveals notable insights. In the pre-survey, more than 50% of the respondents who had before used electric scooters stated that their usage would decline due to fear. However, in the current study (post-survey), only 19% expressed a decrease in electric scooter usage related to fear. Conversely, the proportion of respondents who believed fear had no effect on electric scooter usage increased from 41% in the pre-survey to 70% in the post-survey. Furthermore, the percentage of respondents suggesting an increase in electric scooter usage due to fear slightly rose from 8% in the pre-survey study to 11% in the current study. In addition to fear, the study also examined respondents' feedback to the application of safety measures to minimize the expansion of COVID-19 on electric scooter systems. Notable changes were observed in this category. The percentage of respondents indicating a decreased usage of electric scooters due to the implementation of precautions has significantly increased from 33% in the pre-survey study to 48% in the current study. Conversely, the proportion of respondents who believed that the precautions had no effect on electric scooter usage has decreased from 51% in the pre-survey study to 34% in the post-survey. There has been a slight rise in the percentage of respondents suggesting increased usage due to the implementation of precautions, from 15% in the pre-survey study to 18% in the post-survey. These findings highlight the evolving perceptions and attitudes towards electric scooter usage in light of the COVID-19 pandemic. As the pandemic gradually recedes, the decreasing fear-related concerns and the implementation of safety precautions may

contribute to shifting patterns in electric scooter usage. Understanding these dynamics is crucial for policymakers and industry stakeholders to adapt their strategies, ensuring a safe and sustainable mobility landscape in Saudi Arabia.

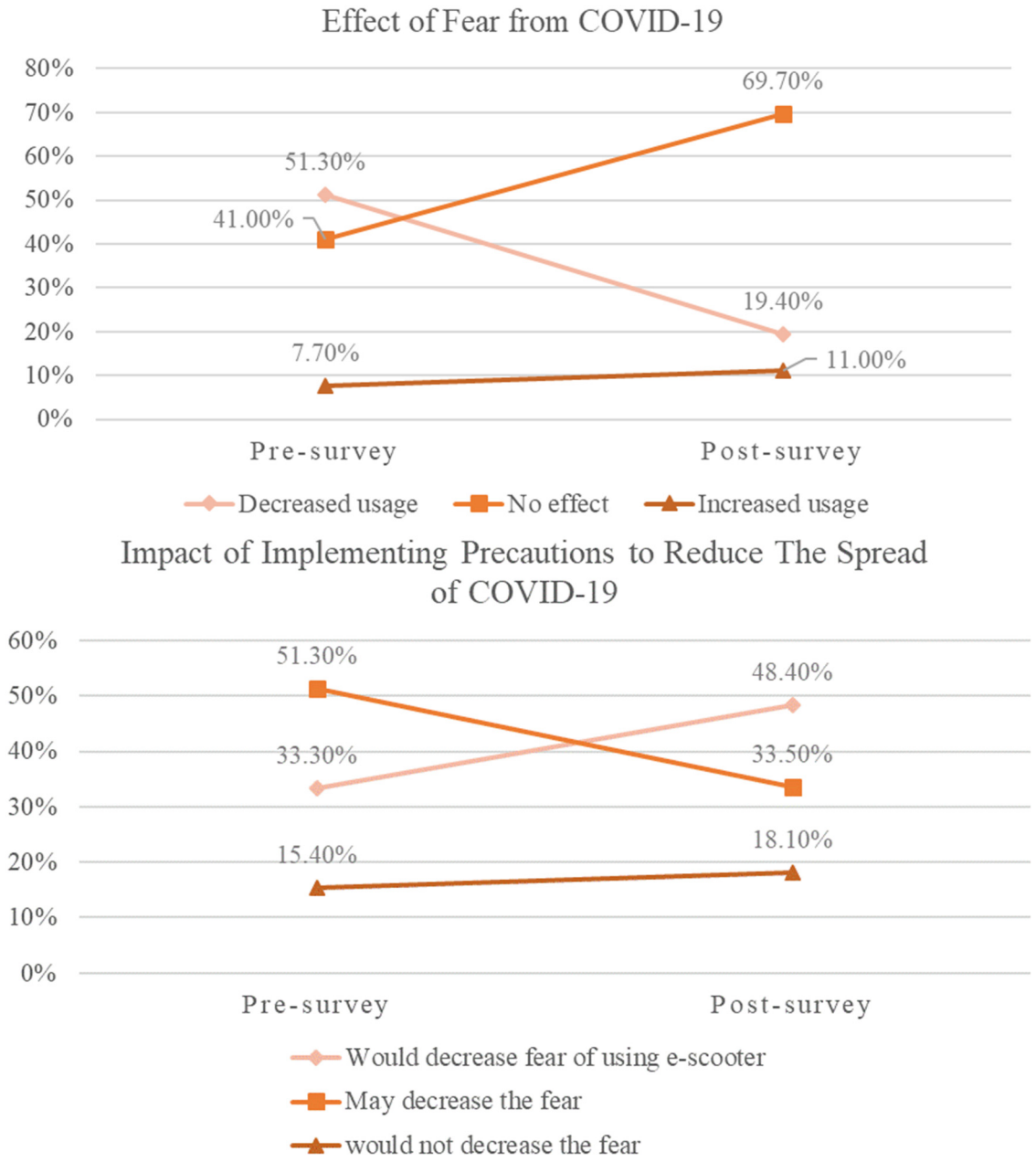

Figure 4. Comparison of both surveys on the impact of COVID-19 on using electric scooters.

In this study, similar to the pre-survey study, respondents were questioned to recommend safety measures for electric scooter operating agencies in order to alleviate the fear about using electric scooters during the COVID-19 pandemic. Recommendations were provided and categorized into five main groups. These suggestions included the provision of sanitizers, such as sprays, for each electric scooter, as well as recommendations for gloves and face masks, one-use covers on holds, and infographics to promote personal hygiene practices and cleanliness. Figure 5 shows a complete breakdown of these suggestions, presenting the results of both the pre- and post-surveys.

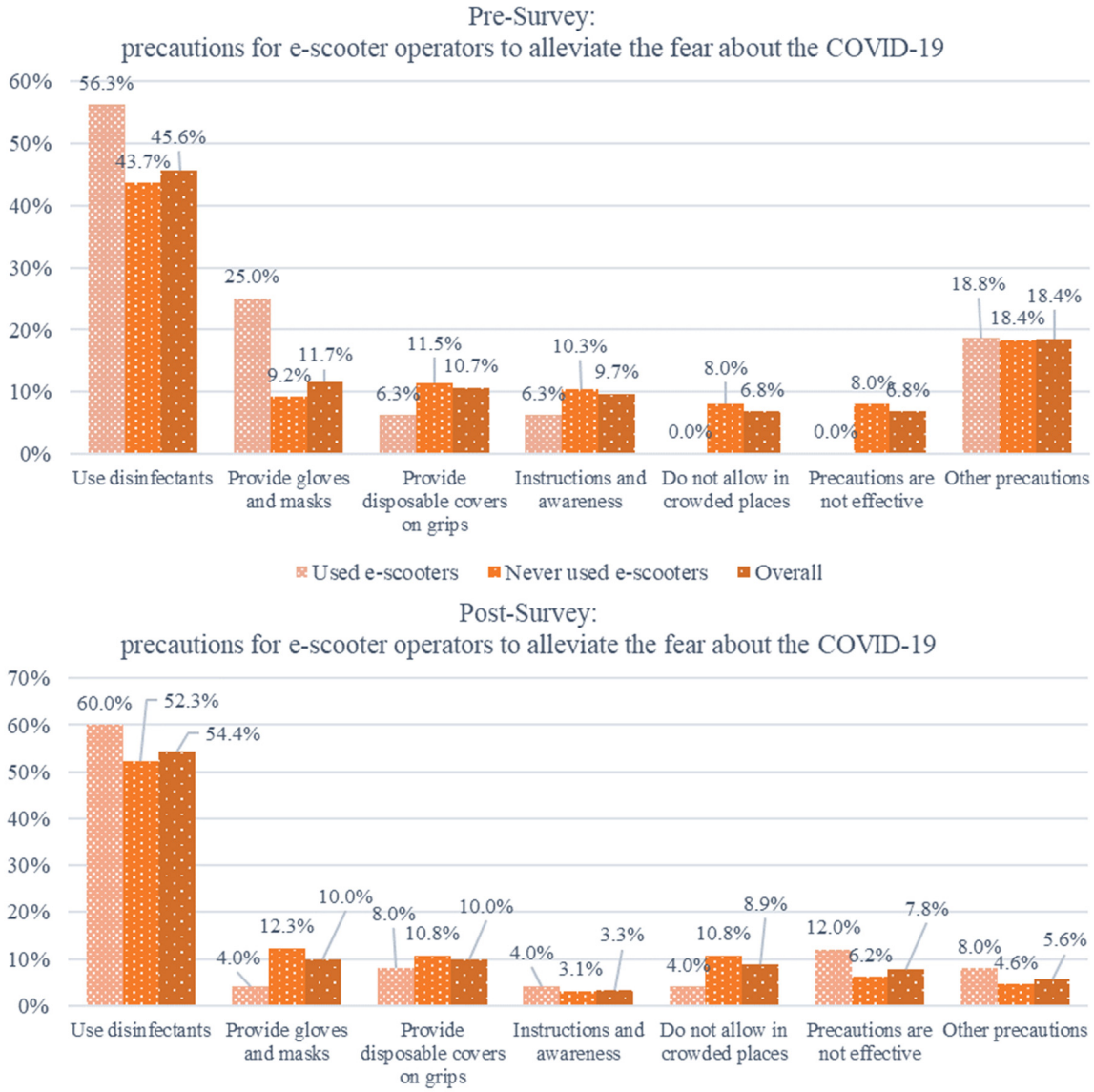

Figure 5. Suggested precautions and preventive measures for consideration of electric scooter operators.

When comparing the findings between the pre- and post-surveys, several interesting changes in the respondents' suggestions for safety measures to be considered by electric scooter operators during the COVID-19 pandemic have emerged. Firstly, there has been an increased endorsement of using disinfectants, with respondents emphasizing the need for operators to provide sprays or wipes for each electric scooter. This change reflects increasing awareness of the importance of enhanced cleanliness and sanitization practices. However, a significant change in the current study (post-survey) is the decreased support for the provision of gloves and masks by electric scooter operators. In the pre-survey study, 25% of respondents suggested this precaution, whereas in the current study, the percentage decreased to 4%. This decline indicates a shift in respondents' perspectives and preferences regarding the role of personal protective equipment in reducing the risk of COVID-19 transmission during electric scooter usage. Furthermore, the suggestion of implementing disposable covers on grips remains consistent between the two studies, highlighting the sustained recognition of the significance of maintaining hygiene and reducing potential contact with contaminated surfaces. However, it is worth noting that respondents in the current study expressed increased skepticism regarding the effectiveness of the suggested precautions. This skepticism may stem from evolving scientific understanding, media coverage, or personal experiences. Additionally, the responses categorized as "other precautions" in the

pre-survey study primarily focused on policy and regulations, emphasizing the importance of adhering to safety measures mandated by the government. This underscores the need for clear guidelines and regulations to instill confidence in electric scooter users regarding safety protocols. Overall, these changes reflect an evolving understanding of COVID-19 and its impact on electric scooter usage, emphasizing the need for operators to adapt safety measures and address emerging concerns to ensure user well-being and confidence in the post-pandemic period.

4.5. Electric Scooter Policies and Regulation

A new set of questions was included in the current study (post-survey), aiming to comprehensively assess the perceptions and preferences of respondents regarding electric scooter policies and regulations in Saudi Arabia. These findings are summarized in Table 5. The questionnaire covered various aspects related to electric scooters, including accessibility and availability. The results revealed that 63.2% of respondents considered electric scooters accessible, but 36.8% expressed difficulty in reaching them, suggesting room for improvement in terms of visibility and distribution. Sidewalks were the preferred floor for riding electric scooters for 47.1% of respondents, while 8.4% used roads exclusively and 44.5% used both. This highlights the popularity of sidewalks as a preferred option for electric scooter riders. Trip durations varied, with 20.6% reporting short trips of 5 min or less, 24.5% reporting 5–10 min trips, 29.7% reporting 10–30 min trips, and 25.2% reporting trips of 30 min or more, indicating a diverse range of trip lengths. Parking preferences indicated that 58.7% of respondents favored private electric scooter parking, while 41.3% preferred the option to park anywhere, indicating a need for a balance between designated parking spaces and flexible parking regulations. The questionnaire also explored the concept of geofencing, which refers to a technology that utilizes GPS or other location-based technologies to create virtual boundaries or zones, enabling location-based restrictions or regulations. Only 21.3% of respondents were familiar with this constraint. Payment according to use, such as per minute, was the preferred method of payment for renting electric scooters, with 81.2% of respondents expressing this preference. The questionnaire further revealed that 60.1% of respondents reported seeing underage individuals (-18 years old) riding electric scooters (although this is illegal), and 31.8% expressed a willingness to purchase a personal insurance package with additional fees. Moreover, the majority of respondents (75.9%) reported being unannoyed by electric scooters parked in pedestrian lanes and sidewalks. Overall, the comprehensive questionnaire provided valuable insights into various aspects of electric scooter policies and regulations in Riyadh, offering information that can be useful for related authorities, such as the Transport General Authority (TGA), as well as electric scooter operators aiming to better understand user preferences and enhance their services. The findings highlighted the need for increased awareness among respondents regarding the concept of geofencing. Additionally, the post-survey revealed that more than two thirds of respondents reported witnessing underage individuals (-18 years old) riding electric scooters, indicating a discrepancy between the existing regulations and actual practice. Addressing this issue is in the interest of regulatory authorities to ensure the safety and compliance of electric scooter users.

4.6. Regression Model

In this study, logistic regression analysis was conducted to investigate the relationship between various demographic and behavioral factors and respondents' attitudes towards using scooters as a mode of transportation between the pre- and post-surveys. The dependent variable "Survey" represents whether the observation is from the pre- or post-survey, while the independent variables include demographic factors such as age and gender, as well as behavioral factors such as owning a car, previous scooter usage, perceptions of safety, and attitudes towards COVID-19 safety measures. The regression model was fitted using the 'logit' function from the statsmodels formula API ('smf'), with the specified formula encapsulating the relationship between the dependent and independent variables.

The findings from this analysis provide valuable insights if a notable shift is observed in riders' perceptions in the post-survey.

Table 5. Additional questions added on the topics of regularization and policies.

Category	Subcategory	Percent (%)
Electric scooter accessibility	Accessible	63.2
	Difficult to find	36.8
Floor used for riding electric scooter	Sidewalk	47.1
	Road	8.4
	Both	44.5
Trip duration	5 min or less	20.6
	5–10 min	24.5
	10–30 min	29.7
	30 min or more	25.2
Private electric scooter parking or free to park anywhere	Private parking	58.7
	Free to park	41.3
Electric scooter parked in pedestrian lane and sidewalk	Annoyed	24.1
	Unannoyed	75.9
Riding electric scooter on sidewalk and pedestrian lane	Annoyed	33.8
	Unannoyed	66.2
Purchasing a personal electric scooter	Would purchase	11
	May purchase	29.7
	Would not purchase	59.3
The term "Geofencing"	Heard of it	21.3
	Never heard of it	78.7
Unifying electric scooter applications in one platform along with other public transportation means	Unify	70
	Do not unify	30
The preferred method of payment to rent an electric scooter	According to use (for example, per minute)	81.2
	Monthly subscription	18.8
Seeing an underage (-18) person riding an electric scooter	Have seen	60.1
	Have never seen	39.9
Purchasing a personal insurance package with additional fees	Would purchase	31.8
	Would not purchase	68.2

The results of the logistic regression analysis, which are shown in Table 6, reveal important insights into the factors influencing respondents' attitudes towards using scooters as a mode of transportation between the pre- and post-surveys. Among the demographic variables, age and gender show some associations with respondents' attitudes, although not all are statistically significant. Notably, respondents who have seen someone using a scooter before, but have not used it themselves, exhibit a significantly higher likelihood of expressing willingness to use scooters in the future. Additionally, certain attitudes towards safety, particularly perceptions of COVID-19 safety measures, are associated with respondents' attitudes towards scooter usage. Respondents who perceive no change in COVID-19 safety measures or view them positively are more inclined towards using scooters.

Table 6. Results of the logistic regression.

Variable	Coefficient	*p*-Value	OR
Intercept	−0.650	0.970	0.522
Age[T. > 60]	0.810	0.100	2.256
Age[T. > 30–45]	−0.160	0.340	0.852
Age[T. > 45–60]	0.390	0.080	1.478
Gender[T.Male]	−0.070	0.770	0.934
Own_Car[T.Yes]	0.010	0.961	1.012
Use_Bike[T.Yes]	0.350	0.170	1.421
Used_Scooter_Before[T.No, but seen someone using it]	1.870	0.000	6.522
Used_Scooter_Before[T.Yes, More than once]	0.010	0.880	1.009
Used_Scooter_Before[T.Yes, once]	0.240	0.820	1.266
Near_Crash[T.Yes]	0.280	0.400	1.324
Crash[T.Yes]	−0.580	0.170	0.559
Use_Scooter_Future[T.No]	0.490	0.020	1.643
Use_Scooter_Future[T.Yes]	−0.280	0.260	0.748
Safety_Perception[T.No]	0.060	0.740	1.059
Safety_Perception[T.Yes]	0.400	0.069	1.487
COVID_Safety[T.No Change]	0.970	0.000	2.645
COVID_Safety[T.Positive]	0.810	0.010	2.256
COVID_Safety_Measurements[T.No]	0.300	0.150	1.348
COVID_Safety_Measurements[T.Yes]	0.470	0.010	1.597

The odds ratios (ORs) provide valuable insights into the strength and direction of the associations between the predictor variables and respondents' attitudes towards using scooters between the pre- and post-surveys. The OR represents the change in odds of the outcome (willingness to use scooters) associated with a one-unit change in the predictor variable, holding all other variables constant. Notably, respondents who have seen someone using a scooter before, but have not used it themselves, exhibit a significantly higher likelihood of expressing willingness to use scooters in the future, with an OR of 6.52. Similarly, respondents who perceive no change in COVID-19 safety measures or view them positively are more inclined towards using scooters, with ORs of 2.64 and 2.26, respectively. Conversely, certain demographic factors such as age, gender, and car ownership show weaker associations with respondents' attitudes towards scooter usage, with ORs close to one. These findings underscore the importance of previous exposure to scooter usage and perceptions of safety measures in shaping attitudes towards scooter adoption. Policymakers and urban planners can leverage these insights to design-targeted interventions aimed at promoting sustainable and safe transportation options in urban areas.

5. Conclusions

This study focuses on Riyadh, Saudi Arabia, a city that has faced unique challenges in integrating electric scooters due to high temperatures, cultural barriers, insufficient infrastructure, and the absence of relevant policies and regulations. The research commenced with a pre-survey in 2020, exploring the feasibility of shared electric scooter systems in Riyadh. Subsequently, a post-survey was conducted to assess changes in behavior and preferences after the official deployment of more than 25 shared electric scooter systems. The analysis of survey data, involving 464 respondents, reveals noteworthy shifts in the distribution of electric scooter users. The findings include increased familiarity with electric

scooters, heightened usage rates, significant changes in domestic electric scooter usage, and variations in willingness to use electric scooters across genders. Of particular significance is the substantial increase in female electric scooter users, rising from 3% to 13%, reflecting a paradigm shift in gender-specific electric scooter adoption. The regression analysis demonstrates a historical uptrend in the utilization of e-scooters, juxtaposed with a discernible decline projected for forthcoming usage (odds ratio [OR] = 0.74). Intriguingly, there is evidence indicating an enhancement of riders' confidence towards e-scooters, as reflected by an augmented perception of safety (OR = 1.48).

The analysis also scrutinizes safety considerations, indicating a decrease in the perception of electric scooters as safe among users. Factors contributing to this shift include reckless riding, inadequate infrastructure, and heightened awareness of accidents. Insights into safety perceptions inform recommendations for improving infrastructure, promoting responsible riding behavior and enhancing safety measures.

The study probes the impact of the COVID-19 pandemic on electric scooter usage, revealing decreasing fear-related concerns and evolving attitudes toward safety precautions. As the pandemic wanes, these changes may contribute to shifting patterns in electric scooter usage, underscoring the importance of adapting strategies to the evolving landscape. Insights into respondents' preferences regarding electric scooter policies and regulations highlight key considerations for policymakers and industry stakeholders. Issues such as accessibility, preferred riding locations, trip durations, parking preferences, awareness of geofencing, and payment preferences offer valuable guidance for optimizing electric scooter services in Riyadh.

In conclusion, this research contributes towards generating a comprehensive understanding of the evolving landscape of electric scooter adoption in Riyadh. The findings offer valuable insights for policymakers, regulatory authorities, and electric scooter operators seeking to enhance the integration of shared electric scooter systems into the city's transportation fabric. Addressing challenges, fostering safety, and aligning services with user preferences are crucial steps in shaping a sustainable and efficient future for electric scooter mobility in Riyadh and beyond. Moreover, it is imperative to emphasize the importance of the sustainable development of human society by prioritizing environmentally friendly modes of transportation like electric scooters, which can contribute to reducing carbon emissions and promoting cleaner and greener cities. By encouraging the adoption of electric scooters and implementing supportive policies, Riyadh can take significant strides towards making a more sustainable and eco-friendly transportation system.

Author Contributions: Conceptualization, M.A., H.I.A. and M.E.; methodology, M.A., A.A., H.I.A. and M.E.; formal analysis, A.A.; investigation, M.A.; writing—original draft, M.A., A.A., H.I.A. and M.E.; visualization, A.A.; supervision, M.A. All authors have read and agreed to the published version of the manuscript.

Funding: Researchers Supporting Project number (RSP-2024R291), King Saud University, Riyadh, Saudi Arabia.

Data Availability Statement: Dataset is available upon request.

Conflicts of Interest: The authors declare no conflicts of interest.

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