TRUST AND PERCEIVED SAFETY OF VULNERABLE ADULT ROAD USERS TOWARDS REGULAR AND AI-ENABLED E-SCOOTERS

by

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ABSTRACT

ARGHAVAN AZARBAYJANI. Trust and Perceived Safety of Vulnerable Adult Road Users Towards Regular and AI-enabled E-scooters. (Under the direction of DR. OMIDREZA SHOGHLI)

In recent years, the increase in e-scooter usage as an urban transportation mode has spotlighted the imperative for research on safety concerns, especially from the perspective of vulnerable road users. This study bridges the gap by examining the trust and perceived safety towards both regular and AI-enabled e-scooters among vulnerable adult road users. Central to this research is the exploration of how prior experiences and skills with e-scooters influence trust levels in AI technology's integration into these mobility devices. Survey responses from 195 eligible participants were analyzed to understand usage patterns, safety perceptions, and the potential impact of AI-enabled features on user acceptance. The findings underscore a predominant use of e-scooters among younger adults. This investigation into the selection preferences for AI-enabled e-scooters, based on participants' racial backgrounds, revealed statistically significant differences, highlighting the impact of race on technology acceptance. Also, a significant correlation was observed between both gender and race with par-participants' trust in AI-enabled e-scooters' capability to manage unexpected situations, underscoring the importance of demographic considerations in technology adoption and trust dynamics. Moreover, age-related analysis of safety perceptions around e-scooters unveiled varied responses, with younger adults feeling safer compared to other age groups. The study also identified a significant gender-based difference in confidence levels when using AI-enabled e-scooters in diverse traffic conditions, suggesting the influence of gender on the perceived reliability of AI technologies in transportation. These findings provide insights into the demographic factors influencing trust, safety perceptions, and technology acceptance among e-scooter users, essential for tailoring future e-scooter technologies and policies to diverse user needs.

The educational levels of users were another factor that influenced preferences for AI-assisted over regular e-scooters. Concerns regarding AI-enabled e-scooters' ability to navigate traffic situations effectively, privacy issues, and the potential for technological malfunctions emerged as significant barriers to trust and acceptance. Furthermore, the research identified a critical gap in formal training for e-scooter usage, pointing to a need for educational interventions. These findings are instrumental in guiding the future design and integration of AI technologies into e-scooters, ensuring they align with users' safety perceptions and preferences.

DEDICATION

I dedicate my thesis to my father for his continuous support in pursuing my academic goals and to my mother, my greatest encourager. Thanks to my sibling Arsalan and my spouse, Kourosh, for your unwavering support, which has given me the courage to persist. I am incredibly grateful to Dr. Omidreza Shoghli for initiating this research journey and for his guidance. His presence and belief in me have motivated me to achieve my goals. Thank you for being my pillar of strength and my greatest supporter.

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LIST OF ABBREVIATIONS

AI Artificial Intelligence

AV Autonomous Vehicle E-

scooter Electric Scooters

CHAPTER 1: INTRODUCTION

1.1 Overview

The landscape of urban transportation has undergone a notable transformation with the introduction of e-scooters, capturing the attention of both researchers and practitioners alike. E-scooters have become a popular mode of transportation in cities, providing riders with a flexible option for short trips. However, because of the limited regulations surrounding these scooters, there are concerns about their safety among the public and government agencies. The lack of reliable data on crashes involving e-scooters makes it difficult to understand the current state of these accidents. A comprehensive study [1] carried out by the Centers for Disease Control and Prevention (CDC) revealed that 20 out of every 100,000 e-scooter trips resulted in injury, nearly half of these being head injuries, with a significant 15% amounting to severe traumatic brain injuries. Even more alarmingly, e-scooter-related injuries among children have risen noticeably, with hospitalizations increasing from 4.2% in 2011 to 12.9% in 2020 [2]; the average age of patients was around 11 years [3].

Given these alarming incidents and injury statistics, it is clear that the safety of e-scooters needs to be addressed promptly [4]. Despite the notable convenience and substantial environmental benefits that e-scooters bring to urban mobility, there exist major safety issues that demand urgent attention. A critical contributory factor to these challenges lies in the limitations of our current infrastructure, which was designed with conventional modes of transportation in mind, making it ill-suited to accommodate and regulate the novel dynamics of e-scooter traffic effectively.

A recent study [5] analyzed the data from reported crashes and revealed distinct characteristics of these incidents, including uneven distribution among states, different user groups, facilities, time periods, and severity levels. The findings also highlight the need for public awareness and timely development of safety measures, including helmet use, preventing riding under the influence, protecting vulnerable riders, and addressing data deficiencies.

Conducting research on e-scooter safety poses challenges due to limited empirical data availability, particularly because e-scooter incidents that are not severe or do not involve motorized vehicles are often under-reported, making it difficult to gather comprehensive information [6]. The growing use of e-scooters raises numerous safety-related concerns, such as establishing appropriate legal speed limits, implementing rider restrictions based on age and protective equipment requirements, and ensuring proper vehicle certification [6]. It is crucial to explore the impact of human factors as they are known to play a significant role in approximately 95 percent of all accidents [6]. Human factors may have a distinct influence on e-scooter riding compared to bicycles, as these vehicles differ in various aspects such as size, the specific set of skills required, available protective measures, minimum rider age requirements, travel purposes, and more[6]. Recognizing these differences is essential when examining the impact of human factors on riding behavior and safety [6].

To our knowledge, no peer-reviewed studies looking into the perceived safety of e-scooters from vulnerable road users' points of view have been reported. However, there are some articles related to the attitudes of e-scooter users toward non-users and their behavior and characteristics [7, 8, 9, 10].

As riders use e-scooters more frequently, their personal perspectives on safety become important. This study aims to understand their perspectives and the intricate interplay of exhilaration and apprehension that accompanies their e-scooter journeys. Beyond the riders, the broader public, the pedestrians, cyclists, e-bike rid- ers, motorists, and car drivers witness the e-scooter revolution from various vantage points. Their perceptions and reservations towards e-scooters can offer a panoramic view of the urban ecosystem's response to this novel mobility solution.

1.2 Research Objective

This study aims to investigate the association between participants' demographics, background factors, preferences, and trust in AI-enabled e-scooters compared to regular e-scooters. The research also seeks to provide insights into the factors influencing individuals' choices, trust levels, and comfort when interacting with AI technology in the context of e-scooter usage. With this, the specific objectives of this study are to: **Objective 1:** Explore and understand the usage patterns, experiences, incidents, and safety perceptions of participants.

Objective 2: Evaluate the correlation between participants' background factors and their preferences when choosing between AI-enabled e-scooters and regular e-scooters.

Objective 3: Examine the influence of participants' racial background and gender on trust in AI-enabled e-scooters in handling unexpected situations.

Objective 4: Examine potential associations between participants' gender and racial backgrounds and their preferences regarding the mode of receiving notifications from AI-enabled e-scooters.

Objective 5: Investigate the correlation between participants' level of confidence in AI when using AI-enabled e-scooters in diverse traffic conditions compared to regular e-scooters, with a focus on the influence of age and gender.

Additionally, this study seeks to identify safety concerns, uncovering the barriers that may discourage individuals from embracing e-scooters. Our aim is to identify these barriers and evaluate a potential solution: AI-enabled e-scooters can pave the way for wider adoption and safer mobility. To accomplish these objectives, the research employs a structured data collection approach in the form of a questionnaire. This instrument has been carefully crafted to elicit insights into individuals' responses concerning e-scooters. Through this systematic inquiry, the research endeavors to

Shed light on the multifaceted dimensions of knowledge and attitudes surrounding e-scooters within the sampled population.

1.3 Organization

This research is structured into five chapters and three appendices. The second chapter of this proposal introduces the research's contextual framework and provides a concise review of relevant studies. Chapter Three outlines the methodology adopted to analyze the survey results and the structure of the designed survey. Then, the results and discussion of the research are presented in Chapter Four, and finally, the conclusion remarks are discussed in Chapter Five. In addition, three appendices are provided, including the questionnaire, consent form, and invitation email to participants. It should be noted that this study was reviewed and approved by the UNC Charlotte Institutional Review Board (IRB-24-0118).

CHAPTER 2: RELATED WORKS

2.1 E-scooter Safety and Regulations

E-scooters have presented a set of regulatory questions encompassing both social and economic aspects. Similar to other forms of transportation, scooters bring about environmental and safety concerns. Consequently, municipal authorities have been progressively formulating regulatory frameworks to address local scooter-related issues within the context of broader policies that govern existing transportation modes. Established channels of communication exist among different stakeholders, including transportation providers, local government bodies, residents, and users, concerning ongoing modifications to regulations and their implementation [11].

Buehler et al., in 2021, concluded that it is clear that e-scooters are used for several different activities and purposes. Many people use electric scooters to travel to/from school, to/from social activities/friends, and as a source of entertainment. As with adult users, electric scooters among young people also seem to largely replace walking and travel by public transport [8].

According to Gioldasis and Seidowsky, inattention played a contributing role in approximately 78% of all crashes and 65% of all near-crashes [6]. In the study by Tian et al. in 2022, the risk factors linked to self-reported incidents of e-scooter crashes and injuries within a specific community of e-scooter riders were examined. Riding in designated bike lanes, whether protected or unprotected, emerged as the primary protective factor against e-scooter-related injury crashes [12].

E-scooters are predominantly seen as recreational devices, and concerns about safety act as a deterrent to their usage in Germany [13]. The potential of e-scooters to replace environmentally harmful vehicles, such as cars, is limited and is primarily feasible for short-distance trips (<2km). Interestingly, the primary alternative that respondents intend to replace with e-scooters is walking [13].

In Dublin, Ireland, Carroll and colleagues investigated travel behaviors, mode choices, and perceptions of e-scooters before the COVID-19 pandemic. The absence of operational e-scooter companies due to legal constraints has resulted in a scarcity of user data, which has posed significant challenges to the development of effective regulations in the region. This study utilizes survey data collected from Dublin residents to explore the sociodemographic factors influencing mode choice, assess current and potential demand for e-scooters, and examine perceptions regarding this emerging mode of transportation [14].

Based on Button and colleagues' work in 2020, The reality in the United States reveals that e-scooter operations have struggled to achieve short-term cost recovery, let alone secure a viable long-term return on investment. While precise figures are elusive, Lime, for instance, encountered significant financial losses, averaging 6 million dollars per month during the first half of 2018 [11].

Gioldasis and Seidowsky determined that distracted driving constitutes a pivotal factor influencing road safety. To define driver distraction, first, we have to define this word. Driver distraction is characterized by a situation where a driver experiences a delay in perceiving vital information necessary to safely perform the driving task. This delay is caused by an event, activity, object, or person either inside or outside the vehicle that prompts or tempts the driver to divert their attention away from the primary task of driving [6].

While respondents generally acknowledge the benefits of e-scooters, concerns are prevalent regarding potential future regulations, particularly those related to speed limits, age restrictions, and designated riding zones aimed at enhancing safety on roads and paths [14]. However, it should be noted that the integration of e-scooters into existing systems is still in its early stages and can be characterized as being in its infancy. Although there is ample evidence indicating that a substantial portion of the population holds a positive perception of scooters, particularly within the context of their current availability, there are valid concerns related to environmental impacts and safety [11].

Qi et al. (2020) concluded that regulators should consider implementing clear and consistent regulations that prioritize safety and balance the needs of different road users. Additionally, the study's finding that signage with pictures and text is more effective in communicating rules to E-Scooter riders highlights the importance of clear and accessible communication in promoting safe riding practices [15].

Additionally, regulations for e-scooters can also vary within cities and municipalities, with some allowing them on bike lanes and others requiring them to be ridden on the streets with cars based on a Gioladasis investigation in 2021. The lack of uniform regulations and laws can make it difficult for riders to know where they can and cannot ride their e-scooters and can also create challenges for companies providing e-scooter-sharing services as they navigate different regulations in each location [6].

According to respondents in the 2020 European research, in most countries, there is a restriction on the maximum power e-scooters can have in public spaces [16]. The study conducted in Europe highlights the significance of government policies. The multitude of explanations and interpretations offered by participants serves as clear evidence of the increasing attention that governmental bodies and research institutions are directing toward this issue [16].

The findings of the study by Gioldasis and Seidowsky are important for policymakers and urban planners who are responsible for regulating and managing E-Scooters in public spaces. The study highlights the importance of public education campaigns in promoting safe and legal E-Scooter use. It also emphasizes the need for infrastructure improvements, such as dedicated bike lanes, to improve the safety of E-Scooter riders and other road users [6].

By understanding the behavior of E-Scooter riders and the factors that influence their decisions, policymakers and urban planners can design regulations and infrastructure that promote safe and sustainable E-Scooter use in cities [6].

As research by Button and colleagues in 2020 progressively uncovered the evolving role of e-scooters in urban transportation networks and speculated on their future potential, the outbreak of COVID-19 disrupted the observations. It is important to acknowledge that much of the available quantitative data lacks the usual statistical rigor [11].

2.2 E-scooter Riders Behavior and Characteristics

It is evident that e-scooters serve various purposes and cater to different activities. Many individuals in their youth utilize electric scooters for commuting to and from school, attending social gatherings, or simply for entertainment [17].

The primary motivation for e-scooter users is time-saving during travel, followed by a sense of playfulness and cost savings. A significant proportion, 72% of users, made the shift from walking to public transportation [18]. In the study in 2023, the behaviors and preferences of e-scooter riders with the aim of enhancing their safety have been studied [19]. Furthermore, it highlights that younger, high-income individuals without private cars or licenses are more inclined to choose e-scooters for shorter trips [14].

The findings showed that female riders had a higher likelihood of experiencing e-scooter injury incidents, often associated with riding on sidewalks and non-paved surfaces [12]. In Saudi Arabia, it is anticipated that males will be more inclined to use such a system than females, and the majority of potential users are expected to fall within the age range of 18 to 45 years old. Also, gender, age, and the use of ride-hailing services are key factors that influence respondents' willingness to use e-scooters [20].

In a study in Greece, there appeared to be a lower inclination among females to use

E-scooters in comparison to males [21]. There appeared to be an association between extended trip duration and the manifestation of risk-taking behaviors among riders [22]. In a different study in Paris, e-scooter ownership is infrequent among users, with the majority being male, aged between 18 and 29, and possessing a higher level of education [18]. Also, in Paris, Younger and male riders are statistically more prone to adopting risky behaviors [22].

In a study conducted in Vienna by Laa and colleagues, the highest usage of the people was related to male, young, and educated people. The criteria considered as bias in this study were the distribution location, which was social media, and links related to the university and educated people. This study highlighted the importance of distributing the future survey in all communities, including a variety of backgrounds and education. Female e-scooter drivers in Vienna were less in comparison to female bicycle users [23].

This gender disparity warrants further examination as a potential focal point for future research within the realm of this transportation mode. Given that e-scooters in Vienna are mandated to utilize cycle paths, this practice also implies that e-scooter riders contribute as supplementary users of the cycling infrastructure [23].

In the study by Buehler in 2019, the authors focused on sociodemographic characteristics, going beyond technical aspects, to gain a comprehensive understanding of user acceptance, which encompasses both individual and societal dimensions [24].

In a study of nine Norwegian municipalities, a significant proportion of the younger generation has access to electric scooters, either through personal ownership, borrowing, or the availability of rental options in their vicinity. While most young individuals have experienced riding electric scooters, only a limited number of respondents can be categorized as frequent users [17]. Similar to their adult counterparts, young people also appear to rely on electric scooters as a substantial substitute for walking and public transportation when it comes to their travel needs [17].

The study by Buehler and colleagues in 2021, in a study at Virginia Tech, aimed to collect data on attitudes, preferences, and e-scooter usage patterns from members of a university community through an online survey. They recruited students, faculty, and staff through online dissemination and in-person data collection using tablets. This study showed that the sociodemographic characteristics of e-scooter riders on the Virginia Tech campus followed patterns identified in city surveys [8].

The data was collected in two surveys: one before and one after e-scooter deployment. The post-survey revealed that 28% of respondents had used e-scooters on campus. Overall, the study analyzed both the general survey data and the post-ride survey data to identify significant correlations and changes over time related to travel behavior and attitudes toward e-scooter usage [8].

Key findings from the 2022 review by Carroll include the substantial influence of time and convenience on mode choice, variations in willingness to pay for shared e-scooter services between genders, openness to increased fees among individuals with daily trip costs ranging from 1 to 5 Euro, and a notable willingness to incur higher travel expenses for shared e-scooters [14]. It is uncommon for users to spend more than 3-4 minutes searching for an available e-scooter, while the majority of trips fall within the 10-19 minute duration range [18].

According to a study by Krier and colleagues in Paris in 2021, if e-scooters were not available for the participants' last trip, 44% of them would have chosen to walk, and 31.4% would have opted for public transportation. Only 7% would have considered using a personal or shared car. However, it's worth noting that e-scooters can complement public transportation systems and may serve as an incentive for people to utilize collective modes of transportation [25]. In the study by Siebert and colleagues in 2021, in Germany, approximately 10% of users are riding against the flow of traffic. About 5% engage in dual use, with two riders on a single e-scooter [26].

Approximately 16% of participants made the transition from motorized modes of

Transportation (private cars, taxis, motorcycles) to e-scooters [18]. E-scooter owners tend to be younger, have higher incomes, and exhibit fewer risk-taking behaviors compared to riders who use shared scooters [18].

In northern Poland, only 3 percent of citizens use e-scooters for their daily commute. Also, the rate of usage for bike-sharing systems is more than that of e-scooters in the US [27]. A big portion of e-scooter riding in Tucsan appears to be more recreational (for pleasure) travel, including generating more trips for restaurant travel that wouldn't have otherwise happened [28].

In Singapore, certain personal characteristics, including age group and personal negative experiences with e-scooters, along with subjective norms such as having family members or close friends who share their perspective, have been identified as factors that are correlated with individuals' levels of support for a ban on e-scooters [29].

In that research [23], it is noteworthy that walking trips are the most commonly replaced mode of transportation, both for e-scooter owners and renters. Hence, the authors assert that shared e-scooters are more aligned with competing against public transport rather than serving as a preferred choice for first or last-mile connectivity [23].

Regarding race and ethnicity of users, in a study conducted in Arizona, African American and non-white Hispanic respondents showed a significantly higher likelihood compared to non-Hispanic white respondents when it came to their intent to try e-scooters and their dissatisfaction with existing transportation choices [30]. These results suggest that e-scooters have the potential to play a role in promoting equity in urban transportation [30].

While existing research suggests that only a limited portion of e-scooters hinder pedestrian access, it remains crucial to undertake a more holistic assessment of their overall impact on sidewalk accessibility [9]. The significance of this impact may vary depending on local conditions, where a small number of obstructive e-scooters could either pose a substantial barrier or simply be considered a minor inconvenience [9].

The first reason that discourages the public from using e-scooters is the price they have to pay for use and the hardship of finding any available e-scooter when they actually need it [27]. It is noteworthy that around 13% of people have never tried riding an e-scooter and still show no interest in trying that [27].

The survey in 2019 provides empirical evidence indicating that the parking behavior of scooter riders has the potential to obstruct pedestrian pathways and sidewalks [9]. In other words, how scooter riders choose to park their scooters can create physical barriers and hindrances for pedestrians, thereby potentially impacting the flow of foot traffic and the overall accessibility of sidewalks [9].

In Saudi Arabia, the primary challenge hindering the deployment of e-scooters in Saudi Arabia is the inadequate infrastructure, cited by 70% of respondents. Weather conditions are also a significant concern, with 63% of respondents mentioning this factor, followed by safety concerns at 49% [20].

In the study of nine Norwegians, a significant proportion of the younger generation has access to electric scooters, either through personal ownership, borrowing, or the availability of rental options in their vicinity. While most young individuals have experienced riding electric scooters, only a limited number of respondents can be categorized as frequent users [17].

Laa et al. concluded that owners typically use their e-scooters multiple times per week, whereas renters, in contrast, utilize them at a reduced rate, generally using them on a monthly basis. While e-scooter renters predominantly substitute their walking trips, with public transport modes such as buses and trams being the next most commonly replaced options, e-scooter owners exhibit a noteworthy proportion of replaced car and subway journeys[23].

The report by Milch et al. emphasizes the need to better understand the connectiontions between risk behavior and risk perception among young e-scooter users. The study's multivariate analysis suggests that frequent e-scooter use, riding under the influence, and breaking the rules while riding are factors associated with a higher likelihood of accidents [17].

The barriers to using e-scooters were asked about in a study by Sanders and colleagues at Arizona State University in 2020; significant gender-based differences were observed in the barriers to e-scooter use, particularly regarding safety concerns. These disparities align with gender variations observed in studies focused on bicycling and underscore the importance of street design in promoting gender equity in transportation. Creating safer and more accommodating urban environments can empower women to fully embrace and benefit from this emerging mode of transportation [30]. For instance, the study by Button showed that in 2017, Washington DC initially capped the number of scooters per operator at 400. However, by the end of 2018, this limit was increased to 600, with the possibility of expanding fleets by 25% every three months with regulatory approval. This policy shifted in 2020, allowing only Jump, Lyft, Spin, and Skip, each with a maximum of 2500 scooters, to serve the city. In 2018, Denver issued permits to five scooter companies to operate 350 scooters each during a trial period [11].

The initial companies that had launched services without permission were excluded, although Jump, Spin, and Lime eventually obtained market approval. These measures reflect the efforts of cities to strike a balance between fostering e-scooter accessibility and mitigating the challenges posed by unregulated expansion[11].

As a result of the study by Laa and colleagues in 2020, the perception of risk associated with e-scooter usage was rated relatively low. This suggests that both providers and policymakers should work to clarify the hazards associated with e-scooter riding and potentially consider enforcing the use of protective gear while riding. When considering the impact of ownership on e-scooter usage, it becomes evident that owners tend to utilize their e-scooters at a higher frequency [23].

Previous observations of bike users and pedestrians from an intercept survey conducted on the campus of the University of British Columbia (UBC) in Vancouver, Canada, addressed the conflicts between pedestrians and cyclists [10]. As cyclists are considered non-motorized users, these conflicts will be anticipated for e-scooter riders in the same way [10]. Also, cyclists tend to avoid places where pedestrians are prevalent, but they consider this aspect alongside factors like travel duration, navigation, and avoiding motor vehicle congestion [10].

2.3 Impact of Infrastructure and Urban Planning on Safety

The compact size and lighter weight of e-scooters make them highly maneuverable, facilitating seamless transitions between sidewalks and streets[31]. These distinctions in infrastructure preferences underscore the need for tailored considerations when planning and accommodating e-scooter riders within urban transportation systems [31].

To obtain a thorough understanding of sidewalk accessibility and its relationship with e-scooters, it is imperative to conduct a more comprehensive examination [9]. The data indicates that female users exhibit a preference for segregated cycling infrastructure, where they are separated from motor vehicles [23].

Interestingly, e-scooter riders might perceive roads with steep gradients as less challenging, primarily because operating an e-scooter requires minimal physical effort compared to pedaling a bicycle uphill [31].

Regarding the road choice by users in the US, e-scooters and bicycle users tend to favor sidewalks, especially on wider roads. Interestingly, in the research by Currans and colleagues, respondents who expressed a preference for riding on sidewalks were 151% more likely to have reported experiencing a crash, whereas those who rode in designated bike lanes were 52% less likely to have experienced a crash [28].

Findings reveal an unexpectedly elevated occurrence of interactions between pedestrains and cyclists within a heavily used, non-motorized shared environment [10].

It is important to note that allowing e-scooters on sidewalks could pose significant risks to pedestrians, particularly those with disabilities or who are elderly [15]. While it may be more comfortable for e-scooter riders to ride on the sidewalk, it is important to prioritize the safety and well-being of all road users, including pedestrians [15].

James et al., in their research, mentioned it is essential to extend research efforts to encompass various forms of sidewalk obstructions, including but not limited to automobiles, debris, and signage. This broader investigation will help determine whether e-scooters represent a distinctive challenge in terms of sidewalk accessibility or if their prominence is primarily due to their recent introduction into the urban landscape [9].

Given the inadequacy of segregated cycle paths in Vienna, this may account for the lower usage rates among women compared to men, as well as the similar trend observed among female e-scooter users [23].

An observational study along three mixed-use corridors in Rosslyn by James and colleagues was conducted aiming to examine the correlation between the urban infrastructure and e-scooter parking behaviors. The results indicated that out of 606 observed e-scooters, 16 percent were not parked correctly, and 6 percent (equivalent to 36 e-scooters) were obstructing pedestrian pathways [9].

In Greece, both individuals who currently use e-scooters and those who do not have identified the insufficient infrastructure as a crucial factor preventing them from using e-scooters more frequently or being drawn to using them [21]. In Germany, the findings are over 25% of riders are using incorrect infrastructure for e-scooters [26].

Zhang et al. studied existing route choice modeling endeavors that have been examined and geared toward cyclists. This examination will serve as a foundation for the construction of a route choice model specific to e-scooters. This differentiation arises from the inherent dissimilarities between the two modes of transport. Bicycles, characterized by their larger tire size and stable geometry, tend to perform more effectively on uneven or rugged road surfaces [31]. Conversely, e-scooters, with their smaller wheels and unique geometric designs, necessitate a more upright steering angle, rendering them less stable when encountering rough terrain, such as gravel or bumps [31].

2.4 Trust and Safety in AI-enabled Transportation Systems

Reducing the risks linked to riding e-scooters could prove more effective in minimizing injuries than depending solely on protective gear to mitigate harm in the event of a fall or collision [19].

Othman et al. found that There is a heightened concern among the public regarding autonomous vehicles (AVs), and this concern tends to escalate with the increasing number of reported accidents. The public's previous experience with AVs plays a significant role in shaping their acceptance of this technology, with those who have prior experience generally displaying more positive attitudes toward adopting AVs [32].

In the case study in Rosslyn, Virginia, provided valuable insights into two critical issues. Firstly, a survey was administered to both e-scooter riders and non-riders, inquiring about their perceptions of safety concerning e-scooter riders and their encounters with sidewalks obstructed by e-scooters. The responses gathered revealed significant disparities in safety perceptions and views on sidewalk obstruction between riders and non-riders [9].

In a study by Gkekas et al. in 2020, it was found that the result of the study could be influenced by response biases associated with self-reporting of behavior and recalling incidents from the past year. Elements like lighting and weather may not be adequately represented in recollections. Social desirability bias may have influenced self-reported travel habits, incident reporting, and the identification of causal factors. Intoxication could have played a role in more incidents than reported, possibly due to a lack of awareness or reluctance to disclose such information [10].

The inclination to ride micro mobility vehicles is significantly influenced by taking into account safety, making it crucial to consider when promoting such modes of transportation [19]. The data indicates that the perception of safety while cycling rises with the frequency of cycling. As the number of days spent cycling per week increases, the likelihood of viewing cycling as less safe than driving in Dublin diminishes [33].

Safety is the foremost concern for individuals utilizing transportation in their daily lives, focusing on both personal safety and the security of their belongings. This study utilized value stream mapping to showcase the integration of geofence technology with GPS, RFID, and API in e-scooter deployment, demonstrating enhanced performance and operational monitoring. While the analysis highlighted the significance and development process, it did not empirically establish or quantify the added value to the operator's performance. Subsequent empirical research is essential to establish the impact of deploying intelligent technology in this context [34].

Among the elderly population, there is greater recognition of potential benefits associated with autonomous vehicles (AVs) than with their younger counterparts. This reinforces the notion that AVs can provide sustained mobility for senior citizens. Findings on safety perceptions emphasize the significance of prior experience with AVs and the role of vehicle speed [35].

Survey data by Thomas in 2020 revealed that individuals aged between 36 and 65 express more apprehension and even resistance towards driving autonomous vehicles when contrasted with individuals aged 18 to 35 and those aged 65 and older [24].

Interestingly, people in countries with lower GDP levels tend to display more positive attitudes toward AVs compared to those in countries with medium or high GDP levels [32]. The risk associated with operating autonomous vehicles is relatively low. Individuals holding a university degree (Bachelor's, Master's, or PhD) exhibit a lower level of apprehension regarding accident liability and autonomous vehicle system failures compared to those without a degree [24].

In Othman et al. research, despite the expectation that older individuals would be early adopters of AVs due to increased accessibility, survey results indicate that older people tend to hold more pessimistic views towards AVs, contradicting the notion that they would benefit the most from this technology. While the willingness to pay for new technology is a critical factor in its success, previous surveys have shown that only a small percentage of individuals are willing to pay a premium for AVs [32]. Gender differences emerge in attitudes towards AVs, with males expressing more positivity compared to females. Similarly, individuals with higher levels of education tend to exhibit more favorable attitudes than those with lower educational backgrounds [32]. Hilgarter et al. in a study in 2020 expressed the public perception toward autonomous vehicles have been asked. The funding is in rural regions, where autonomous vehicles (AVs) garner a more favorable reception compared to urban areas. Within these rural settings, AVs have the potential to transition individuals from using private cars to embracing public transportation. Survey participants predominantly view AVs as an alternative rather than a complete replacement for existing transportation
methods [35].

In a study in 2020 in Phoenix, Arizona, exploration of the safety perceptions of road users who will interact with AVs, including vulnerable road users, have been asked. There is a gender difference, with females generally feeling less safe around AVs than males. Safety perceptions when traveling near autonomous vehicles (AVs) are linked to reduced concerns about potential threats from hackers, terrorists, or similar parties. Both awareness of and personal experience with AVs can influence safety perceptions in both positive and negative ways [36].

CHAPTER 3: METHOD

The research methodology encompasses an online survey targeting both e-scooter riders and non-riders, asking about the perceived safety and trust in regular and AI-enabled e-scooters. The survey was administered through the Qualtrics survey tool and focused on gauging the perceived safety of e-scooters and their impact on vulnerable road users. Ethical approval for the survey was obtained from the University of North Carolina Charlotte Institutional Review Board (IRB-24-0118).

3.1 Data Collection

The survey consisted of four main parts: 1. The first part delved into participants' experiences with e-scooters. Specific conditions were established based on the perspective of road users, including pedestrians, car drivers, bike riders, e-bike riders, and e-scooter riders. Respondents were asked about their general opinions regard- ing e-scooters. Participants with prior e-scooter experience were asked more detailed questions about their usage frequency and any previous accident experiences.

2. In the second part, participants were asked questions about Perceptions of Safety and Trust in AI-Assisted Technologies.

3. In the next part, all survey participants, whether experienced e-scooter users or not, responded to questions regarding the perceived safety of a conceptual scenario involving e-scooters equipped with Artificial Intelligence (AI) systems. This scenario explored participants' sentiments about AI-enabled e-scooters and their preferences for how this AI system could assist them with notifications.

4. The last part collected demographic information about participants.

The following presents the research and survey questions formulated to achieve the study's objectives. By aligning these questions with the research's core aims, we aimed to collect data that is not only pertinent but also rich in insights, facilitating a deeper analysis and interpretation.

Objective 1: Explore and understand the usage patterns, experiences, incidents, and safety perceptions of participants. Specifically, to achieve this objective, we aimed to address the following key questions.

- What is the frequency of e-scooter usage among participants?
- What training in e-scooter operation have participants received, and how do they perceive the ease of use?
- What are the preferences for e-scooter sidewalk use and perceptions regarding shared lanes?
- What are the safety perceptions and incident experiences?
- What circumstances lead to e-scooter accidents or near misses?
- What is the severity of injuries sustained in e-scooter incidents?

Objective 2: Evaluate the correlation between participants' background factors and their preferences in choosing between AI-enabled e-scooters and regular e-scooters. Specifically, to achieve this objective, we aimed to address the following key questions.

1. Is there any association between gender and the choice of e-scooter type (regular vs AI-enabled) in a scenario where both options were available at equal cost?
2. Is there any association between ethnic background and the choice of e-scooter type (regular vs AI-enabled) in a scenario where both options were available at equal cost?

3. Is there any association between the highest level of education and the choice of e-scooter type (regular vs AI-enabled) in a scenario where both options were available at equal cost?

To address these research questions, we used the following questions from the survey:

- Q25. Given a choice between two e-scooters priced the same, which one would you buy/select from the deck?
- Q27. Which gender identity do you most closely align with?
- Q29. What is your ethnic background?
- Q32. What is the highest level of education you have attained?

Objective 3: Examine the influence of participants' racial background and gender on trust in AI-enabled e-scooters in handling unexpected situations.

To achieve this, we used Likert-scale questions to assess participants' evaluations of statements related to trust in AI-enabled e-scooters. The statements were designed to capture participants' perceptions and attitudes toward the reliability and performance of AI technology in handling unforeseen circumstances. Specifically, the study aimed to address the following key questions.

1. Is there a significant association between gender and trust in AI-enabled e-scooters to handle unexpected situations?
2. Is there a significant association between racial background and trust in AI-enabled e-scooters to handle unexpected situations?

To address these research questions, we used the following questions from the survey:

- Q24. Please evaluate each of the following statements on a scale from ’Strongly Agree’ to ’Strongly Disagree/I trust the AI’s ability to handle unexpected situations while I’m on the e-scooter.
- Q27. Which gender identity do you most closely align with?
- Q29. What is your ethnic background?

Objective 4: Examine potential associations between participants’ gender and racial backgrounds and their preferences regarding the mode of receiving notifications from AI-enabled e-scooters. Specifically, the study aimed to address the following key questions.

1. Is there any relation between participants’ gender and the way that they prefer to receive notifications from AI-enabled e-scooters?
2. Is there any relation between participants’ ethnic backgrounds and the way that they prefer to receive notifications from AI-enabled e-scooters?

To address these research questions, we used the following questions from the survey:

- Q23. If this AI-assisted e-scooter could provide safety notifications and/or control feedback, how do you prefer to receive the notification/control feedback?
- Q27. Which gender identity do you most closely align with?
- Q29. What is your ethnic background?

Objective 5: Investigate the correlation between participants’ feelings of confidence when using AI-enabled e-scooters in diverse traffic conditions compared to regular e-scooters, with a focus on the influence of age and gender. Specifically, the study aimed to address the following key questions.

1. Is there any relationship between participants' gender and their level of confidence in using the AI-enabled e-scooter in various traffic conditions?

To address this research question, we used the following questions from the survey:

- Q24. Compared to regular e-scooters, I feel more confident using the AI-enabled e-scooter in various traffic conditions because of its AI capabilities.
- Q27. Which gender identity do you most closely align with?
- Q28. What is your age group?

3.2 Distribution of Survey

The survey was accessible to respondents from November 7th and still accessible to the participants until the current date. However, for this study, the responses that are considered for this research were those received until December 14th, 2023.

The survey's target population encompassed all road users in the United States, including e-scooter riders and non-riders. Respondents were initially asked whether they had any disabilities, including color blindness, substance use disorders, visual impairments that impede passing a driving test, and various physical and cognitive disabilities. Those who did not have such disabilities proceeded to participate in the survey. The complete survey is available in the appendix of this study.

The survey was prepared and disseminated using Qualtrics. After inputting all the questions and answer choices, Qualtrics generated an active link. This link served as the access point for participants, who could participate in the survey through various devices. Participants could click on the provided link to access and complete the survey. Qualtrics streamlined the survey process by automatically generating the necessary tools for data collection and providing a convenient means for participants to engage with the survey content.

The survey was disseminated through various channels, including email distribution, social media platforms, UNC Charlotte classes, and campus communication.

Survey links were shared with participants through these channels, accompanied by a concise description of the study's purpose, assurance of confidentiality, and instructions for participation. We also utilized LinkedIn to promote the survey, with posts containing study descriptions and survey links. We distributed flyers in downtown Charlotte, strategically targeting areas frequented by e-scooter riders, where people commonly encounter and interact with e-scooters.

To ensure a more diverse participant population, including working professionals, we specifically targeted working professionals at construction work sites by approaching them with flyers. To further engage participants, we distributed flyers, both posted at physical locations and electronically, to provide essential information about the survey, its objectives, benefits, and instructions for access. Flyers were also distributed at locations (stations) along the Charlotte light rail. Individuals who encountered these flyers could choose to follow the provided instructions to access and complete the survey. The flyers were also posted on the UNC Charlotte transit buses and were accessible to any commuter to the campus.

In addition, targeted emails were dispatched to specific groups or mailing lists, including academic institutions and professional organizations.

To incentivize survey participation, respondents were offered the option to receive a $3 incentive gift card upon completion. Eligibility criteria required participants to be over 18 years old and possess normal vision, enabling them to obtain a driver's license. All the other participants with eligibility criteria were able to complete the survey.

3.3 Statistical Analysis

In this study, we analyzed the dataset composed of 221 survey responses using a combination of data analysis tools. These tools included Microsoft Excel, Qualtrics statistical analysis tools, and statistical methods facilitated through Microsoft Excel. By employing this approach, we aimed to extract meaningful insights and draw conclusions from the gathered data.

Our data analysis process encompassed various techniques, including data cleaning, manipulation, and statistical testing. Microsoft Excel served as a platform for initial data organization and basic calculations, facilitating a structured and orderly dataset. Qualtrics, with its statistical analysis tools, further aids in exploring patterns and relationships within the dataset. It provided an efficient means to generate summary statistics, visualize data, and perform preliminary statistical tests.

The Chi-Square Test served as a statistical method in this study, specifically implemented to analyze the data derived from respondents regarding their profiles and motivations for using AI-enabled e-scooters. This statistical tool is well-suited for examining associations between two categorical variables. In the context of our study, these variables were related to respondent characteristics (such as demographic information) and their reasons for choosing AI-enabled e-scooters. The Chi-Square Test facilitated an investigation, determining whether an association exists or not between these variables. Doing so allowed for an exploration of the alignment or divergence in proportions or frequencies within the distinct respondent groups, providing valuable insights into potential patterns or correlations.

Analysis of Variance (ANOVA) was used to assess and compare means related to the perceived safety of each type of road user. In this case, ANOVA was instrumental in identifying and quantifying potential differences among the means associated with the safety perceptions of different vulnerable road user categories. The utilization of ANOVA allowed for a better examination of the perceived safety levels across various groups, explaining any statistically significant variations. This methodological approach enabled an exploration of the differences in perceived safety, providing a quantitative basis for understanding distinctions in safety perceptions among the diverse types of road users considered in the study.

In summary, the Chi-Square Test and ANOVA were statistical methods capable of analysing and drawing meaningful insights from the data collected in this study. The Chi-Square Test addressed associations between categorical variables, while ANOVA facilitated a detailed comparison of means, enhancing the depth and validity of the research findings.

Additionally, graphical representations, such as histograms, box plots, and scatter plots, were employed to visually convey the distribution and relationships of relevant variables. These visuals aided in providing a more intuitive understanding of the data patterns.

The results presented through descriptive statistics and visualizations offered a comprehensive overview of our findings, facilitating an understanding of the research objectives and enhancing the credibility of our study.

CHAPTER 4: RESULTS AND DISCUSSION

In this chapter, the participants' responses to the key questions of the survey are analyzed, examining their perspectives on both regular and AI-enabled e-scooters. Out of 221 respondents, 195 were eligible and completed the survey, and the remaining were excluded from the study due to not meeting the eligibility criteria explained in the previous section. Analysis findings provided an important understanding of the underlying factors that influence perceptions of trust and safety among vulnerable adult road users in urban environments. Following the presentation of the analysis results, the discussion progresses to explore the connections between the participants' socio-demographic backgrounds and their prior experience in relation to their trust and safety perceptions towards AI-assisted e-scooters.

Figuring out who uses e-scooters will tell us which age or education groups use them the most. Any future design of AI-enabled e-scooters should consider these user groups. Knowing if people from specific educational backgrounds feel differently about e-scooters can help us predict how this group will use them in the future. Even though non-users are important, as they might become users, understanding their safety perceptions toward e-scooters is crucial. How often e-scooters are used is crucial because it indicates the current usage level of this transportation method and highlights the overall importance of paying attention to it.

Another key aspect of the findings is understanding why current e-scooter users hesitate or are unsure about using future AI-enabled e-scooters. Knowing these reasons could help us find solutions for designing this technology in the future, plan better, and encourage more users to use them.

The findings are important because they help us understand what factors affect

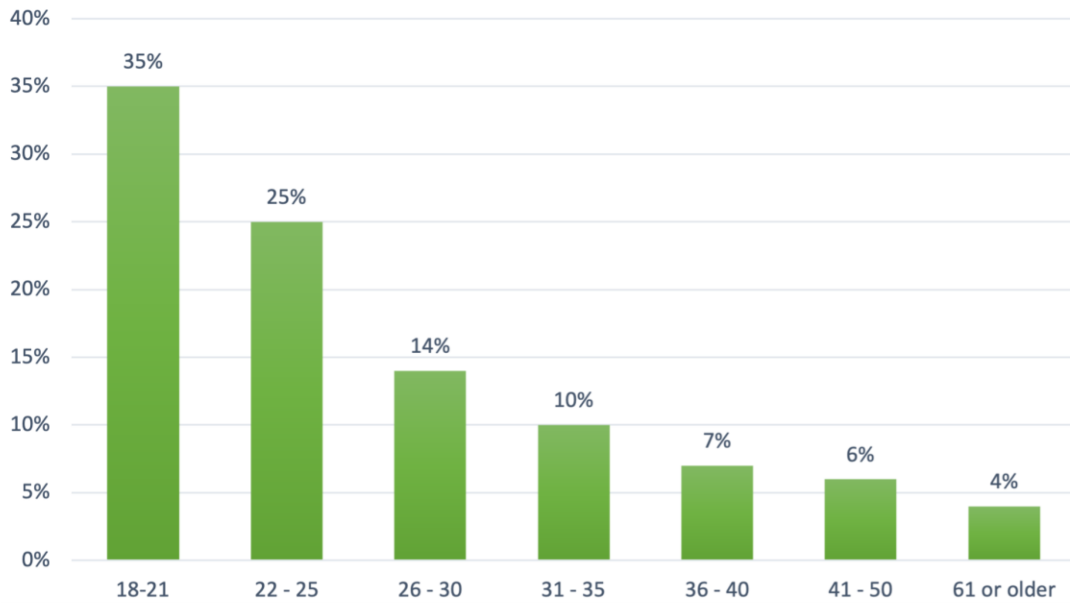

Figure 4.1: Age distribution (N=195)

how people feel safe around e-scooters and AI-enabled e-scooters. By taking these factors into account, future planning and design for AI-enabled e-scooters can be more accurate and practical.

4.1 Demographics and Background of Respondents

4.1.1 Gender, Age, and Race Distribution

In order to gain a deeper understanding of the survey population, participants were asked questions pertaining to gender, age, location, and e-scooter experience level (N= 195). As shown in Table 4.1, participants were asked (Q27), "Which gender identity do you most closely align with?" Results indicated that 118 participants were male, 72 were female, one was non-binary, and four preferred not to disclose.

When asked about their age (Q28), out of 195 total responses, the large majority (83%) of respondents were younger adults between 18 and 35, which appears to be in line with the general age distribution of e-scooter users. To better represent this data, their age distribution is also visualized in Figure 4.1.

Respondents to the survey were also offered (Q29) the opportunity to disclose their

Table 4.1: Demographic Distribution of Survey Respondents by Gender Identity, Age, and Racial Background

Gender Identity	**Count**	**Percentage**
Female	72	37%
Male	118	60%
Non-binary	1	1%
Prefer not to disclose	4	2%
Total	*195*	*100%*
Age		
18-21	68	35%
22 - 25	48	25%
26 - 30	27	14%
31 - 35	19	10%
36 - 40	14	7%
41 - 50	12	6%
51 - 60	0	0%
61 or older	7	4%
Total	*195*	*100%*
Racial Background		
White/Caucasian	68	35%
Asian	54	28%
Hispanic/Latino	32	16%
Middle Eastern	17	9%
African American	14	7%
Native American	2	1%
Other	3	2%
Prefer not to disclose	5	3%
Total	*195*	*100%*

racial background. The demographic composition of participants, as shown in 4.1, exhibits the following distribution about race: 35% of the participants were white. 28% were Asians. 16% were Hispanic or Latino. 9% were Middle Easterns. 7% were African American. 2% were Native American, and 3% preferred not to disclose their ethnic background.

4.1.2 Education Background and Annual Household Income

Within the examined participant's annual household income, as shown in Figure 4.2, 47 individuals conveyed household incomes falling below $20,000 annually. Forty- one participants(22%) expressed their household income, in a range from $20,000 to $50,000. Moreover, 16 participants (9%) conveyed household income within the range of $100,000 to $125,000, and an additional 16 (9%) participants reported incomes within the bracket of $50,000 to $75,000. The next group, around 14 participants (7%), reported household incomes falling within the range of $75,000 to $100,000. Twelve participants (7%) indicated between $125,000 and $150,000, while 9 participants (5%) reported incomes between $150,000 and $175,000. Ten participants (6%) indicated household incomes exceeding $200,000, and 6 participants (4%) fell within the income bracket of $175,000 to $200,000. This data provides an overview of the income distribution within the analyzed participant cohort.

Participants were also asked (Q32) regarding their highest level of education. Among 195 responses, approximately 58 participants have high school graduates or equivalent. Of the respondents, 53 reported holding a bachelor's degree, while 45 indicated attainment of a master's degree. Additionally, 19 participants disclosed having earned an associate degree, 18 articulated possession of a doctorate degree, and 2 participants attested to holding a professional healthcare degree. As shown in Figure 4.3, it is noteworthy that no participants reported their education below the level of high school, including individuals with a middle school education or no formal education.

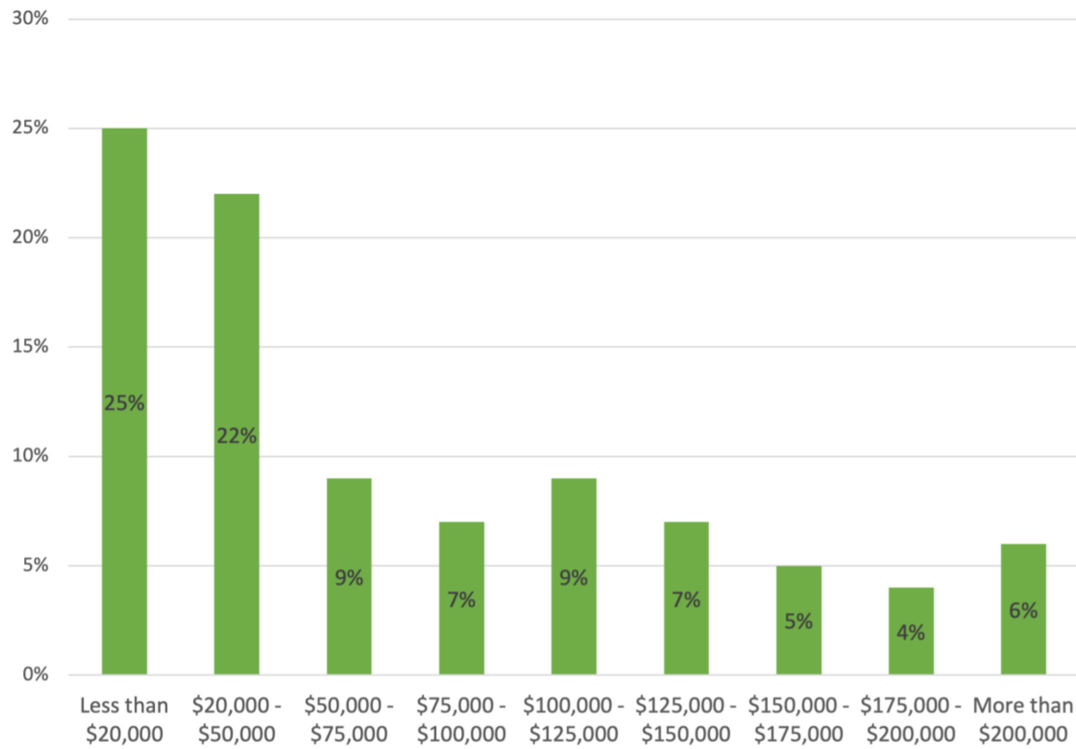

Figure 4.2: Income distribution (N=195)

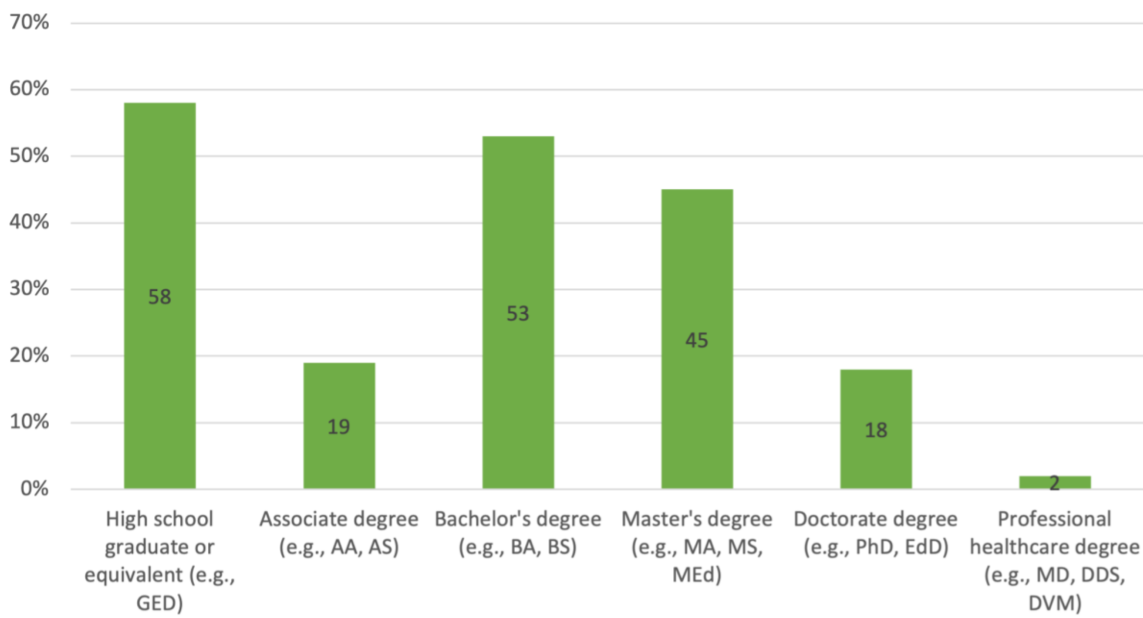

Figure 4.3: The highest level of education (N=195)

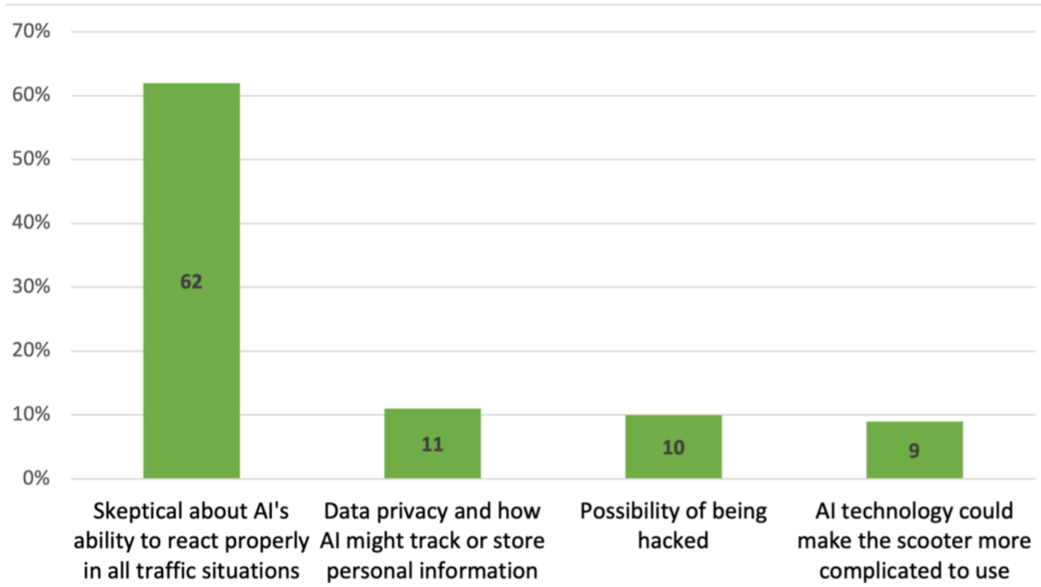

Figure 4.4: Factors influencing participants' reservation in choosing the AI-assisted e-scooter (N=92)

4.1.3 Participants' main concern for not choosing the AI-enabled e-scooters

Participants who initially conveyed reservations or uncertainty about choosing the AI-assisted e-scooters were subsequently asked about their primary concerns. We asked 92 participants about their main concerns for not choosing AI-enabled e-scooters or not being confident about their choice. As shown in Figure 4.4, the majority of responses, around 67%, were that participants expressed that they were skeptical about the AI's ability to react properly in all traffic situations. 12% of responses were about data privacy and how AI might track or store personal information. While 11% were concerned about the possibility of being hacked, 10% of participants felt that the AI technology could make the scooter more complicated to use.

4.1.4 Distribution of Driver's License Categories Among Respondents

Participants were asked (Q1) to select all the categories that represented their current licensing status. The diverse range of options allowed for the understanding of the various types of licenses held by the respondents, including potential combinations and the presence of any additional, unspecified licenses falling under the "Other."

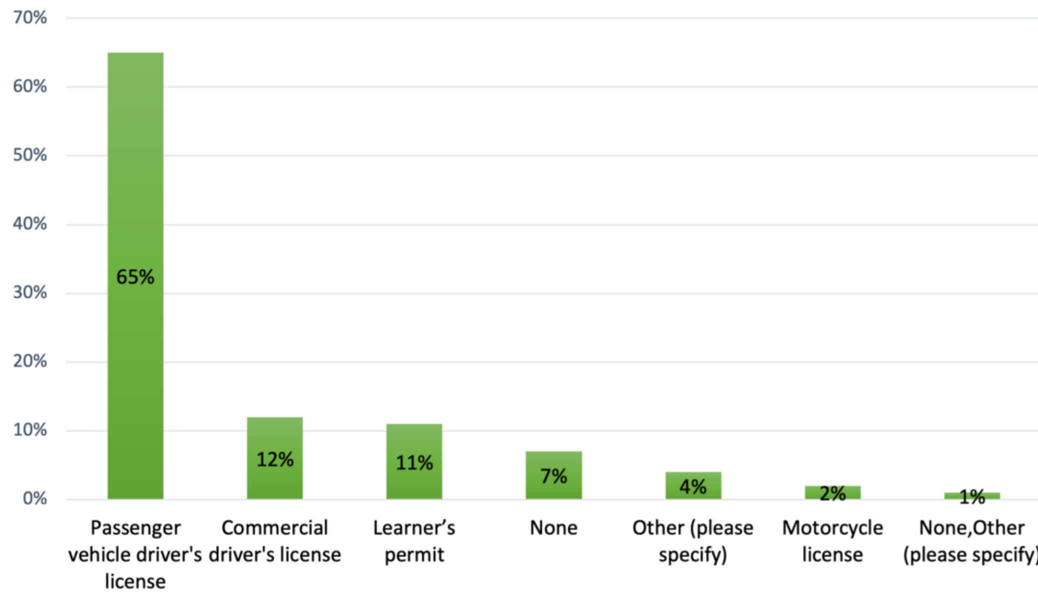

Figure 4.5: Category of participant's driving license (N=195)

This information serves to capture the 195 responses about the licensing profiles of the survey participants, as shown in Figure 4.5.

4.2 Participants' Usage Patterns and Experience with E-scooters

4.2.1 Frequency of e-scooter usage

The survey inquired (Q2) about participants' frequency of e-scooter usage, yielding diverse responses. As shown in Figure 4.6, close to half of the participants have used e-scooters, while more than half (55%) indicated that they have never used e-scooters. A smaller group of 11 participants attested to utilizing e-scooters on a daily or almost daily basis. Furthermore, 8 participants reported using e-scooters several times a month, while 7 participants indicated a frequency of use several times a week. These findings provide insights into the varied patterns of e-scooter utilization among the surveyed participants.

4.2.2 Training in E-Scooter Operation and Perceived Ease of Use

In the survey, participants were also asked (Q13) if they had undergone any training for e-scooter usage. As shown in Figure 4.7, the available response options covered a

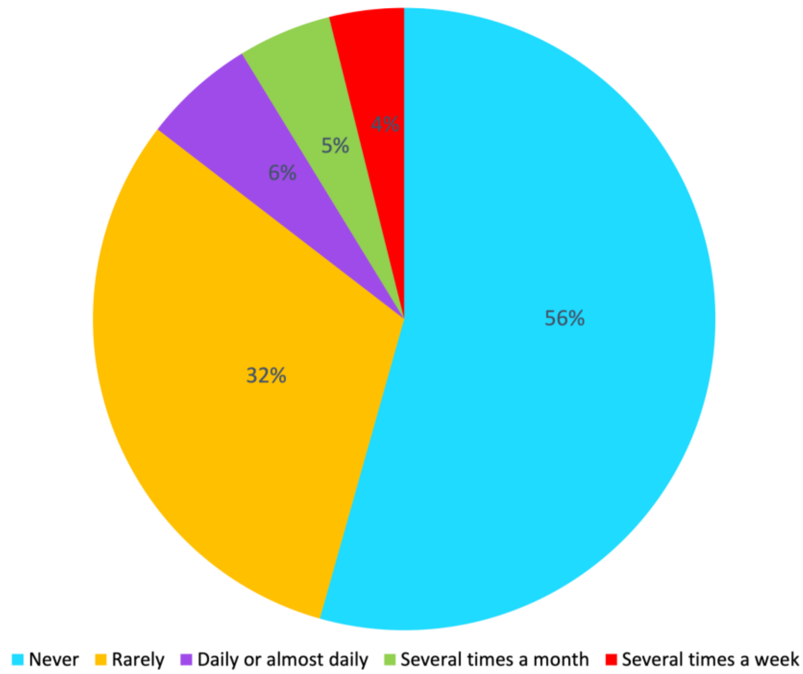

Figure 4.6: Frequency of usage of e-scooters (N=195)

spectrum of training scenarios, and participants were asked to select the option that best described their training experience. These ranged from ’Comprehensive,’ which covered all aspects, including e-scooter operation, safety, maintenance, and etiquette, to ’I have never received any training,’ acknowledging those who had no formal training in e-scooter usage. Additionally, the ’Introductory’ option was included for those who received a basic overview of e-scooter operation along with some safety tips. For participants who pursued learning independently, the ’Self-guided’ option was available, indicating the use of online resources or manuals without formal training. Lastly, the ’Standard’ option catered to those who underwent training that addressed the essential aspects of e-scooter operation and safety.

As shown in 4.7, the survey responses indicate the majority, with 129 respondents, have ’never received any training,’ highlighting a significant gap in formal training among e-scooter users, which could have implications for their safety and the safety of others on the road. Only a small fraction of the respondents, specifically five individuals, reported receiving ’Comprehensive’ training. Around 30% of participants reported

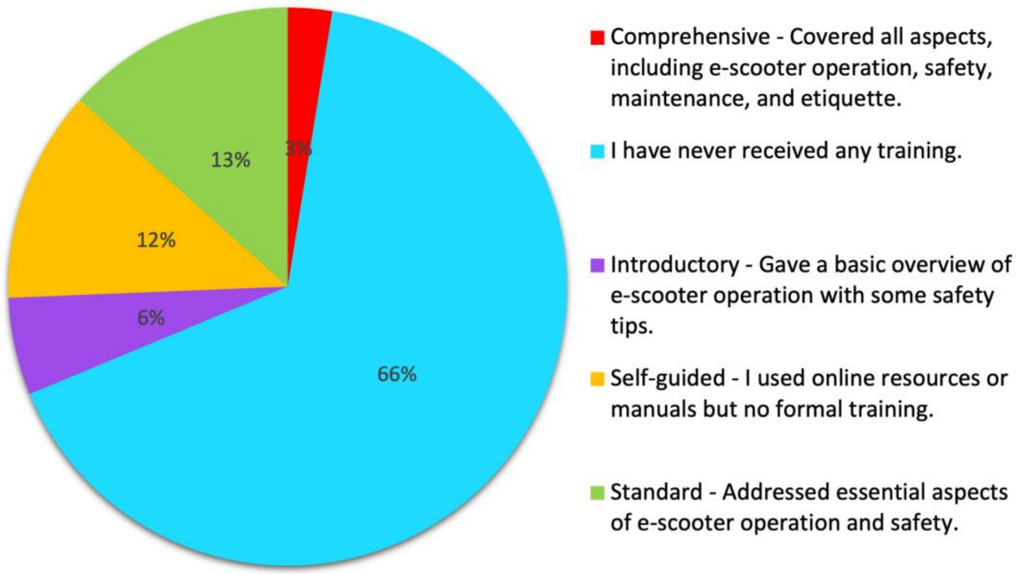

Figure 4.7: Training for E-scooter Usage (N=195)

receiving ’Standard,’ ’Introductory,’ or ’Self-guided’ training.

The participants were asked (Q11) about their perceived ease of operating an e-scooter. As shown in 4.8, of (195) participants, 35% of participants responded operating an e-scooter is easy for them, while 29% responded moderate, and 29% responded very easy to the question of how easy operating an e-scooter is for them. Meanwhile, 5% and 4% responded with difficulty and very difficultness, respectfully.

4.2.3 Preferences for E-Scooter Sidewalk Use and Shared Lane Perceptions

We asked participants about the conditions under which they would be more inclined to utilize e-scooters on sidewalks (Q12). The objective of this inquiry was to gain an understanding of the infrastructure preferences among e-scooter users and ascertain instances when they opt for sidewalks, considering the heightened vulnerability of pedestrians in such scenarios. As shown in Figure 4.9, the most common response, constituting 24% of participants, indicated an inclination to use sidewalks in the presence of heavy road traffic. Furthermore, 19% of respondents cited a preference for sidewalks when they are wide, providing enough space to accommodate both e-scooters and pedestrians, while 17% mentioned resorting to sidewalks in the absence of designated e-scooters or e-bike lanes.

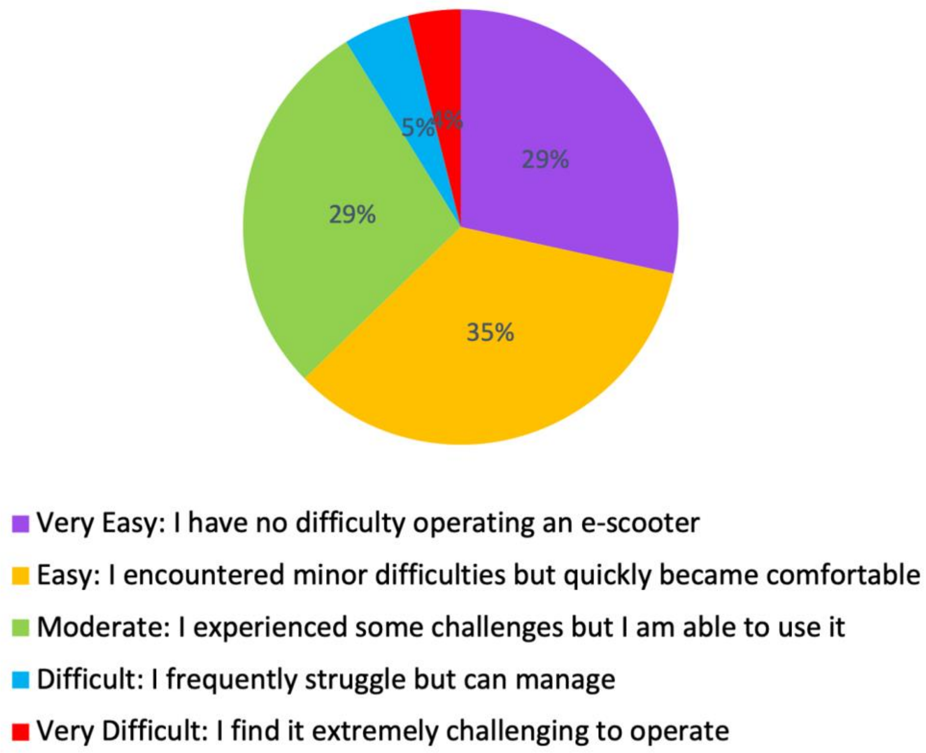

Figure 4.8: Participants perception of ease of operating e-scooters (N=195)

Additionally, 16% expressed a pro- clivity for sidewalk usage when pedestrian traffic is sparse. 13% identified post-dark hours as a circumstance influencing their choice. Notably, 9% specified opting for sidewalks in the vicinity of major or multi-lane roads. A distinct minority, comprising 2% of participants, asserted an unequivocal refusal to use sidewalks under any circumstances. This data provides insights into the nuanced considerations influencing e-scooter users' decisions to utilize sidewalks, particularly when confronted with factors such as traffic congestion, infrastructure characteristics, and time considerations.

In our survey, participants were then presented with a scenario involving the im- implementation of a shared lane for bicycles, e-bikes, and e-scooters (Q10). The specific question addressed the perceived safety of such a lane from the perspective of individuals who use e-scooters. Participants were asked to provide their opinions on the

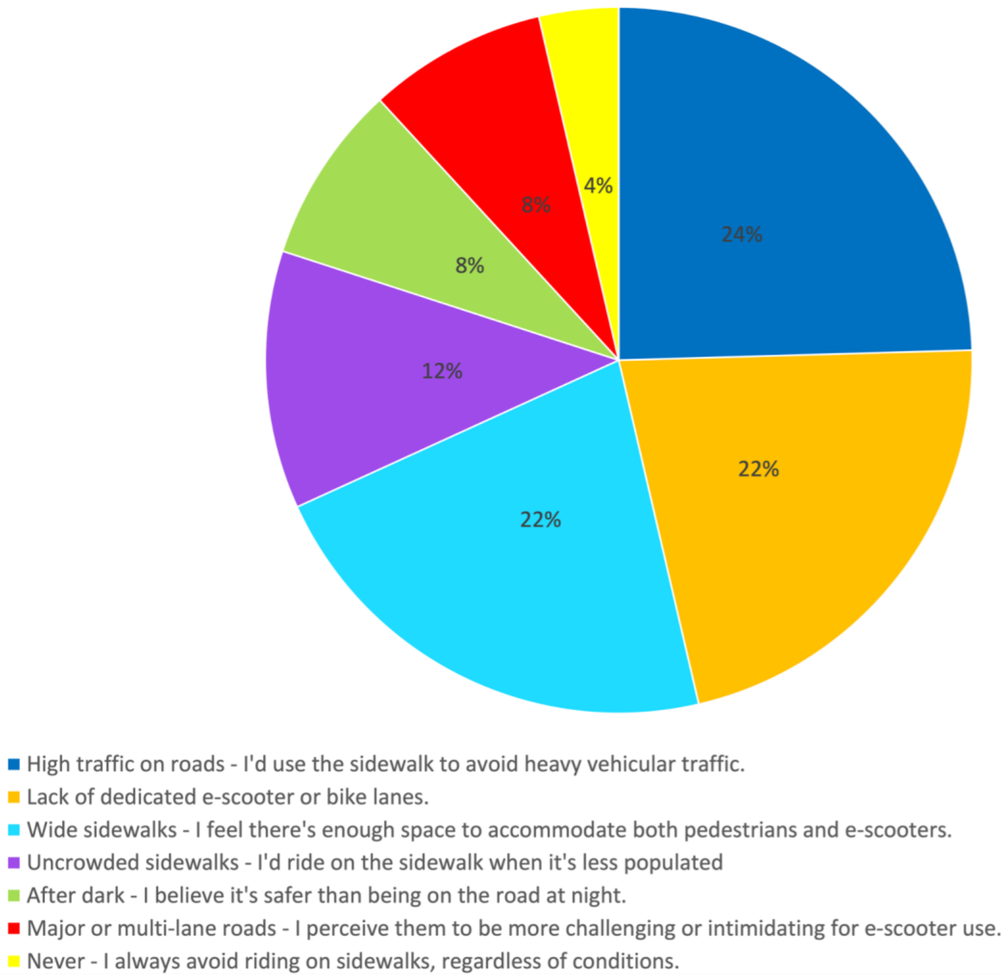

Figure 4.9: Factors Influencing Riders' Inclination to Use E-Scooters on Sidewalks (N=195)

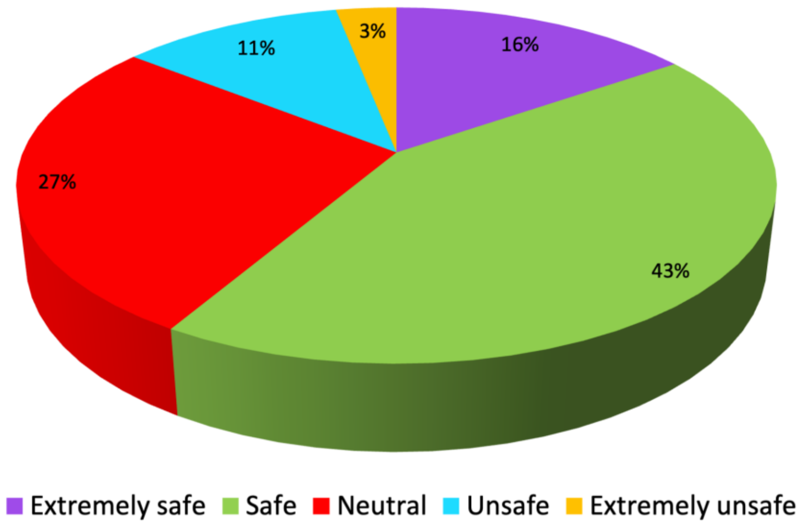

Figure 4.10: Perception of safety about shared lanes between e-scooters, e-bikes, and bicycles (N=195)

safety of the proposed shared lane, with response options ranging from "extremely unsafe" to "extremely safe." The objective of this question was to find out the comfort level and perceived safety concerns of e-scooter riders in the context of shared infrastructure; as shown in Figure 4.10, 43% of participants expressed that they feel safe, and 16% feel extremely safe in the shared lane. While 27% of participants said that they were neutral about it, participants who expressed they felt unsafe or extremely unsafe were 11% and 3%, respectively.

4.3 Safety Perceptions and Incidents

4.3.1 Accident and near-miss accident experience

In response to the question of whether you have ever been involved in an acci- dent while riding an e-scooter. This question was asked from the participants who expressed they have used e-scooters before. alongside with that 78% said they have never been in or close to getting into an accident, and 18% have been close to getting into an accident, and 3% have experienced an accident while riding an e-scooter as shown in Figure 4.11.

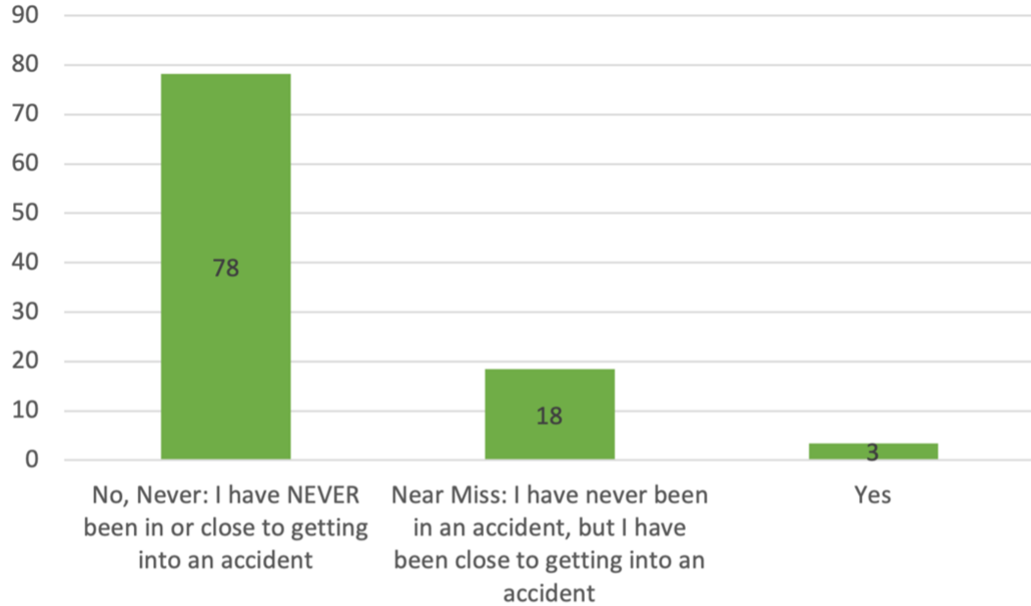

Figure 4.11: participants accident experience (N=87)

4.3.2 Circumstances leading to an accident or near miss

We asked participants who reported they had experienced an accident or near-miss accident about the circumstances that led to their accident. The distribution of the reported circumstances that led to the accident for 40 participants is shown in Figure 4.12.

4.3.3 Injury Severity

As shown in 4.13, among 40 participants who expressed they had experienced an accident while riding an e-scooter, 63% responded they had no injury, and 20% had experienced minor injury with little to no medical attention. 10% of the respondents reported moderate injuries, with the need for some medical attention but not hospitalization, while 5% had critical injuries that required intensive medical care or surgery. Finally, 3% rated their experiences as severe with hospitalization needs, as shown in Figure 4.13.

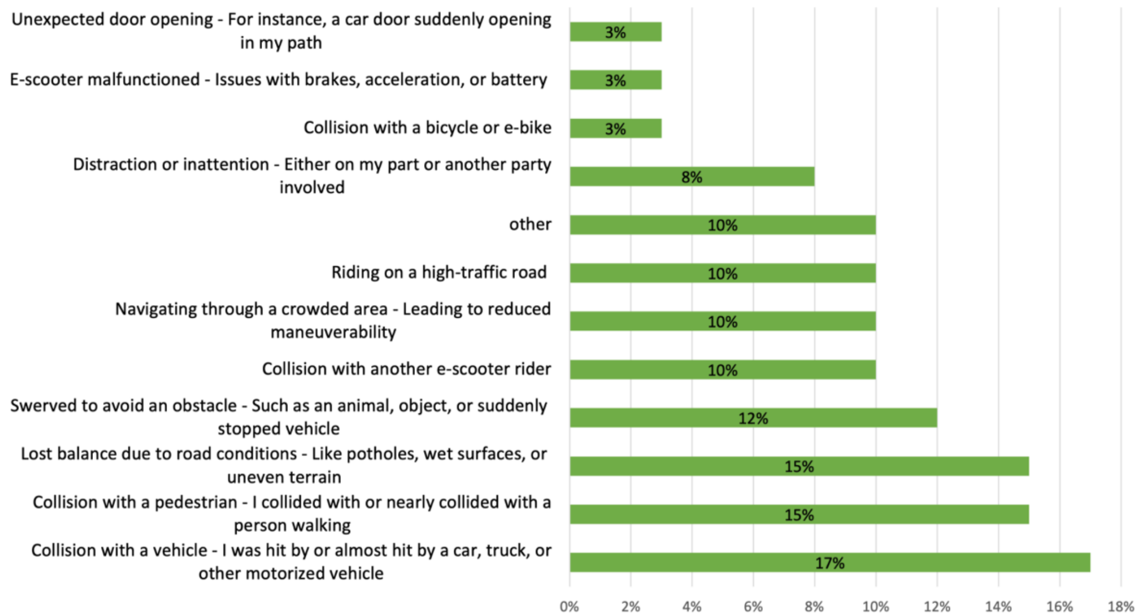

Figure 4.12: Circumstances that led to accidents or near-miss accidents while using the e-scooter

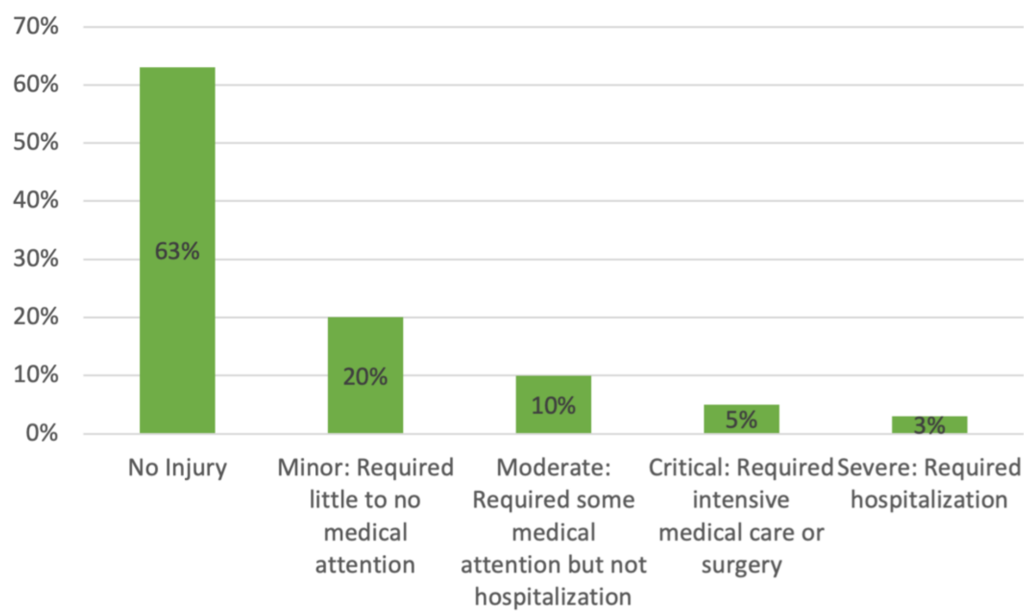

Figure 4.13: The severity of the injury that participants have in their e-scooter accident

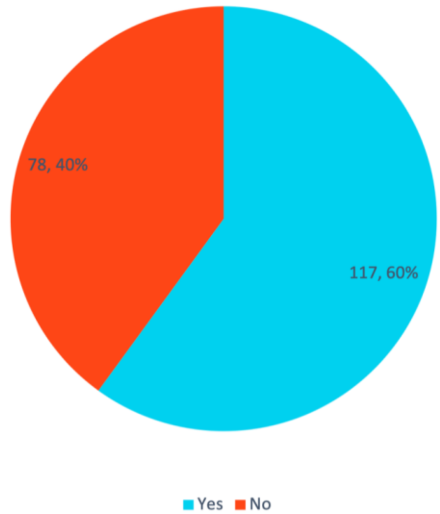

Figure 4.14: Experience in using driving assistance technologies in cars (N=195)

4.4 Experience with driving assistance technology

Concerning automotive technologies such as lane departure warning, collision avoidance, blind spot monitoring, adaptive cruise control, etc., participants were queried (Q20) regarding their utilization of these features. Out of a total of 195 respondents, 117 individuals (60%) affirmed having employed these technologies, whereas 78 participants (40%) declared non-utilization of such features, as shown in Figure 4.14. The purpose of this inquiry was to ascertain the prevalence of engagement with these automotive technologies within the sampled cohort.

In response to the inquiry on sentiments toward the safety of driving assistance technologies, a total of 195 participants furnished their perspectives. The prevailing sentiment within this cohort leaned towards a positive experience, as the majority articulated a sense of safety in utilizing driving assistance technologies. The subsequent category comprised individuals expressing neutrality on the matter. Notably, approximately 20 respondents conveyed either feeling exceptionally secure or unsafe when engaging with these technologies. A smaller subset of participants conveyed a distinct apprehension, expressing feelings of extreme insecurity in relation to the use of driving assistance technologies.

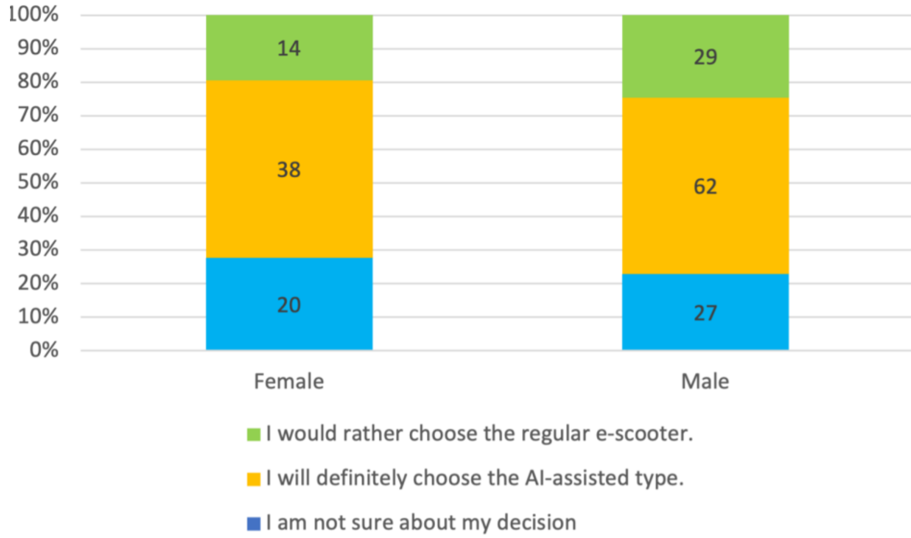

Figure 4.15: Gender-Based Preferences in E-Scooter Selection Between AI-Assisted and Regular E-Scooters at Equal Pricing

4.5 Inferential Analysis

4.5.1 The Impact of Gender, Race, and Educational Background on Choices Between AI-Assisted and Regular E-scooters

We examined the preferences of participants regarding the choice between AI-assisted and regular e-scooters when they are priced identically. The survey question (Q25) specifically asks participants to choose between an AI-assisted e-scooter and a regular e-scooter, with three response options: a definite preference for the AI-assisted type, uncertainty about their decision, or a preference for the regular e-scooter. By analyzing responses to this question alongside demographic data of gender and race of the participants, as shown in Figure 4.15, we investigated any potential correlations or differences in preferences based on these demographic factors.

We conducted a Chi-square test to determine if there was a significant association between gender and the choice of e-scooter type when both were available at the same price. The results indicated no significant association between gender and e-scooter preference ($p = 0.98$), suggesting that gender does not play a decisive role in this specific preference.

The investigation into potential disparities in the selection of AI-enabled e-scooters from the deck based on participants' racial backgrounds yielded statistically significant outcomes (p = 0.02) as shown in Figure 4.17.

We conducted a single-factor analysis of variance (ANOVA) test to examine whether there exists a difference in the preference for AI-enabled e-scooters between Hispanic and Asian participants. The results, with a p-value of 0.5, indicate a lack of statistical significance about this matter.

An investigation was conducted to explore whether a variation exists in the international community regarding AI-enabled e-scooters among participants possessing different levels of educational background. The findings from the Chi-square test did not show a statistically significant difference, signifying that participants with diverse educational backgrounds exhibited varying preferences in their selection of AI-enabled e-scooters (p = 0.054).

A subsequent t-test was employed to scrutinize the preferences of two distinct groups: 58 participants possessing high school degrees and 53 participants holding bachelor's degrees. The obtained t-test statistic of 0.741 does not reach the conventional threshold of 0.05 for statistical significance. Therefore, based on the results of the t-test, we fail to reject the null hypothesis. This suggests that there is insufficient evidence to assert a significant difference in the preferences for AI-enabled e-scooters between participants with high school degrees and those with bachelor's degrees in the observed sample.

Following a similar analytical approach, a t-test was executed to examine potential distinctions in preferences for AI-enabled e-scooters among 19 participants with associate degrees and 18 participants holding doctorate degrees. The computed t-test statistic for this comparison was 0.935. Based on the obtained results, there is insufficient evidence to support the hypothesis of a significant difference in preferences between the two groups of participants in the context of preference for choosing

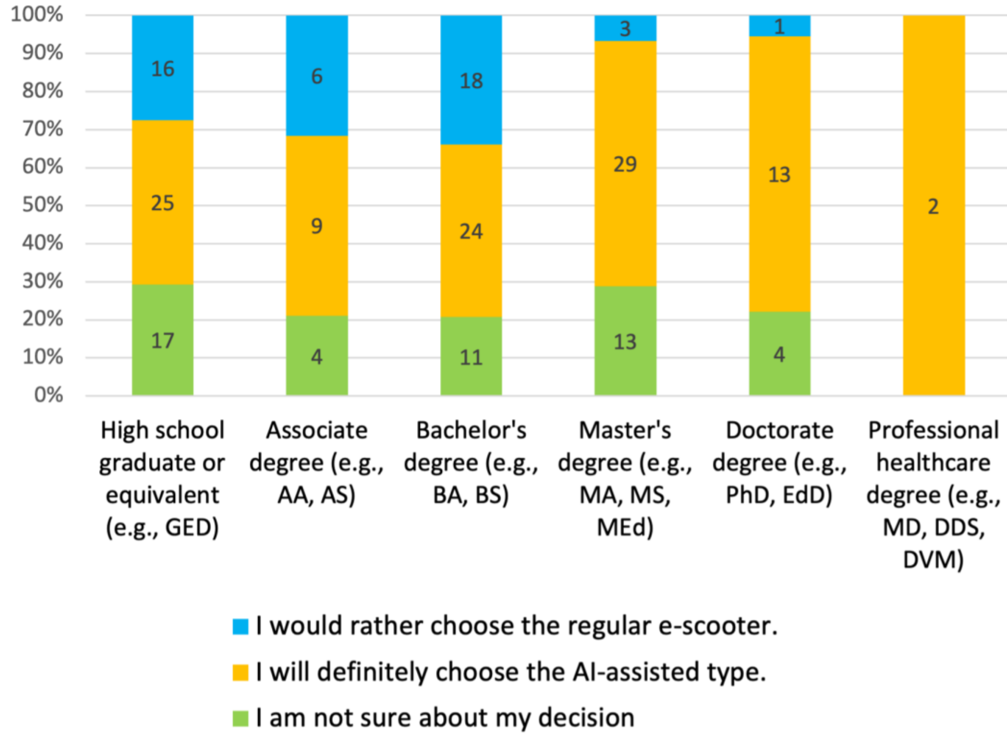

Figure 4.16: Participants preference on choosing AI-enable e-scooters based on their educational background (N=195)

AI-enabled e-scooters instead of regular e-scooters.

When comparing the choices between AI-enabled e-scooters and regular scooters and the level of education, participants with doctorate degrees are the major group that expressed that they will definitely choose the AI-enabled type. Participants with bachelor's degrees and high school degrees were the next group to express a preference for AI-assisted e-scooters. The number of participants with high school degrees who expressed that they would rather choose the regular e-scooters is higher than other groups, as shown in Figure 4.16.

4.5.2 Correlation between e-scooter choosing and race

When exploring the relationship between race and e-scooter choice, we analyzed responses to two specific survey questions. The first question (Q25) asked participants to select between an AI-assisted e-scooter and a regular e-scooter, both priced.

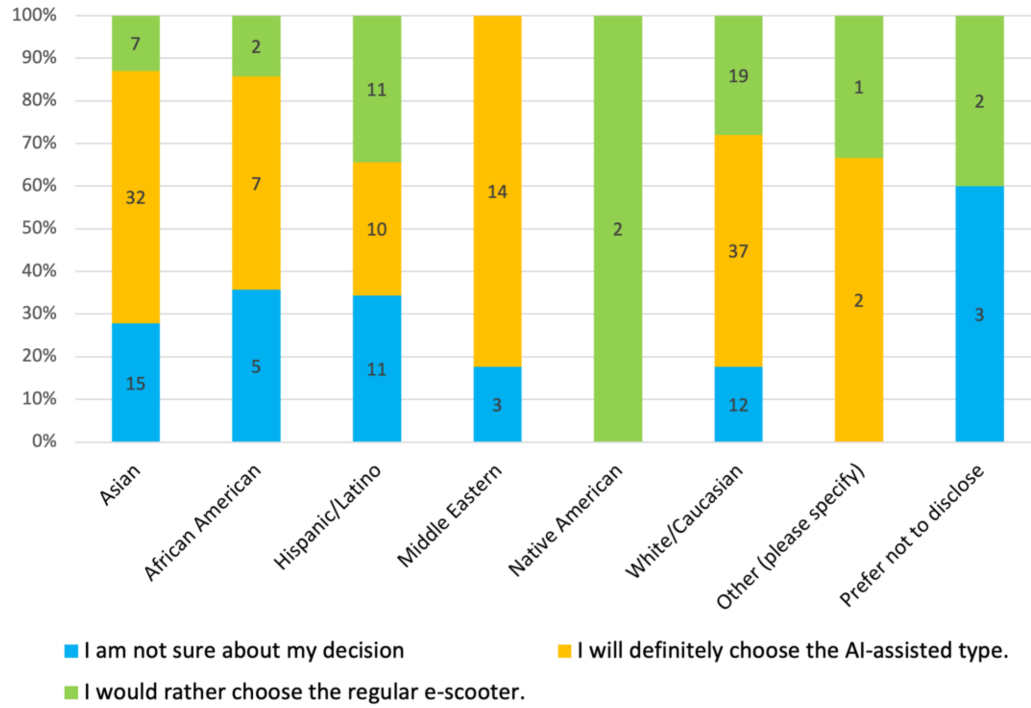

Figure 4.17: Race-Based Preferences in E-Scooter Selection Between AI-Assisted and Regular E-Scooters at Equal Pricing (N=195)

Equally, the second question (Q29) gathered demographic data, focusing on participants' ethnic backgrounds. The options in Q29 included Asian, African American, White/Caucasian, Hispanic/Latino, Native American, Pacific Islander, Middle Eastern, and an 'Other' category with a prompt for specification. By cross-referencing e-scooter preferences with the racial demographics, as illustrated in Figure 4.17, we aimed to uncover any patterns or differences in e-scooter choices among various ethnic groups. This analysis is key to understanding how cultural and societal factors might influence transportation technology choices.

4.5.3 The impact of race and gender on trust in AI-enabled e-scooters in handling different situations

We assume the potential existence of a correlation between the gender of participants and their level of trust in the artificial intelligence's capacity to manage unexpected circumstances while individuals are utilizing e-scooters (Q24), as shown.

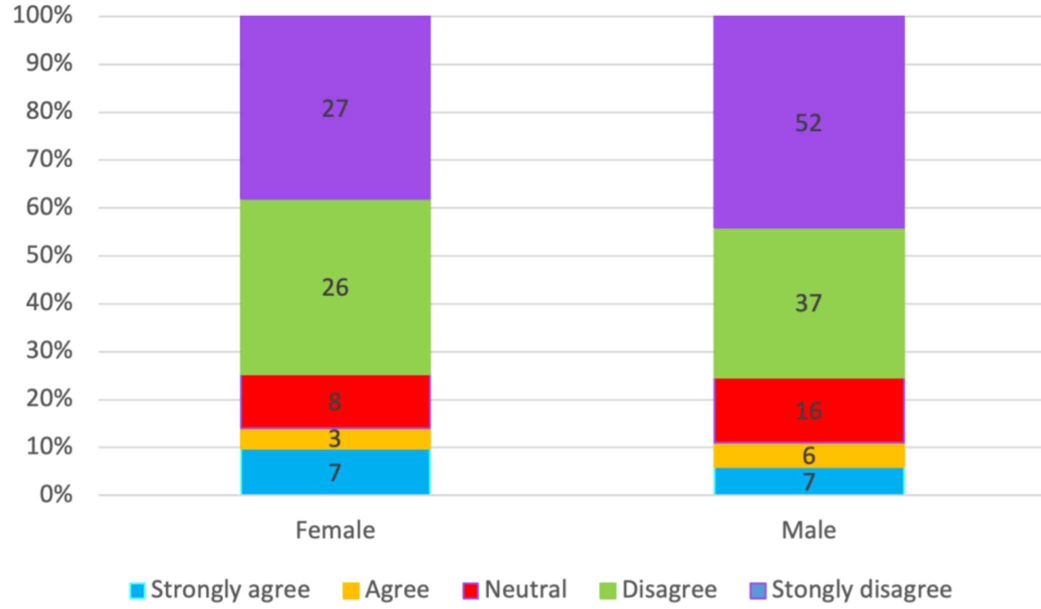

Figure 4.18: Trust in AI-enabled e-scooters based on gender (N=195)

In Figure 4.18. A Chi-square test was employed to investigate whether participants' trust in AI-enabled e-scooters to handle unexpected situations varies based on their gender. The obtained result was deemed statistically significant (p = 0.0001), suggesting that participants exhibit distinctive levels of trust in AI-enabled technology on e-scooters that are contingent upon their gender. A Chi-square test was employed to in- investigate whether participants' trust in AI-enabled e-scooters to handle unexpected situations varies based on their race. The obtained result was deemed statistically significant (p = 0.016), suggesting that participants exhibit distinctive levels of trust in AI-enabled technology on e-scooters contingent upon their racial background.

4.5.4 Perception of safety around e-scooters in different situations based on age

In the survey, participants were asked (Q3) about their perceptions of safety concerning e-scooters while they were pedestrians. Their responses were systematically classified on a spectrum ranging from "extremely safe" to "extremely unsafe." Subsequently, these responses were juxtaposed with participants' self-identified age groups, which were delineated as 18-21, 21-25, 26-30, 31-35, 36-40, 41-50, 51-60, and

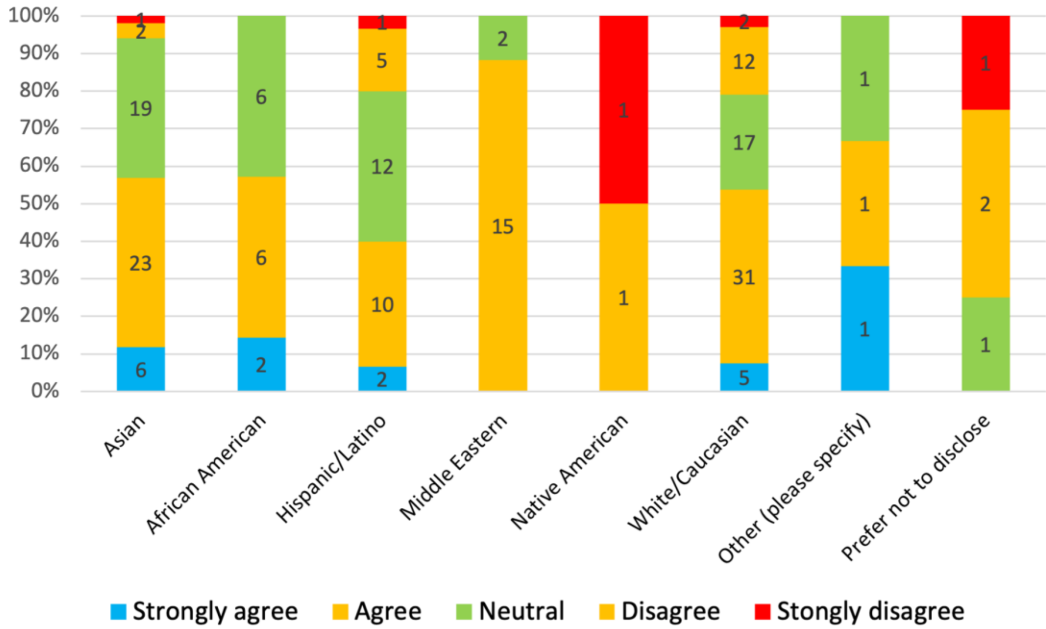

Figure 4.19: Trust in AI-enabled e-scooter based on racial background (N=195)

61 years and older. Individuals aged 22-25 demonstrated a heightened inclination towards perceiving e-scooters as "extremely safe," while those in the 18-21 and 41-50 age brackets expressed a notable sense of safety in comparison to other age groups. Intriguingly, the 26-30 age group emerged as the primary demographic expressing a predilection towards feeling "unsafe" in relation to e-scooters.

In the next steps, Participants were asked about their perceived safety levels in the presence of e-scooters across various scenarios as vulnerable road users, including when they were pedestrians, riding bicycles, operating e-bikes, driving cars, or riding e-scooters themselves. The analysis of responses revealed notable variations in perceived safety. When participants assumed the role of pedestrians, over 60 individuals expressed a heightened sense of safety around e-scooters. Additionally, more than 40 participants reported feeling safe while riding a bicycle or driving a car in the vicinity of e-scooters, as shown in Figure 4.20. The subsequent groups in terms of perceived safety included participants riding another e-scooter, with the least sense of safety reported by those on e-bikes. More than 40 participants expressed feeling unsafe around e-scooters when driving a car, making this the largest group reporting a lack of perceived safety.

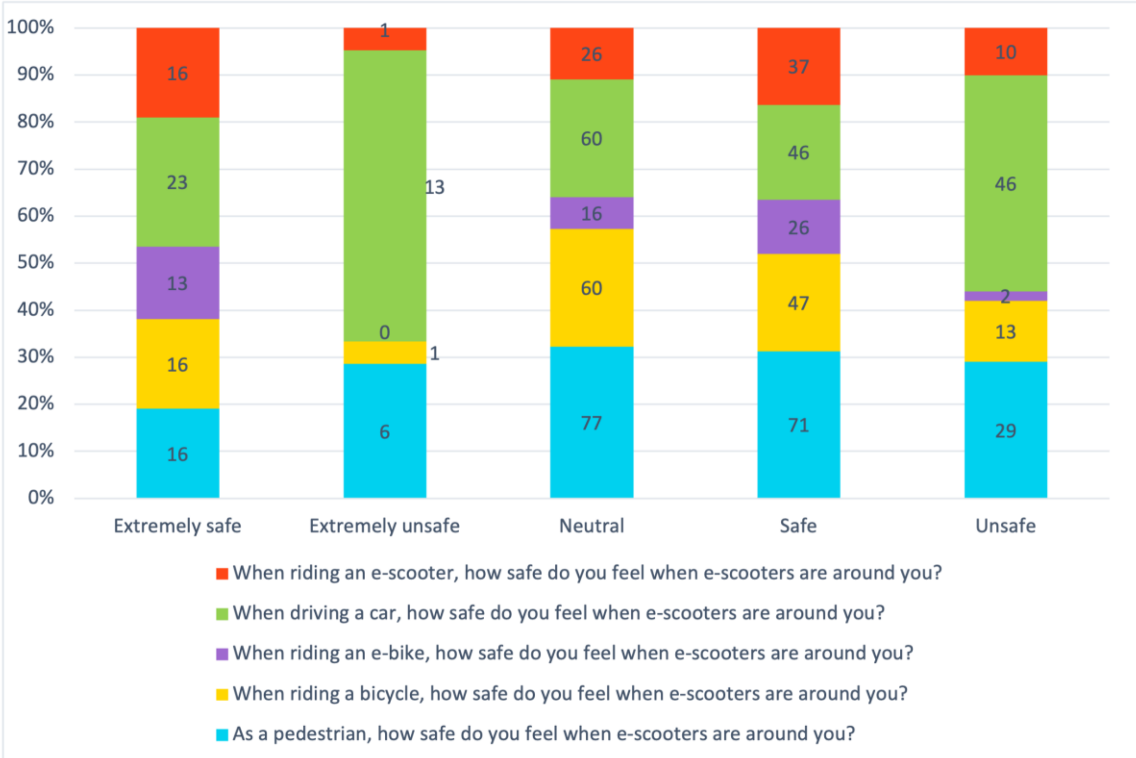

Figure 4.20: Perceived safety levels as a pedestrian in the presence of e-scooters in different situations (N=195)

Pedestrians comprised the next group with heightened feelings of unsafety, while riders of e-bikes constituted a smaller subset expressing a sense of vulnerability around e-scooters.

4.5.5 Preference for the notification style on AI-enabled e-scooters

The hypothesis was that there is a significant difference between the gender of the participants and their preference on the way that they are more preferred to receive notification from the AI-enabled e-scooters. The participants were given a choice between vibration in the e-scooter handlebar, speed control assistance, sound alarm, lane-keeping assistance, the combination of sound alarm and vibration, the combination of speed-control and lane-keeping assistance, and at the end, the combination of all of the mentioned notification styles (Q23). To examine this hypothesis, we con-

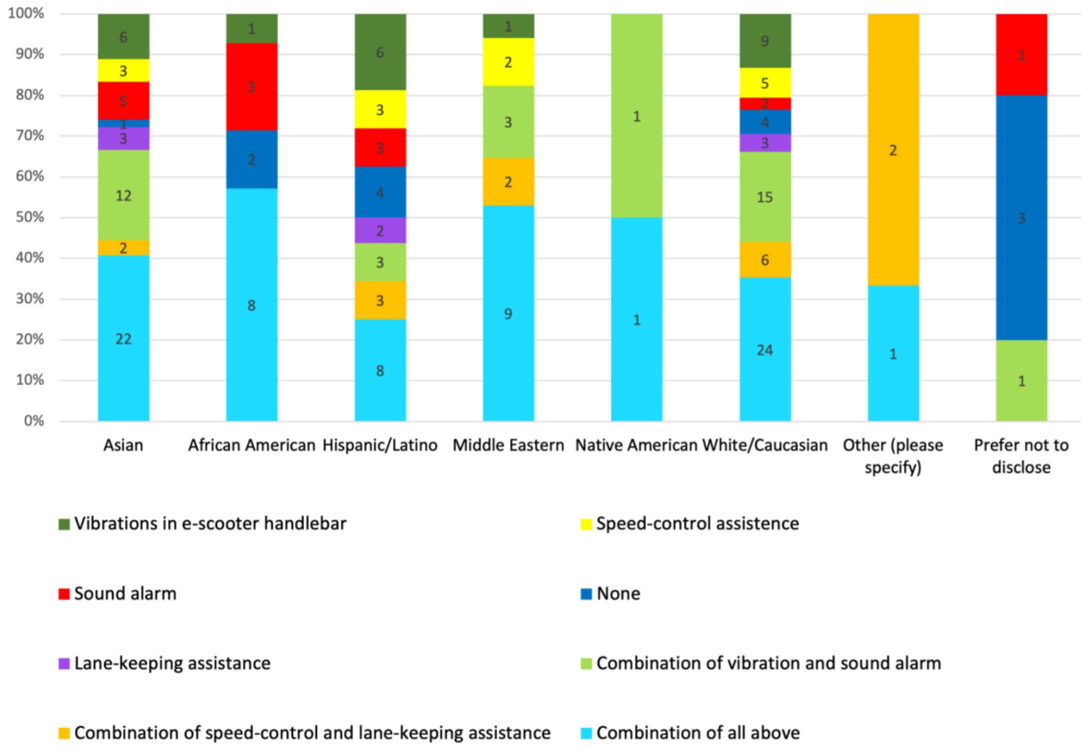

Figure 4.21: Participants preference on AI-enable e-scooter notification style (N=195)

Ducted a CHI Square test, and the results show that there is not a significant difference between the female and male participants in the ways that they prefer to receive the notifications from the AI-enabled e-scooters ($p = 0.093$).

The hypothesis was that there is a significant difference between participants' recent background and their preference on the way that they are more preferred to receive notification from the AI-enabled e-scooters, as shown in Figure 4.21. To examine this hypothesis, we conducted a CHI Square test, and the results show that there is a significant difference between the racial backgrounds of participants and the ways that they prefer to receive notifications from the AI-enabled e-scooters. The p-value is extremely small, and it shows that the difference between observed and expected frequencies is highly significant.

4.5.6 Participants feeling confident in using AI-enabled e-scooter

Participants were tasked with assessing their confidence levels in employing the AI-assisted e-scooters across diverse traffic conditions in comparison to regular e-scooters. The evaluation was conducted on a scale ranging from ’Strongly Agree’ to ’Strongly Disagree’ to hypothesize the theory of whether their level of confidence in using AI-assisted e-scooters in various traffic conditions has any relation with their age (Q24). After conducting a chi-square test to examine our hypothesis, the results indicate that there is no significant relationship between age and the level of confidence in using AI-enabled e-scooters (p = 0.256).

To assess whether the level of confidence in using AI-enabled e-scooters, as compared to regular e-scooters, is associated with participants’ gender, a Chi-square test was conducted (Q24). Participants were tasked with assessing their confidence levels in employing the AI-assisted e-scooter across diverse traffic conditions in comparison to conventional e-scooters, as shown in Figure 4.22. The result showed a specific relationship between gender and the level of confidence in using AI-enabled e-scooters in different traffic situations.

4.5.7 Perception of safety around e-scooters

In the survey, respondents were asked about their perceptions of the safety of e-scooters while they are pedestrians. The responses were categorized along a spectrum ranging from "extremely safe" to "extremely unsafe." The outcomes of this inquiry were subsequently cross-referenced with participants’ self-identified racial categories, which encompassed classifications such as Asian, African American, white or Caucasian, Hispanic or Latino, Native American, Pacific Islander, Middle Eastern, and those who either preferred not to disclose their racial identity or identified with another race.

The graphical representation presented herein illustrates the varying perspectives.

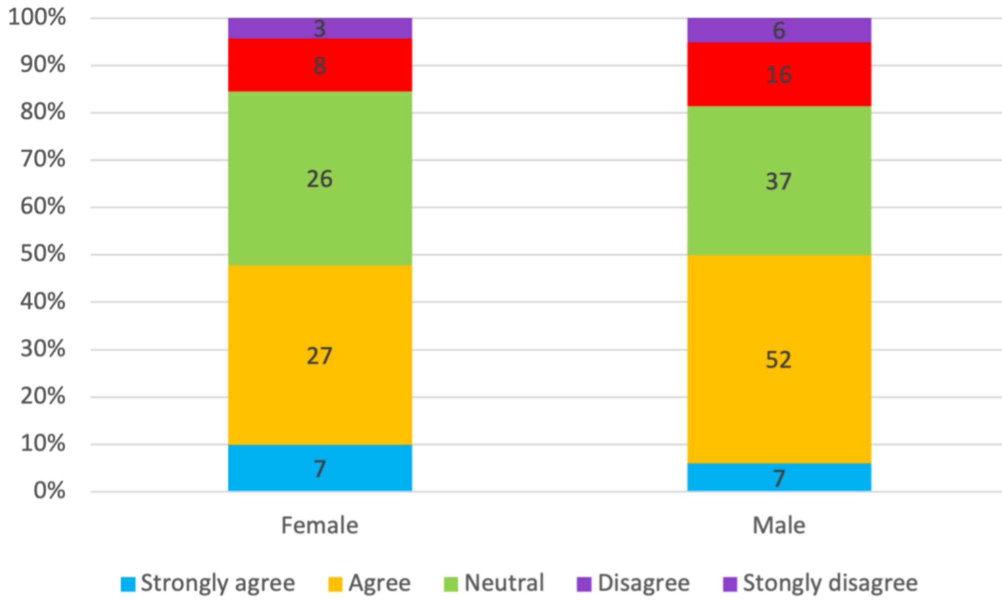

Figure 4.22: Participants' trust in using AI-enable e-scooter in different traffic situations (N=195)

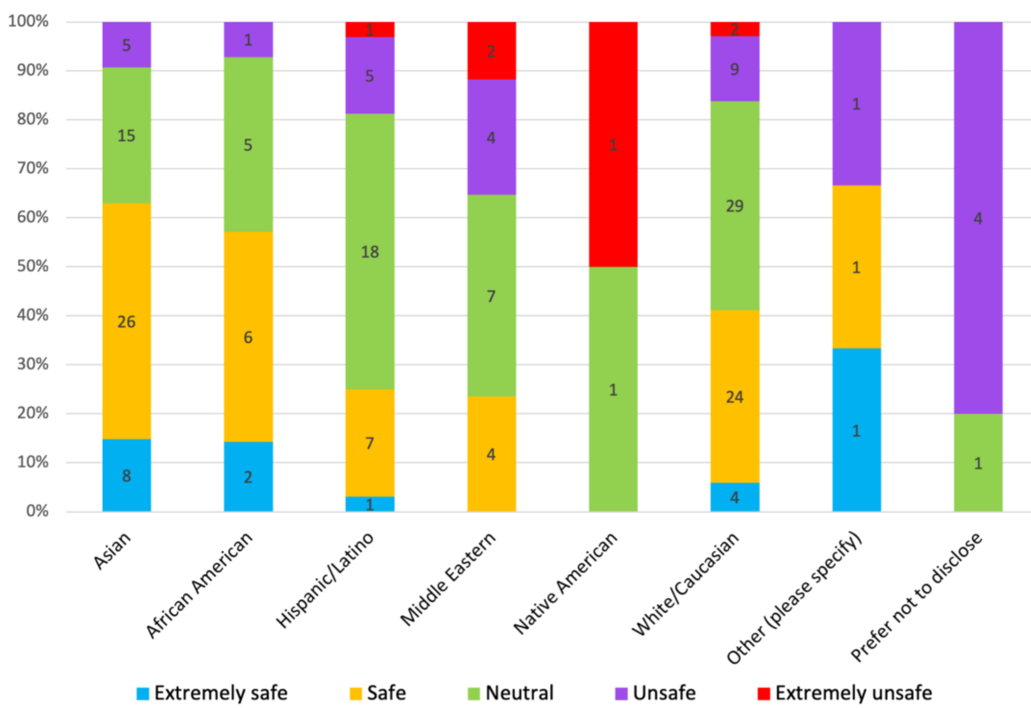

Figure 4.23: Perception of safety as pedestrians based on race around e-scooters (N=195)

On e-scooter safety among participants from diverse racial backgrounds. Analysis of the dataset indicates that Asian respondents express a heightened sense of security about e-scooters, whereas individuals of Middle Eastern descent tend to perceive a lower degree of safety in this context.

After surveying participants with e-scooter riding experience and inquiring about their perceived safety when around other e-scooters (Q7), we categorized responses from extremely safe to extremely unsafe. The chi-square test conducted to examine the hypothesis regarding the relationship between the gender of e-scooter riders and their feelings of safety towards other e-scooters yielded results indicating a significant association between the two variables. A very small p-value suggests that the observed data are extremely unlikely under the assumption that the null hypothesis is correct.

CHAPTER 5: CONCLUSIONS

This research explored the attitudes and preferences towards AI-enabled and regular e-scooters among all adult road users. By focusing on a range of demographic factors, including gender, race, age, and education level, the study aimed to uncover the nuanced influences these variables have on the adoption and trust of AI-enabled e-scooter technologies. Through a survey study, the investigation evaluated participants' preferences for e-scooter types, their trust in AI to handle unexpected situations, their perceptions of safety, and their preferred methods of receiving notifications from AI-enabled e-scooters.

The study revealed that gender does not have a significant influence on preference in choosing AI-enabled e-scooters. However, a statistically significant association was found based on participants' racial backgrounds. The findings suggest that education level plays a role in influencing decisions related to the adoption of AI-enabled e-scooters instead of regular e-scooters. This insight emphasizes the importance of considering educational and racial backgrounds when examining factors influencing individuals' choices in choosing AI-enabled e-scooters.

Further, the research identified that gender and racial background significantly influence the level of trust in AI-enabled e-scooters, highlighting the complexity of trust dynamics in technology adoption. Further research is needed to explore the factors influencing trust in AI-enabled e-scooters based on gender.

In terms of safety feedback preferences, results indicate a significant difference between participants from different racial backgrounds in their preferences for receiving notifications from AI-enabled e-scooters. On the other hand, there is no significant difference between female and male participants in their preferences for receiving notifications from AI-enabled e-scooters. These findings highlight race-based distinctions in notification preferences, while gender appears not to be a significant factor in this aspect of participants' preferences. Moreover, while age does not significantly affect confidence levels in using AI-enabled e-scooters, a distinct gender-based disparity in confidence levels was noted, emphasizing gender as a pivotal factor in the perceived efficacy and reliability of AI technologies in e-scooters.

In summary, this study has provided insights into the multifaceted factors that influence individuals' choices and perceptions of safety regarding AI-enabled e-scooters. These findings contribute to an understanding of the interplay between demographic factors and attitudes toward AI-enabled e-scooters, offering insights for future research and practical implications for the design and implementation of such technologies.

5.1 Limitations

Despite the insights gained from this study, it is important to acknowledge its limitations. One limitation is the absence of participants within the 51-60 years age group. This gap in age representation hinders a comprehensive understanding of preferences and attitudes among individuals in this specific age range. Additionally, the study acknowledges the need for increased racial diversity among participants, which would enhance the robustness of the results by capturing a more comprehensive range of perspectives and experiences. Lastly, the study could benefit from a broader sampling of e-scooter users, allowing for a more extensive and diverse dataset from the e-scooter user community. Addressing these limitations in future research endeavors will contribute to a more comprehensive understanding of the factors influencing preferences and attitudes toward AI-enabled e-scooters.

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APPENDIX: SURVEY QUESTIONS

Trust and Perceived Safety of Vulnerable Adult Road Users Towards Regular and AI-enabled E-scooters

Eligibility Criteria Hello, and thank you for taking the time to participate in this study.

Before we get started, we have a quick question to ensure that you are eligible to participate. Do you have a diagnosis or condition from the following list?

- Missing limbs or partially missing limbs
- Intellectual or developmental disability
- Cerebral palsy
- Deaf or serious difficulty hearing
- Epilepsy or other seizure disorder
- Schizophrenia, PTSD, Anxiety disorder
- Mobility impairment, benefiting from the use of a wheelchair, scooter, walker, leg brace(s), and/or other supports for Parkinson's disease or Multiple sclerosis (MS)
- Neurodivergence, for example, autism spectrum disorder, dyslexia, dyspraxia
- Partial or complete paralysis (any cause)
- Alcohol or other substance use disorder
- Blind or low vision that prevents you from passing the driving test or Color blindness
- Short stature (dwarfism)
- Traumatic brain injury

o Yes

o No

Consent Agreement

Consent Agreement Thank you for considering participation in this research study. Participation in this study is entirely voluntary. You have the right to withdraw at any point during the study, for any reason, and without any prejudice. The information provided is to give you key information to help you decide whether or not to participate.

This study aims to gauge the level of trust and perceived safety that adult road users have towards both regular and AI-enabled e-scooters.

You must be 18 or older to participate in this study.

You are asked to complete a survey asking a series of questions about your perception of safety and trust in e-scooters. The questions are not sensitive or personal.

It will take you about 15 minutes to complete the survey.

We do not believe that you will experience any risk from participating in this study.

You will not benefit personally by participating in this study. What we learn about how people are motivated from this study may be beneficial to others.

You will have the option of receiving a $3 electronic Starbucks gift card by email after you finish the survey. If you do not complete the survey, you will not receive the gift card.

Your privacy will be protected, and confidentiality will be maintained to the extent possible. Your responses will be treated as confidential.

If you opt-in to receive the incentive, you will be prompted to provide your email address. We need your email address so we can send you the e-gift card. Also, incentive payments are considered taxable income. Therefore, we are required to give the University's Financial Services division a log/tracking sheet with the names of all individuals who received a gift card. This sheet is for tax.

Purposes only and is separate from the research data, which means the names will not be linked to (survey or interview) responses.

You have indicated in the previous question that you do not have any of the following exclusion criteria:

- Cerebral palsy
- Deaf or serious difficulty hearing
- Epilepsy or other seizure disorder
- Intellectual or developmental disability
- Schizophrenia, PTSD, Anxiety disorder
- Missing limbs or partially missing limbs

- Mobility impairment, benefiting from the use of a wheelchair, scooter, walker, leg brace(s) and/or other supports
- Parkinson’s disease, or Multiple sclerosis (MS)
- Alcohol or other substance use disorder
- Blind or low vision that prevents you from passing the driving test, or Color blindness. Neurodivergence, for example, autism spectrum disorder, dyslexia, dyspraxia
- Partial or complete paralysis (any cause)
- Short stature (dwarfism)
- Traumatic brain injury

Survey responses and email addresses will be stored separately, with access to this information controlled and limited only to people who have approval to have access. After we send you the e-gift card, your email address will be deleted. We might use the survey data for future research studies and we might share the non-identifiable survey data with other researchers for future research studies without additional consent from you. The survey includes an option for respondents to participate without providing their email or any other identifier. In such cases, respondents will not be eligible for the incentive. After this study is complete, study data may be shared with other researchers for use in other studies without asking for your consent again. The data we share will NOT include information that could identify you. If you have questions concerning the study, contact the principal investigator, Dr. Omidreza Shoghli, at (704) 687-8285 or by email at oshoghli@charlotte.edu. If you have further questions or concerns about your rights as a participant in this study, contact the Office of Research Protections and Integrity at (704) 687-1871 or uncc-irb@uncc.edu. You may print a copy of this form. If you are 18 years of age or older, have read and understand the information provided, and freely consent to participate in the study, you may proceed to the survey. Do you consent to participate in this study?

o Yes, I agree and consent to participate.

o No, I do not consent to participate.

Experiences and Safety Perceptions

Q1.What category of driver's license are you currently in possession of? (Select all that apply)

○ None

○ Learner’s permit

○ Passenger vehicle driver's license

- ○ Motorcycle license
- ○ Commercial driver's license
- ○ Other (please specify)

Q2.How frequently do you use any of the following vehicles:

Never

Rarely Several times a month Several times a week Daily or almost daily

E-scooter o o o o o

Bicycle o o o o o

E-bike o o o o o

Motorcycle o o o o o

Car oo o o o

Q3. As a pedestrian, how safe do you feel when e-scooters are around you?

- o Extremely safe
- o Safe
- o Neutral
- o Unsafe
- o Extremely unsafe

Q4.When riding a bicycle, how safe do you feel when e-scooters are around you?

- o Extremely safe
- o Safe
- o Neutral
- o Unsafe
- o Extremely unsafe

Q5.When riding an e-bike, how safe do you feel when e-scooters are around you?

o Extremely safe

o Safe

o Neutral

o Unsafe

o Extremely unsafe

Q6.When driving a car, how safe do you feel when e-scooters are around you?

o Extremely safe

o Safe

o Neutral

o Unsafe

o Extremely unsafe

Q7. When riding an e-scooter, how safe do you feel when e-scooters are around you?

o Extremely safe

o Safe

o Neutral

o Unsafe

o Extremely unsafe

Q8.Where do you commonly travel to when using an e-scooter? (Select all that apply)

○ Work or office

○ School or educational institution

○ Shopping or grocery areas

○ Parks or recreational areas

○ Public transportation hubs such as bus stops and train stations

○ Restaurants, cafes, or bars

○ Others (please specify)

Q9.What are your most significant concerns about riding an e-scooter? (select all that apply)

○ Being hit by a moving vehicle

○ Running into cars

○ Collision with pedestrians

○ Poor road conditions (potholes, uneven surfaces, or debris)

○ Difficulty in controlling or balancing

○ Inadequate infrastructure (e.g., lack of designated lanes)

○ Unclear or varying legal regulations regarding e-scooter use

○ Clutter and improper parking on sidewalks and public spaces.

○ Mechanical malfunctions (e.g., brake or electrical system failures).

○ Low visibility to motorists, especially at night.

○ Others (Please Specify)

Q10. Imagine a shared lane for bicycles, e-bikes, and e-scooters. As an e-scooter rider, how safe would you feel using this lane?

o Extremely safe

o Safe

o Neutral

o Unsafe

o Extremely unsafe

Q11. In your opinion, how easy is operating an e-scooter?

o Very Easy: I have no difficulty operating an e-scooter

o Easy: I encountered minor difficulties but quickly became comfortable

o Moderate: I experienced some challenges, but I am able to use it

o Difficult: I frequently struggle but can manage o Very Difficult: I find it extremely challenging to operate

Q12. Under which of these conditions would you be more inclined to ride an e-scooter on sidewalks? (Select all that apply)

○ Lack of dedicated e-scooter or bike lanes.

○ High traffic on roads - I'd use the sidewalk to avoid heavy vehicular traffic.

○ Wide sidewalks - I feel there's enough space to accommodate both pedestrians and e-scooters.

○ Major or multi-lane roads - I perceive them to be more challenging or intimidating for e-scooter use.

○ Uncrowded sidewalks - I'd ride on the sidewalk when it's less populated

○ After dark - I believe it's safer than being on the road at night.

○ Never - I always avoid riding on sidewalks, regardless of conditions.

○ Others (Please specify)

Q13. Have you undergone any training for e-scooter usage? If so, how would you rate the training?

o Comprehensive - Covered all aspects, including e-scooter operation, safety, maintenance, and etiquette.

o Standard - Addressed essential aspects of e-scooter operation and safety.

o Introductory - Gave a basic overview of e-scooter operation with some safety tips.

o Self-guided - I used online resources or manuals but no formal training.

o I have never received any training.

Q14. Have you ever been involved in an accident while riding an e-scooter?

o Yes

o Near Miss: I have never been in an accident, but I have been close to getting into an accident

o No, Never: I have NEVER been in or close to getting into an accident

Q15. Can you describe the circumstances that led to your accident or near miss while using the e-scooter? (Select all that apply)

○ Collision with a vehicle - I was hit by or almost hit by a car, truck, or other motorized vehicle.

○ Collision with a pedestrian - I collided with or nearly collided with a person walking.

○ Collision with another e-scooter rider.

○ Collision with a bicycle or e-bike

○ Lost balance due to road conditions - Like potholes, wet surfaces, or uneven terrain.

○ Navigating through a crowded area - Leading to reduced maneuverability.

○ Swerved to avoid an obstacle - Such as an animal, object, or suddenly stopped vehicle.

○ Distraction or inattention - Either on my part or another party involved.

○ E-scooter malfunctioned - Issues with brakes, acceleration, or battery.

○ Unexpected door opening - For instance, a car door suddenly opens in my path.

○ Riding on a high-traffic road

○ Other (please specify)

Q16. How would you categorize the severity of your injury from the e-scooter incident?

o No Injury

o Minor: Required little to no medical attention

o Moderate: Required some medical attention but not hospitalization

o Severe: Required hospitalization

o Critical: Required intensive medical care or surgery

Q17. After the incident, did you resume riding e-scooters?

o Yes, I immediately resumed

o Yes, but after a period of time

- o Yes, but very rarely
- o No, I've stopped using them altogether

Q18. Which of the following vehicles do you personally own? (Select all that apply)

- ○ E-scooter
- ○ Bicycle
- ○ E-bike
- ○ Motorcycle
- ○ Car
- ○ Other (Please specify)

Perceptions of Safety and Trust in AI-Assisted Technologies

Q19. Have you encountered any situations that have negatively impacted your trust in AI-assisted systems? (Some examples of AI-assisted systems are virtual assistants, autonomous vehicles, smart home hubs and controllers, etc.)

- o Yes
- o No

Q20. Have you ever used any driving assistance technologies in cars? (E.g., Lane departure warning, collision avoidance, blind spot monitoring, adaptive cruise control, etc.)

- o Yes
- o No

Q21. How do you feel about the safety of these driving assistance technologies?

- o Extremely safe
- o Safe
- o Neutral

o Unsafe

o Extremely unsafe

Q22. Do you think autonomous vehicles (self-driving cars) offer a higher or lower level of safety compared to vehicles driven manually by humans?

Higher Safety: Autonomous vehicles offer a higher level of safety than vehicles driven by humans.

o About the Same, I am undecided, or I think the safety levels of autonomous vehicles and vehicles driven by humans are about the same.

o Lower Safety, autonomous vehicles offer a lower level of safety compared to vehicles driven by humans.

Perception of safety and Trust in AI-enabled E-Scooters

Imagine a scenario where you can ride an e-scooter equipped with AI-assisted technologies. This system actively monitors the surrounding environment and provides real-time warnings and control feedback about risky situations, such as upcoming obstacles, potential collision, fast-approaching vehicles, or unsafe riding behaviors.

As you respond to the following questions, keep this scenario in mind and consider how it might influence your perceptions and trust.

Q23. If this AI-assisted e-scooter could provide safety notifications and/or control feedback, how would you prefer to receive the notification/control feedback?

o Vibrations in e-scooter handlebar

o Sound alarm

o Combination of vibration and sound alarm

o Speed-control assistance

o Lane-keeping assistance

o Combination of speed-control and lane-keeping assistance

o Combination of all the above

o None

Q24.Please evaluate each of the following statements on a scale from 'Strongly Agree'to 'Strongly Disagree.'

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I trust this system for a safer ride	○	○	○	○	○
Compared to regular e-scooters, I feel more confident using the AI-assisted scooter in various traffic conditions because of its AI capabilities.	○	○	○	○	○
Compared to regular e-scooters, the AI-assisted features will reduce the likelihood of accidents.	○	○	○	○	○
I trust the AI's ability to handle unexpected situations while I'm on the e-scooter.	○	○	○	○	○

I trust that the AI won't malfunction and compromise my safety while I'm using the e-scooter.	○	○	○	○	○

Q25. Given a choice between two e-scooters priced the same, which one would you buy/select from the deck?

o I wll definitely choose the AI-assisted type.

o I am not sure about my decision,

o I would rather choose the regular e-scooter.

Q26. What is your main concern that you do not choose the AI-assisted e-scooter or not confident about your choice?

o Data privacy and how AI might track or store personal information

o Possibility of being hacked

o Skeptical about AI's ability to react properly in all traffic situations

o AI technology could make the scooter more complicated to use

Q27. Which gender identity do you most closely align with?

o Female

o Male

o Non-binary

oother (please specify)

o Prefer not to disclose

Q28. What is your age group?

o 18-21

- o 22 - 25
- o 26 - 30
- o 31 - 35
- o 36 - 40
- o 41 - 50
- o 51 - 60
- o 61 or older

Q29. What is your ethnic background?

- o Asian
- o African American
- o White/Caucasian
- o Hispanic/Latino
- o Native American
- o Pacific Islander
- o Middle Eastern
- o Other (please specify)
- o Prefer not to disclose

Q30. Which income bracket best describes your annual household income?

- o Less than $20,000
- o $20,000 - $50,000
- o $50,000 - $75,000
- o $75,000 - $100,000
- o $100,000 - $125,000
- o $125,000 - $150,000
- o $150,000 - $175,000

o $175,000 - $200,000

o More than $200,000

o Prefer not to disclose

Q31. Please provide the zip code for your primary residence.

Q32. What is the highest level of education you have attained?

o No formal education

o Completed elementary school

o Completed middle school

o High school graduate or equivalent (e.g., GED)

o Associate degree (e.g., AA, AS)

o Bachelor's degree (e.g., BA, BS)

o Master's degree (e.g., MA, MS, MEd)

o Professional healthcare degree (e.g., MD, DDS, DVM)

o Doctorate degree (e.g., PhD, EdD)

Q33. Do you have any experience or background in following technical fields? If so, please select all that apply.

○ Information Technology (IT)

○ Engineering

○ Automation

○ Data Science

○ Artificial Intelligence (AI)

○ Machine Learning (ML)

○ Software Development

○ Network Administration

- ○ Systems Analysis
- ○ Cybersecurity
- ○ Medicine/medical fields
- ○ None

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