Evaluating the Influence of Delivery E-bikes and Scooters on Pedestrian Perceived Safety in Groningen

By

Jarrik Overbosch
S4120868

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Professor G. de Roo

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Table of Contents

1. Abstract

This study examines the impact of the rise of delivery e-bikes and scooters on pedestrian safety and infrastructure satisfaction in Groningen. The aim of the research is to explore pedestrians' perceptions of safety and the interplay between actual risks, perceived risks, perception, satisfaction and the presence of e-bikes and scooters. The study investigates the relationship between the use of delivery e-bikes and scooters as delivery vehicles, pedestrians' perceptions of safety, infrastructure satisfaction and factors influencing pedestrian behaviour in urban environments. The research questions address the theories and concepts of perceived safety, perceived risk, actual risk, infrastructure satisfaction, perception and the role of e-bikes and scooters as delivery vehicles. The methodology employs both quantitative and literature research approaches. Data was collected through a survey of 86 pedestrians in Groningen, which included demographic information, perceptions of safety, experiences with delivery e-bikes and scooters, opinions on policies and regulations, and suggested solutions for enhancing pedestrian safety. The collected data was analysed using statistical techniques such as multiple linear regression, ANOVA, and chi-square analysis. The results indicated that perceived safety is influenced by both actual risks and perceived risks, and that the presence of delivery e-bikes and scooters can impact pedestrian safety perceptions, as well as policies. The study also highlights the importance of infrastructure and regulations in promoting pedestrian safety in shared spaces. The conclusions suggest that the increase of delivery e-bikes and scooters may lower pedestrians' perceived safety in Groningen, and there is a need for effective strategies to address the concerns and conflicts between different road users. The study provides insights for policymakers and urban planners to enhance pedestrian safety and create a harmonious environment for all stakeholders involved.

2. Introduction

2.1 Introduction of topic and city

The rise of food delivery services utilizing e-bikes and scooters is noticeable worldwide, and Groningen is no exception. With the rise of e-bikes and scooters, satisfaction with the infrastructure and safety might decrease. Especially for the most fragile road user: the pedestrian.

Groningen, renowned for its commitment to sustainable transportation and cycling, has become an ideal location to examine the impact of the rise of delivery e-bikes and scooters on pedestrian safety. This is partly due to Groningen's dense population and bike-friendly infrastructure, which further contribute to its status as a hub for these delivery services. In fact, according to the Dutch Ministry of Infrastructure and Water Management (2018), approximately 61% of trips in Groningen are made by bike, highlighting the city's high cycling mode share. Additionally, the city has witnessed a transformation in its food culture as a result of the proliferation of food delivery services utilizing bicycles, e-bikes, and scooters.

The municipality of Groningen has implemented measures prioritizing bicycles and pedestrians and adjusting its infrastructure to accommodate e-bikes and scooters. Concerns remain, however, regarding the safety of pedestrians and e-bikes and scooter riders due to uncertain operational policies, and inadequate regulation enforcement (Maiti et al., 2020). Studies across European countries have shown an increase in accidents after the introduction of urban delivery transportation, potentially influenced by time pressures on food delivery drivers, including e-bike and scooter drivers (Cloud et al., 2022; Peng et al., 2022). The increased speed of e-bikes and scooters poses challenges for pedestrians in anticipating their movements (Schepers et al., 2020). This increased speed and usage of e-bikes and scooters has revealed a significant lack of clear regulations governing their use, while the existing rules and regulations for bikes are inadequate to address these developments (Schepers et al., 2020), making it difficult for policymakers to develop effective safety measures. Many cities are ill-equipped to integrate e-bikes and scooters safely, resulting in conflicts between riders and pedestrians, although Groningen's infrastructure is relatively more favourable to deal with this issue as it has developed a comprehensive network of bike lanes (Cloud et al., 2022).

While general rules and regulations exist for scooters, general regulations for e-bikes are comparatively lacking in Groningen (Gemeente Groningen, 2023). This research aims to explore the changes in walkability due to the rise of e-bikes and scooters and how to improve it, based on survey data. As well as investigating best practices in other cities and considering the opinions of Groningen citizens, this research provides valuable insights for managing the integration of delivery e-bikes and scooters into the urban transportation system while prioritizing pedestrian safety and infrastructure satisfaction. The scientific and social relevance of this research lies in contributing to the understanding of sustainable urban mobility and addressing the needs and concerns of Groningen residents.

2.2 Research area and problem

The focus of this paper is the inner city of Groningen, which holds particular significance due to the presence of major delivery services such as Gorillaz and Flink, along with numerous independent delivery services. Not only do these services have their storehouses located in the inner city, the catering industry primarily operates within this area as well. According to Thuisbezorgd (n.d), one of the prominent delivery companies, Thuisbezorgd alone has 250 food establishments in the inner-city offering doorstep delivery services and employs 700 delivery drivers. It is worth noting that Thuisbezorgd is just one of many similar companies, collectively employing a substantial number of delivery drivers. Given the significant presence of delivery e-bike and scooter riders in the inner city, and the fact that 24% of the delivery drivers report to have been in an accident (teamalert, 2022), it becomes important to study the interactions and potential collisions between pedestrians and these vehicles.

The inner city of Groningen is a primary hub for pedestrians, characterized by pedestrian-friendly areas and streets. The presence of a multitude of shops further attracts pedestrians and enhances the overall appeal and atmosphere of the urban landscape. The combination of retail establishments, walkable environments, and accessible public spaces plays a crucial role in drawing pedestrians to the inner city (Wichmann et al., 2021; Bernick, 1996).

Considering the concentration of both pedestrians and delivery vehicles in the inner city, it becomes the focal point where collisions between pedestrians and delivery e-bikes or scooters are most likely to occur. Compared to other locations, the chances of these two parties colliding are significantly higher in this area (Aljohani & Thompson, 2020). Which is evident by the increasing complaints municipalities receive about food delivery drivers, especially those on e-bikes (RTLnieuws, 2021). Throughout the study, it became evident that the increase in delivery e-bikes and scooters, coupled with the limited adherence to regulations by delivery drivers, has had a noticeable impact on the perception of safety. This issue raises concerns about Groningen's standing as one of the leading pedestrian-friendly cities. Therefore, investigating the dynamics between pedestrians and delivery vehicles in the inner city of Groningen is of significant scientific and social relevance to ensure the maintenance of a safe and pedestrian-friendly urban environment.

2.3 Research question

Mitigating the behaviour of delivery e-bike drivers and scooter riders presents a challenging task. As the population of Groningen continues to grow, accompanied by a corresponding increase in the catering industry, there is a subsequent rise in the number of delivery drivers and pedestrians. The escalating growth in these aspects amplifies the likelihood of accidents and might diminish the perceived safety for pedestrians. The increasing prevalence of delivery e-bikes and scooters prompts an inquiry into whether their presence compromises the renowned quality of infrastructure in Groningen and subsequently affects overall satisfaction. This paper aims to investigate the perceived safety perspective of pedestrians in the inner-city of Groningen, while also exploring potential solutions proposed by pedestrians themselves and examining approaches employed in other cities that Groningen currently doesn't employ. The objective is to gather insights from pedestrians that contribute to maintaining Groningen as a pleasant and walkable city. In context of this investigation, the focus is on gathering insights from pedestrians and exploring potential solutions proposed by

pedestrians themselves. By narrowing the scope to the perspective of pedestrians, the aim is to gain a deeper understanding of their experiences and perceptions regarding safety in the inner-city of Groningen. To address this, the following research question will be explored:

- "What is the impact of the rise of delivery e-bikes and scooters on perceived pedestrian safety and infrastructure satisfaction in the city of Groningen? "

To support answering the central research question, the following secondary research questions are formulated:

- "What is the current rate of pedestrian accidents involving delivery e-bikes and scooters in the city of Groningen, and what are the current policies and regulations?"
- "What influences the perceived pedestrian safety and infrastructure satisfaction? "
- "How do pedestrians' perceptions of safety when encountering delivery e-bike and scooter riders, impact their perceived need for improved infrastructure and their views on existing policies?"
- "How does perceived safety differ among the pedestrians of Groningen? "
- "What are the practices in other cities that have successfully managed the integration of delivery e-bikes and scooters into the urban transportation system, and what suggestions do the citizens of Groningen have regarding this matter?"

2.4 structure

The research will initially present the methodological approach employed to address the research question. Furthermore, a comprehensive exploration of theories and concepts to facilitate a deeper understanding of the subject matter. Additionally, a conceptual model is introduced, showing the connections among these theories and concepts, thereby enhancing the overall comprehension of the research afterwards. Subsequently, the formulated hypotheses are mentioned, serving as the basis for the ensuing investigation.

The research methodology is then mentioned, talking about the adopted methods utilized to derive meaningful findings. An explanation is provided on the application and functioning of these methods, alongside a conscientious consideration of ethical implications inherent to the research process.

Moving forward, the findings are analyzed, with a thorough examination of their implications. This segment serves to unravel the obtained results.

Lastly, the research concludes by succinctly summarizing the key aspects throughout the study. The conclusion serves to integrate the main findings, research methodologies, and theoretical frameworks explored, culminating in an overview of the thesis as a whole.

3. Theocratical framework

3.1 Theories and concepts

In order to ensure a thorough examination of the factors being investigated, the study will employ relevant concepts and theories as a framework. These frameworks will guide the development of survey questions, inform the statistical analysis of collected data, and support literature research efforts. By utilizing established concepts and theories, the study aims to gain a deeper understanding of the factors under investigation and establish connections between them and the research objectives. This approach will provide a solid foundation for the analysis and interpretation of the study's findings.

3.1.1 Definition of Perception

Perception is a complex and extensively studied topic in philosophy. According to Hamlyn (2017), perception can be defined as the process through which we become aware of the world around us using our senses. This definition emphasizes that perception is crucial in our experience of the world, as it enables us to gather information, comprehend it, and form opinions. Personal factors such gender and age can also influence perception and are important to identify (Hamlyn, 2017).

In the context of urban planning, perception holds significant importance, as noted by Mell (2010). The author highlights that perception influences how individuals navigate and utilize spaces, as well as their overall satisfaction with the built environment. This aspect is particularly relevant to the present research, which aims to identify perceptions of safety and infrastructure satisfaction. Mell (2010) further argues that spatial planners must consider individuals' experiences and how these experiences shape perception. In this paper, the aim is to understand and identify the experiences related to delivery e-bikes and scooters, which, in turn, have impact perceptions of safety and infrastructure satisfaction.

3.1.2 Defining Actual Risks and Perceived Risks

The concept of risk is complex, and it is crucial to differentiate between actual and perceived risks. Actual risks refer to the probability of an unfavorable outcome based on factual information, in this case actual accidents (Jacoby & Kaplan, 1972). In contrast, perceived risks are subjective evaluations of the possibility of experiencing harm or loss (Choudhary, 2022). Perceived risk can be based solely on the perception that a certain situation is risky. As both impact the perception of safety, both will be identified and researched.

3.1.3 Combination of Perceived Risks and Actual Risks

Considering how the aforementioned theories interlink and overlap, this combination of perceived risks and actual risks together capture the essence of perception on safety (Chopdar et al., 2018). While perceived risks may not align with factual risks, they can still create feelings of unsafety and lower the overall perception of safety (Salam et al., 2021). On the other hand, situations that are factually unsafe, supported by actual accidents, can also contribute to a decrease in the perception of safety (Hamlyn, 2017). Consequently, the combination of perceived and actual risks contributes to the overall perceived safety (*Fig. 1*).

Figure 1. Model showing the combination of risks

Understanding this interplay between perceived and actual risks is important, this can enhance the understanding on perception of safety in urban environments. As well as that of infrastructure satisfaction.

3.1.4 E- bikes and Scooters as Delivery Vehicles

The element under investigation for its impact on perceived safety, namely e-bikes and scooters, holds a significance on par with that of perceived safety on pedestrians itself. E-bikes and scooters represent powered vehicles and are frequently employed within urban environments for local delivery purposes. Their usage aligns with the broader urban planning strategy of prioritizing bicycles and pedestrians over motor vehicles. These electric vehicles offer several advantages compared to traditional vehicles, including lower costs, reduced emissions, and enhanced manoeuvrability in congested streets and heavy traffic conditions (Power, n.d). They have gained prominence, particularly in densely populated urban areas, where they are widely utilized for delivering food, groceries, and small packages. In the specific context of Groningen, e-bikes and scooters have become integral components of the city's food delivery culture. Prominent food delivery services such as Gorillaz, Flink, and Thuisbezorgd rely on these vehicles extensively to facilitate doorstep deliveries (Bretones et al., 2023). The surge in e-commerce and online food ordering, coupled with the city's bicycle-friendly infrastructure and regulatory framework, has fostered the proliferation and acceptance of e-bikes and scooters as preferred modes of transportation for delivery purposes.

3.1.5 Defining Infrastructure Satisfaction

Infrastructure satisfaction, an important aspect to consider, refers to the level of contentment or happiness that individuals or groups feel about the infrastructure surrounding them (Hubaishi et al., 2021). It encompasses a range of physical structures, including roads, bridges, buildings, and utilities (Steph, 2023). Key drivers influencing infrastructure satisfaction, including user experience and functionality, play a significant role in shaping individuals' perceptions, with various factors contributing to overall satisfaction, notably safety (Hubaishi et al., 2021). In the scope of this study, the primary focus will revolve around exploring the correlation between safety and infrastructure satisfaction. Recognizing the importance of infrastructure satisfaction is crucial, as it holds the potential to significantly influence the quality of life experienced by pedestrians.

3.2 Conceptual model

Figure 2 displays the interconnection between pedestrian safety and the rise of delivery e-bikes and scooters, shedding light on the theories previously mentioned and their impact on the conducted research. The figure indicates how these factors can either contribute to perception safety and infrastructure satisfaction.

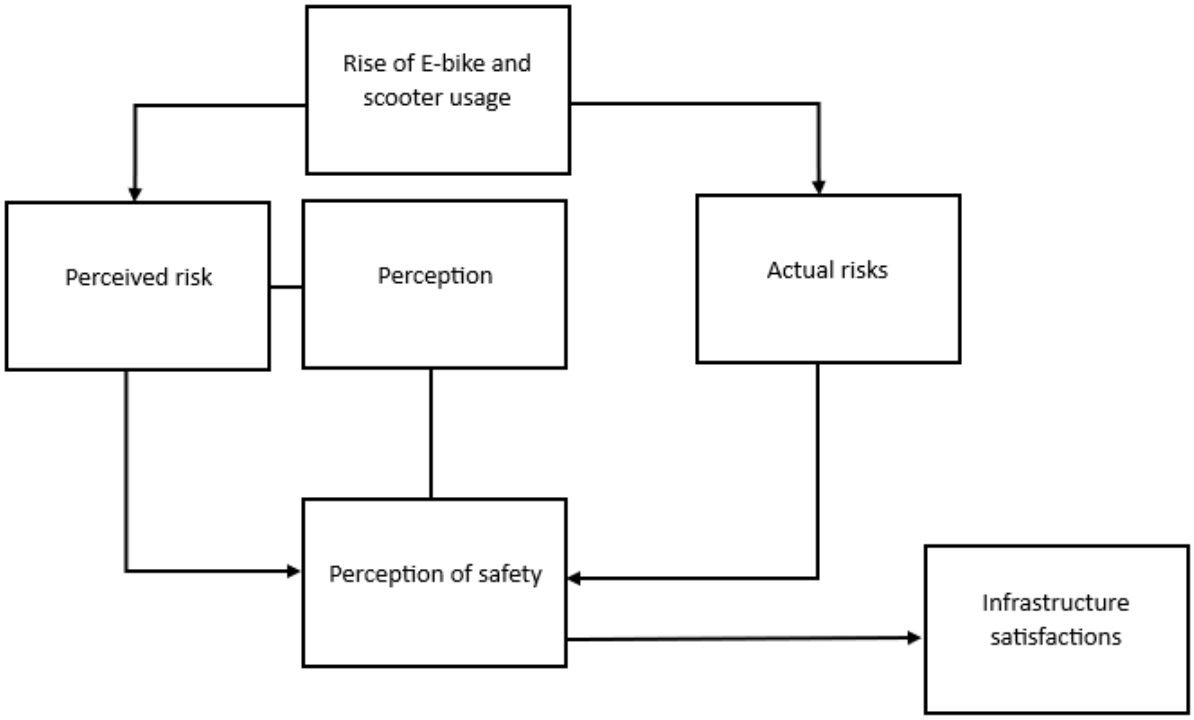

Figure 2. Conceptual model showing the relationship the different theories and concepts.

3.3 Hypothesis

The population of Groningen has been steadily increasing over the years, and this growth is expected to continue. By the end of 2023, the city is projected to have a population of around 238,179, with an additional 40,000 residents expected by 2040 (Citypopulation, 2023; The Northern Times, 2021). As the population continues to grow, ensuring accessibility to services for all individuals becomes increasingly important.

Among the services that need to be accessible is food delivery, which is expected to expand to meet the rising demand. This expansion will result in a higher number of e-bikes and scooters being utilized for food deliveries. Groningen, known for its strong cycling culture, already sees a significant portion of transportation being done by bike, with over 60% of trips made on bicycles (Filibeck, 2022). The city has also embraced alternative forms of mobility, including shared electric scooters. Furthermore, popular food delivery apps such as Uber Eats, Gorillas, and Thuisbezorgd offer delivery services from a wide range of restaurants and stores in Groningen (Thuisbezorgd, 2023; UberEATS, 2023; Gorillaz, 2023).

The food delivery market in the Netherlands has experienced substantial growth, with many consumers opting for online meal delivery and grocery ordering. In 2022, nearly nine million Dutch shoppers purchased meal delivery online, and over five million consumers ordered groceries via the internet (Statista, 2022). This trend is evident in Groningen as well, with around 250 food establishments listed on the Thuisbezorgd platform alone (Thuisbezorgd, 2023).

The combination of a growing population and increased demand for food delivery services however, increases the stress on infrastructure and results in potential conflicts between pedestrians and delivery drivers. Which in turn decreases perceived safety and the satisfaction of infrastructure.

To investigate this hypothesis and assess the impact of delivery e-bikes and scooters on pedestrian safety, further research will be conducted in Groningen. This research aims to explore pedestrians' perceptions of safety, evaluate the existing infrastructure, and examine the potential implications of the rise in delivery vehicles on pedestrian safety. By understanding the dynamics between delivery e-bikes and scooters, pedestrians, and infrastructure, valuable insights can be gained to enhance the overall safety and satisfaction of pedestrians in Groningen.

4. Methodology

4.1 Used methods

To gain insights into pedestrians' perceptions, a survey was conducted involving 86 pedestrians. The collected data was subsequently analyzed using SPSS software. The analysis involved the application of statistical techniques such as Analysis of Variance (ANOVA), multiple linear regression, and Chi-square analysis to examine the relationships and associations between the variables under investigation. By employing these statistical methods, a more comprehensive understanding of the interconnections between the variables was achieved. Other than this quantitative method and subsequent analysis, a comprehensive literature research is employed, providing additional insights (Mertens et al., 2017). The study necessitates the exploration of both perceptual and actual impacts of the surge in e-bike and scooter usage for delivery purposes. It further warrants an examination of pedestrian and rider behaviours in shared spaces, the interactions between these road users, and the implications of existing infrastructure and regulations.

The quantitative approach begins with data collection, a sample of 86 pedestrians in Groningen were asked to fill in the survey, encompassing a diverse range of ages, gender and time spent walking. These surveys will aim to capture data on residents' perceptions of safety, personal experiences and encounters with delivery riders using e-bikes and scooters, and attitudes towards existing urban regulations and infrastructure. Following the data collection, the analysis phase will involve rigorous statistical assessments to identify correlations, and potential relationships within the data set. Furthermore, in addition to surveys, collecting data on actual accidents from statistical databases involving pedestrians and delivery e-bikes or scooters in Groningen is another useful aspect of the quantitative research.

Beyond the quantitative research, the role of literature review in this study cannot be underestimated. This step permits us to delve into the existing scholarly literature on the subject, thereby enhancing our understanding of the wider field. The insights gleaned through this process are helpful in shaping the research problem, hypothesis formulation, and substantiating the research findings.

Furthermore, literature research plays a crucial role in contextualizing the findings within established theories or conceptual frameworks. Specifically, for this investigation, it provides an opportunity to interpret the results through the perspectives of the perceived safety, perceived risk, actual risk, infrastructure satisfaction, perception and the role of e-bikes and scooters as delivery vehicles.

A review of the literature extends its utility beyond just knowledge acquisition and contextualization, enabling us to contrast our findings against those in prior research, serving as a valuable reference point. This comparison is helpful not only in affirming the validity of our results but also in comprehending any discrepancies that may arise.

4.2 Model of methods

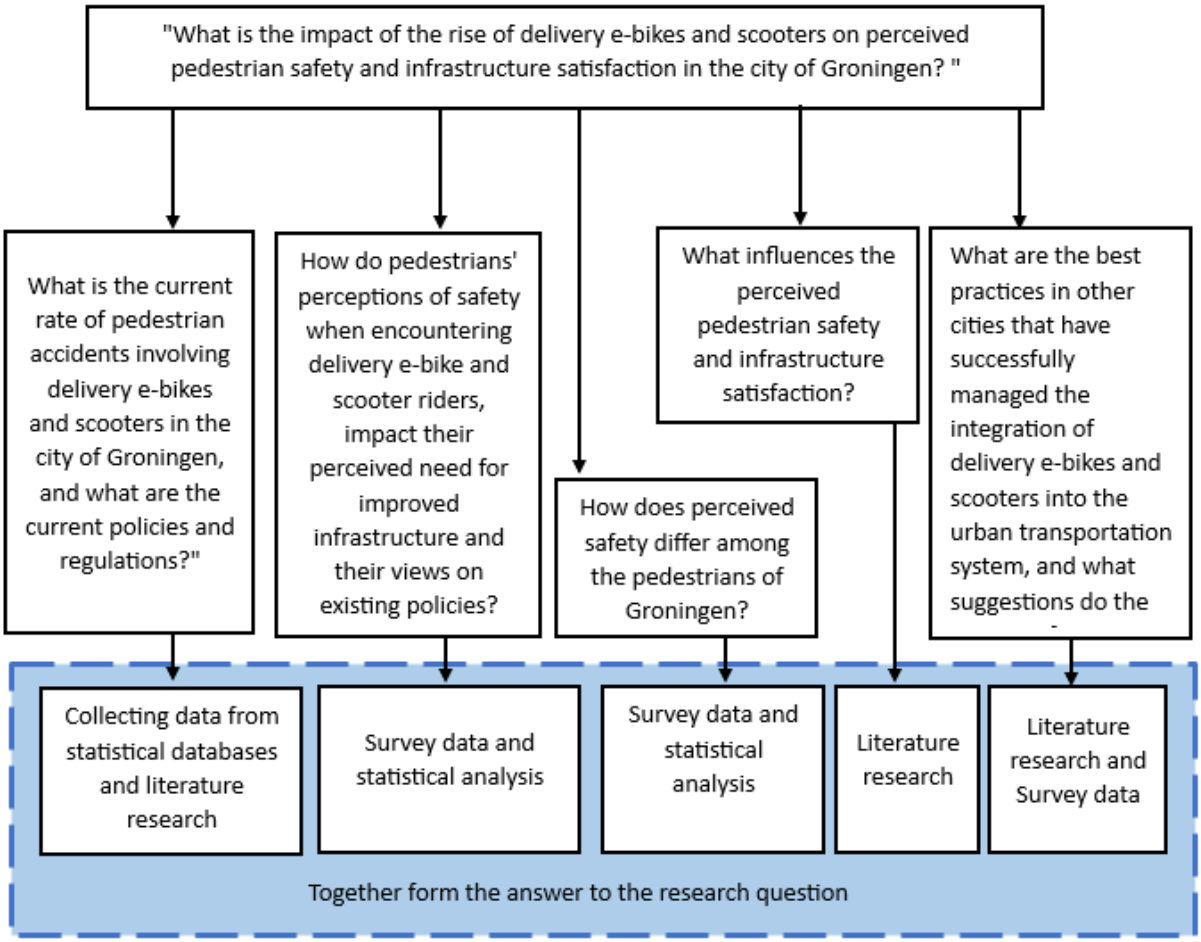

Figure 3. model showing the way the sub question will be answered.

The provided model (*Fig. 3*) outlines the strategic plan for addressing the main research question by leveraging the sub-questions. Each sub-question illustrates a unique methodology to gather and analyse the required data. For instance, the first sub-question is to be resolved using a blend of statistical data and literature review. The second sub-question will also rely solely on comprehensive literature review. The third and fourth sub-questions will be addressed through analysis of the survey data and subsequent statistical interpretations. Lastly, the fifth will make use of literature research and survey data. This holistic approach ensures a thorough exploration of various aspects necessary to successfully answer the overarching research question.

4.3 Data collection

The collection of data went as follows, initially, the target audience was identified as the pedestrians of Groningen, approached as they were walking around in the inner city. To decrease sampling bias, the inner city was divided into squares, creating a grid. In each square a nearly equal number of pedestrians (two) were asked to partake, provided they were capable of articulating an opinion about the current situation. Consequently, this excluded anyone under the age of 16, a criterion clearly stated during the survey process. Other than that, it was ensured that responses were obtained from all gender groups and age categories above the defined age barrier. Furthermore, the target audience had to be a resident of Groningen.

Before administering the survey widely, a pilot test was conducted. This preliminary stage involved administering the survey to a small group of individuals to confirm if the survey was designed effectively, generating the necessary responses, and if the participants found it comprehensible.

Upon receiving satisfactory results from the pilot test, the method of contacting the respondents was determined. The chosen method of data collection involved in-person surveys, which were executed utilizing Google Forms on a tablet, offering an intuitive and user-friendly interface.

The platform of Google Forms not only facilitated the ease of data collection but also streamlined the subsequent data processing step. It allowed the direct conversion of data into Excel spreadsheets, which were subsequently exported to the statistical software SPSS for detailed analysis.

4.4 Survey design

The structure of the survey was divided into four distinct sections (see appendix, survey). The initial segment was devoted to collecting participant demographic information (*fig. 4*), which included queries about age, gender, and the amount of time spent in Groningen's city centre. The second section focused on pedestrian perceptions and experiences with delivery e-bikes and scooters, soliciting a range of responses on these topics. The third part aimed to ascertain pedestrians' understanding and opinions on current policies and regulations. The final section was designed to gather possible solutions, as suggested by the citizens themselves, for enhancing pedestrian safety in the presence of delivery e-bikes and scooters.

Category	*Question Number*
Participant Demographics	Questions 1, 2, and 3
Pedestrian Safety and Delivery E-bikes/Scooters	Questions 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 and 15
Policies and Regulations	Questions 16 and 17
Possible Solutions according to citizens	Questions 18 and19

Figure 4. model showing the categories of the survey questions.

4.5 Data analysis

In order to provide comprehensive responses to the second, third, and fourth sub-research questions, an analysis of the corresponding survey data is necessary. By using the statistical software SPSS, data can be interpreted to yield the requisite insights to address these questions effectively.

Figure 4 shows distinct question categories, which were subsequently refined to establish comprehensive variables for statistical analysis, enabling the investigation of sub-questions two, three, and four. In Figure 5, the combination of various variables yields new variables that encompass coherent categories aligned with the conceptual framework of actual risk and perceived risk. The variables actual and perceived risks from Figure 5 are also combined to formulate perceived safety, the principal variable of this research. Additionally, questions are combined to create perceived Efficacy of Current Policies and Perceived Need for Enhanced Infrastructure, measuring the satisfaction of these factors (*fig. 5*). Perceived efficacy of current policies refers to individuals' subjective assessment of how well existing policies are working, while perceived need for enhanced infrastructure refers to their subjective recognition of the necessity for infrastructure improvements. Both measures capture individuals' perceptions and opinions regarding policy effectiveness and infrastructure deficiencies. To provide a more profound comprehension of citizens' perspectives on existing policies and regulations and their demand for additional measures. Lastly, standalone questions will be interpreted as separate.

Question category	Questions
Participant Demographics	Questions 1, 2 and 3
Perceived risk	Questions 6, 8, 9, 11 and 12
Actual risk	Questions 5 and 7
Perceived safety	Combination of 5, 6, 7 ,8 ,9 ,11 and 12
Perceived Efficacy of Current Policies	Questions 16 and 17
Perceived Need for Enhanced Infrastructure	Questions 13 and 19
Standalone questions	Questions 4, 10, 14, 15 and 18

Figure 5. model showing the new SPSS variables

In the subsequent analysis, perceived risk, actual risk, and perceived safety were individually assessed using multiple linear regression in relation to the perceived efficacy of current policies and the perceived need for enhanced infrastructure (*Fig. 6*). This examination aimed to determine their impact on current policies and the demand for new infrastructure. To explore the relative significance of actual risk and perceived risk, separate analyses were conducted for each factor (*Fig. 6*). These tests will provide insights into sub question two. Furthermore, perceived safety was evaluated against all participant demographics (*Fig. 6*) to aid in addressing sub question three. Finally, the standalone questions will be utilized to support the investigation of different sub questions were deemed necessary.

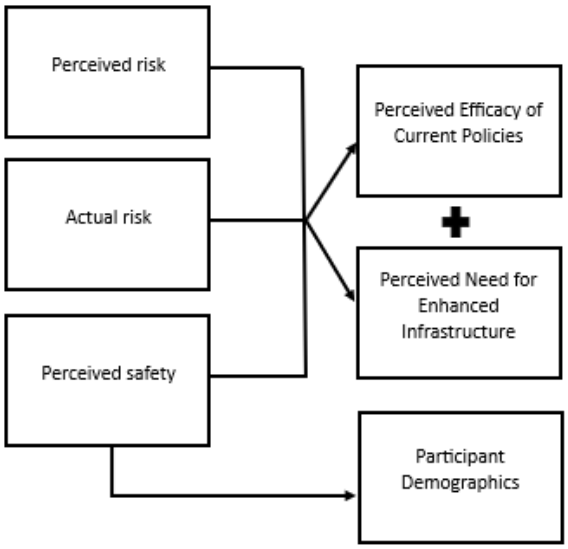

Figure 6. model visualizing the SPSS process

4.6 Data quality

The sample size of 86 participants provides valuable insights, although it should be acknowledged that the sample size is relatively small, which may limit generalizability. Furthermore, the fact that 50% of the respondents are young introduces both strengths and limitations. While it allows for insights into the perspectives of younger individuals, caution should be exercised in generalizing the findings to the broader population.

The application of statistical techniques, such as ANOVA, t-tests, and chi-square tests, demonstrates a rigorous approach to data analysis. However, the assumptions and limitations of these tests should be considered, along with the potential for Type I or Type II errors. Type I error occurs when we mistakenly think something is true when it's not, while Type II error happens when we mistakenly think something is not true when it actually is.

4.7 Ethical considerations

Ethical considerations that will be addressed in this research include obtaining informed consent from all participants, maintaining confidentiality and anonymity, ensuring the safety and well-being of participants during data collection, and minimizing any potential harm or discomfort.

To address these ethical considerations, informed consent will be obtained before any data collection commences. Participants will be informed of their right to withdraw at any time and their confidentiality will be respected. All data will be securely stored and only accessible to the researcher. Additionally, a risk assessment will be conducted prior to data collection to identify any potential risks and take measures to mitigate them.

5. Findings

The following sections of the research will delve deeper into the various aspects related to the impact of the rise of delivery e-bikes and scooters on perceived pedestrian safety and infrastructure satisfaction in Groningen. These sections will explore the current situation in terms of e-bike and scooter accidents, existing policies and regulations, factors influencing infrastructure satisfaction and perceived safety, as well as pedestrians' perceptions of safety, risk, and infrastructure. Additionally, the research will examine the influence of individual characteristics such as age, gender, and habitual behaviors on the pedestrian experience. Furthermore, best practices from other cities will be explored to provide insights and potential solutions for Groningen's path forward.

5.1 E-Bike and Scooter Accidents and Policies in Groningen

This part of the research will help provide a baseline understanding of the current situation, including accident rates and existing regulations. The rise of delivery e-bikes and scooters in urban areas has led to concerns over the safety of pedestrians. In the city of Groningen, the use of these vehicles for delivery purposes has become increasingly popular in recent years.

This increase in delivery vehicles has also led to an increase in actual risks, with 38 accidents reported in 2019 alone, and delivery e-bike accidents in particular happening nationally twice a week (Teamalert, 2023). These e-bike numbers were measured using a weekly news coverage counter, counting how often an e-bike accident was covered, so the true number may be higher. According to Vlakveld et al. (2018) the number of pedestrian accidents in Groningen caused by scooters has increased from 2% in 2005 to 6% in 2012. Furthermore, a study conducted by Bieliński and Ważna (2020) found that in Groningen, there were over 2,300 general e-bike accidents in 2018. The study also reported that there is a lack of data on the specific involvement of delivery e-bikes and scooters in these accidents. According to CBS (2023), normal bike accidents increased as well, with a record high in deaths in 27 years. Meaning that e-bike accidents are not replacing normal bike accidents.

The general increase of accidents caused by e-bikes and scooters has prompted the city to introduce new policies and regulations to improve safety. In 2019, the city implemented a new speed limit of 25 km/h for delivery e-bikes; however, the VVN (veilig verkeer nederland) recommended a lower speed limit of 20 km/h in 2020 (Dagblad van het Noorden, 2020). Additionally, delivery drivers are required to wear helmets, have valid driver licenses, and have reflective clothing, and e-bikes must be fitted with lights and bells. Lastly, the Dutch ministry of labor inspection has implemented laws in 2020 making it mandatory for food delivery services to hire workers above the age of 16, which increases safety as these drivers are more experienced (teamalert, 2023)

Additionally, delivery companies are encouraged to provide training for their riders and to use alternative modes of transportation, such as cargo bikes, when possible (Bieliński & Ważna, 2020). These policies and regulations have been put in place to ensure the safety of pedestrians and reduce the number of accidents involving delivery e-bikes and scooters in the city of Groningen (Bieliński and Ważna, 2020). According to the study conducted by Dong et al. (2021), the incidence of pedestrian accidents involving delivery e-bikes and scooters in Groningen is relatively low when

compared to other cities worldwide. Despite the current low rate of accidents, the study emphasizes that the risk of accidents is actually increasing due to the expanding presence of delivery services.

Despite the aforementioned efforts, there is still room for improvement in the regulation and management of delivery e-bikes and scooters in Groningen. Pressure on delivery drivers, which is one of the primary contributors to traffic accidents, warrants particular attention. In the study by Zhao et al. (2023) food delivery platforms as Uber and Gorillaz were worldwide criticized for using data-driven techniques to set strict delivery time limits, resulting in negative externalities, increasing risky behavior. For example, drivers may engage in reckless behaviour to reduce the travel time to their destination. This behaviour directly impacts pedestrians' perceived safety. A study conducted in Westmount on pedestrian and cyclist safety pointed out several key factors influencing perceived and actual risk. These factors include high traffic speed and volume, disregard for traffic laws, and inadequate traffic signals and signs (Larsen & El-Geneidy, 2017), suggesting that a stronger enforcement of rules on delivery drivers might increase the perceived safety.

In conclusion, while the city of Groningen maintains a relatively low accident rate, the surge in delivery e-bikes and scooters has resulted in an elevated level of accidents. Consequently, the city has implemented measures to address this growing trend and mitigate the impact of delivery e-bikes.

5.2 Influences on Perceived Pedestrian Safety and Infrastructure Satisfaction

Pedestrian safety and infrastructure satisfaction are influenced by a variety of factors, including urban space design variables, environmental attributes, and pedestrian behavior patterns.

Studies have shown that urban space design variables, such as traffic lanes, artificial lighting, and vegetation, can impact pedestrians' perceptions of safety on street crossings (Llinares et al., 2020). Most of these factors are present in the city of Groningen or can’t be added due to lack of space. Additionally, sidewalk width and green space designs have been found to influence pedestrians' satisfaction and preferences (Park and Kwon, 2023). Environmental attributes, including accessibility, aesthetics, comfort, convenience, attractiveness, familiarity, connectivity, safety, and security, also play a role in pedestrians' perceptions of the walking environment (Basu et al., 2022). For example, perceived safety from motorized traffic has been found to be an important factor related to the safety and walkability of an environment and walking behavior, this includes scooter and e-bikes (Basu et al., 2022). Another critical factor according to El Din et al. (2013) that influences pedestrian safety is the behavior of drivers. Driver behavior, such as speeding and ignoring traffic signs, can put pedestrians at risk. Meaning that dangerous driver by food delivery drivers can put the feelings of pedestrians at risk, if they neglect the rules. Moreover, the presence of traffic congestion can also lead to hazardous situations for pedestrians. The perception of safety is another factor that impacts pedestrian safety. If pedestrians perceive a particular area to be unsafe, they may avoid it altogether. In contrast, if they perceive an area to be safe, they may be more likely to use it. Pedestrian behavior patterns, such as waiting and reaction time in the decision phase before crossing and crossing speed and gait variability in the crossing phase, are also influenced by environmental attributes (Kwon et al., 2022). Other factors that can impact pedestrians' perceptions of safety and infrastructure satisfaction include road lighting, buffer, ease of walking, poor infrastructure condition and maintenance, and satisfaction with nighttime safety, zebra crossings, and footpath continuity (Trop, Sharon Shoshany Tavory and Portnov, 2023; Hussain et al., 2021).

In conclusion, many different factors have influence on the perceived safety or the satisfaction with

the infrastructure. However, many of these factors are already implemented in the inner city of Groningen or simply can't be implemented due to the lack of space in the inner city. It is important to note that the behavior of drivers can influence the perception of safety, as can the presence of motorized vehicles.

5.3 Perceived Safety, Infrastructure, and Policy Efficacy in Pedestrian Interactions with Delivery E-Bikes and Scooters in Groningen

Pedestrians' perceptions of safety and risk are crucial factors influencing their interactions with delivery e-bike and scooter riders in urban environments. Understanding how these perceptions shape the perceived need for enhanced infrastructure and the efficacy of current policies is essential for ensuring pedestrian safety. This section examines the results of an SPSS analysis to explore the second sub question by looking at the relationship between pedestrians' perceived safety, perceived risk, actual risk and their perceptions of the need for enhanced infrastructure and the effectiveness of current policies in Groningen. The model will run three times with perceived safety, perceived risks and actual risk, with all three individually running against the following factors: *Need for Enhanced Infrastructure* and *Effectiveness of Current Policies in Groningen.*

The results of SPSS analysis showed that the aforementioned factors enhance the perception of safety, but when we looked at each factor individually, it was found that the perceived effectiveness of current policies had a significant impact on how safe pedestrians felt. On the other hand, the perceived need for improved infrastructure did not have as strong of an influence on perceived safety. When running the other two tests against the same two factors, the results were the same as before. Overall, the analysis showed these listed factors influence pedestrians' views. Individually, however, the factor *Effectiveness of Current Policies in Groningen* showed strong influence on pedestrians' views and almost no influence from the factor *Need for Enhanced Infrastructure*.

This analysis reveals that perceived efficacy of current policies plays a significant role in shaping pedestrians' perceptions of safety, perceptions of risk, and actual risk. The statistically significant model shows that *Effectiveness of Current Policies in Groningen* has a strong influence on perceived safety, perceived risk and actual risk, suggesting that effective policies contribute to enhancing safety. Conversely, the model suggests perceived *Need for Enhanced Infrastructure* does not directly influence pedestrians' *perceptions of safety, perception of risk and actual risk.* This implies that other factors beyond infrastructure improvements may play a more significant role in shaping pedestrians' perceptions of safety and risk. Therefore, while effective policies are crucial, addressing additional factors is necessary to enhance pedestrian safety and improve their encounters with delivery e-bike and scooter riders in Groningen.

5.4 Individual Characteristics and the Pedestrian Experience with E-Bikes and Scooters: Exploring Age, Gender, and Habitual Behaviors

The question; "How does perceived safety differ among the pedestrians of Groningen?" helps identify any patterns or trends in different demographic or behavioral groups' perceptions, further enriching our understanding of the overall pedestrian safety experience in Groningen.

In order to explore the safety perceptions and satisfaction levels among different age groups, gender and habitual behaviours, we will analyse the collected data using SPSS. This survey included participants from a variety of age ranges (*fig. 7*). However, the age group of 18-34 forms a substantial

portion, contributing to 50% of the respondents, while the other five age categories collectively make up the remaining 50%. While this information correlates with inner city age data provided by the municipality of Groningen, generalizability is consequently limited. This distribution aligns with Groningen's demographics, as it's a city with a significant student population and a substantial young adult demographic, as this is the pedestrian population of the inner city of Groningen (Gemeente Groningen, n.d.).

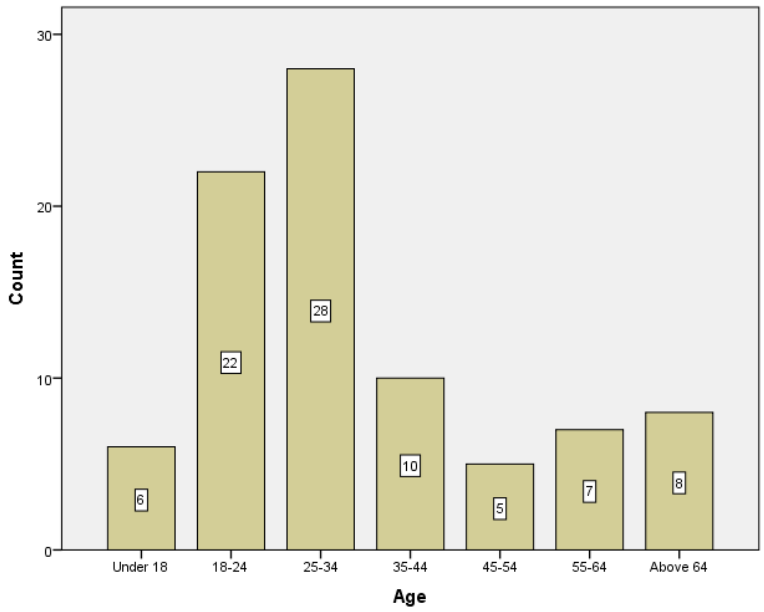

Figure 7. Chart showing the quantity per age category

Moreover, respondents reported varying frequencies of weekly walks. A significant portion fell into the 5-6 walks per week category (*fig. 8*), as many inner-city Groningen residents often have to traverse short distances for shopping, work, university, and other activities. This is the primary reason why 50% of the respondents reported this frequency of walking.

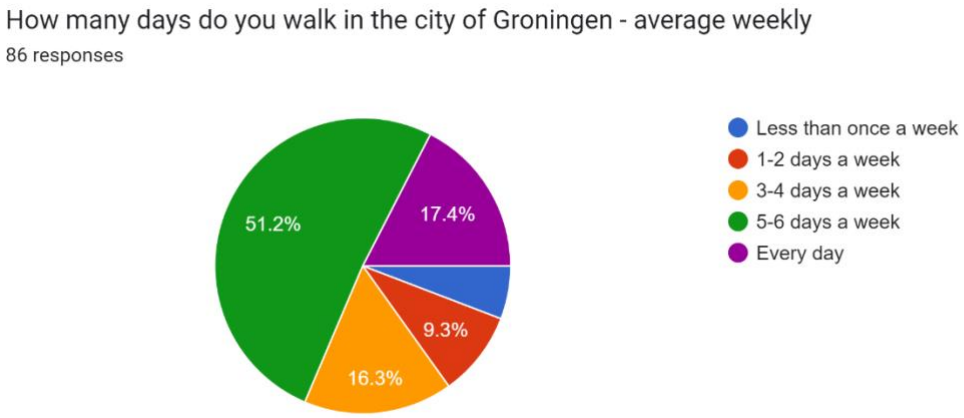

Figure 8. Pie chart indicating range of walks taken in the city of Groningen – weekly average

Considering the influence of gender on the perception of safety among participants may reveal varying effects. As can be seen in figure 9, the division in genders is somewhat equal and distributed in male, female and other. For the purposes of this study other refers to participants identifying as neither male nor female.

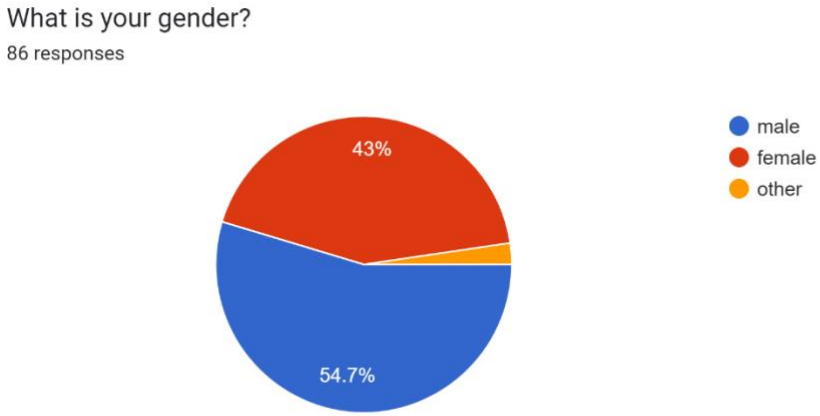

Figure 9. Pie chart indicating the distribution among the different genders

The pedestrian experience with e-bikes and scooters in urban environments may be influenced by individual characteristics such as age, gender, and habitual behaviors like the frequency of walking. Examining the relationship between these factors and the pedestrian experience, the analysis revealed that the mean perceived safety for different age groups is equal, suggesting that age does not significantly impact safety perceptions. Gender differences, however, were found, with females exhibiting lower perceived safety compared to males, indicating potential conflicts in safety experiences. Additionally, while the mean perceived safety did not differ significantly across different walking frequency groups, closer analysis revealed a potential association between walking frequency and safety perceptions. Notably, a strong influence of association was found between the

frequency of walking and encounters with e-bikes and scooters, highlighting that the frequency of walking influences negative encounters with e-bikes and scooters. Overall, further research is needed to deepen our understanding of these relationships and develop strategies to enhance pedestrian safety and satisfaction in the presence of e-bikes and scooters, addressing potential conflicts and power dynamics.

In conclusion, the rise of delivery e-bikes and scooters in the city of Groningen has had an impact on perceived pedestrian safety and infrastructure satisfaction. Individual characteristics such as age, gender, and habitual behaviors, like walking frequency, influence the pedestrian experience. While age does not significantly affect perceived safety, gender differences and potential conflicts emerge, with females reporting lower perceived safety. Additionally, there is a association between walking frequency and safety perceptions.

5.5 Integrating E-Bikes and Scooters: Success Stories and Groningen's Path Forward

This research question: "What are the best practices in other cities that have successfully managed the integration of delivery e-bikes and scooters into the urban transportation system, and what suggestions do the citizens of Groningen have regarding this matter?" seeks potential solutions to any identified issues by examining best practices from other cities and incorporating the opinions and suggestions of the Groningen citizens (Edge et al., 2020). The integration of e-bikes and scooters into urban transport systems has garnered significant attention (Chahine et al., 2022). Successful integration practices require a multi-faceted approach that considers infrastructure, policy, and user behaviour (Edge et al., 2020). Cities like Berlin and Paris have implemented various practices that can enhance pedestrian safety (Chahine et al., 2022). These practices include developing dedicated bike lanes, pedestrian paths, and pedestrianized streets, as well as improving crosswalks, signposting, and positioning (Chahine et al., 2022; Khor, 2018). These practices are already present in Groningen. To further explore Groningen’s path forward, other alternatives are worth noting. One option, education and awareness campaigns, can promote responsible use and address safety concerns (Khor et al., 2018; Mayer & Robatsch, 2018) Additionally, the introduction of mandatory digital training for e-bike drivers may be considered. For example, the company Bezorgveilig has created a game with more than 700 dangerous situations to help delivery drivers navigate safely (Bezorgveilig, 2023) Implementing speed limits for delivery e-bikes and scooters to the VNN recommended 20 km/h and increasing penalties for traffic violations can further improve safety (Dagblad van het Noorden, 2020; Wang & Chen, 2023). Another way to regulate the use of e-bikes and scooters for delivery is to issue permits for delivery companies. These permits could require companies to adhere to certain safety standards and provide training for their drivers. Insurance companies could also play a role in promoting safe driving practices among delivery companies. Some insurance companies, such as Velosurance, offer specialized insurance policies for e-bikes (Treece, 2023). Insurance companies could require delivery companies to adhere to certain safety standards in order to qualify for coverage. A final suggestion which might bear fruit would be establishing more bicycle and scooter-free zones (Boggio-Marzet et al., 2021; Atamanalp, 2018).

The city of Groningen has already incorporated many of these strategies into its urban planning, but there are additional measures that could enhance safety and efficiency (Edge et al., 2020). Boosting education and awareness campaigns, alleviating pressures on delivery drivers, enforcing stricter speed limits, escalating penalties for traffic violations, and increasing pedestrian-only zones are potential actions worth considering (Edge et al., 2020). The idea of creating more separate area for pedestrians only should also be explored, although its feasibility remains uncertain (Edge et al., 2020;

Atamanalp, 2018). It is crucial to involve the opinions and suggestions of the Groningen residents to ensure that these integration practices align with their needs and preferences (Edge et al., 2020).

The pedestrians of Groningen were also surveyed to ascertain their views on the importance of various safety measures aimed at regulating e-bikes and scooters *(fig. 10).* Furthermore, according to Figure 11 in the study, pedestrians identified specific locations where they felt unsafe.

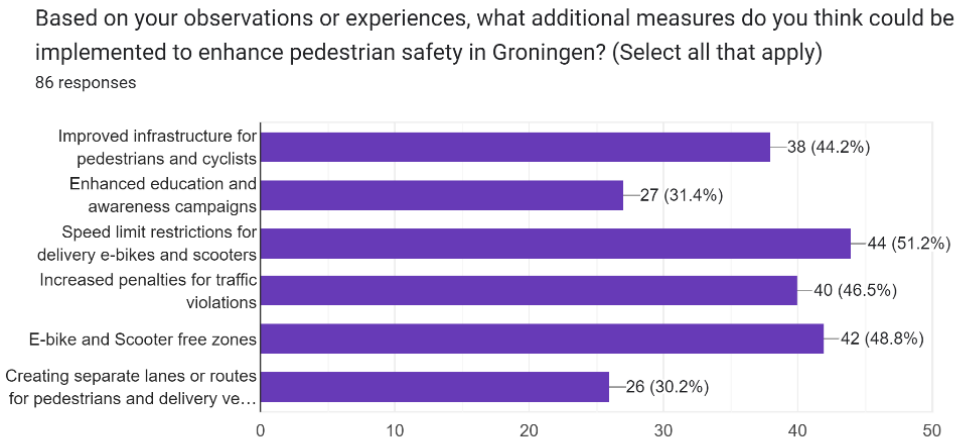

Figure 10. Bart chart showing pedestrian opinions on enhanced pedestrians' safety

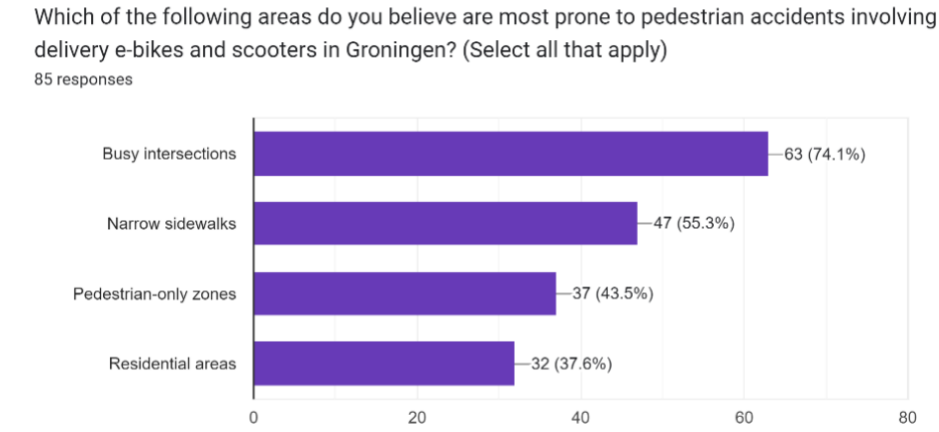

Figure 11. Bart chart showing pedestrian opinions on most prone areas to pedestrians

We can conclude from this that Groningen's residents consider enhanced infrastructure for pedestrians and cyclists, speed limit restrictions for delivery e-bikes and scooters, increased penalties for traffic violations, and creation of e-bike and scooter-free zones as useful solutions to enhance their safety perception concerning e-bikes and scooters to lessen the negative effects of the rise of the delivery e-bike and scooter. Further research should be done on how to negate the negative effects on the "most prone areas to pedestrians' accidents" (*fig. 11*). These being in particular busy intersections and narrow sidewalks. Although, again, the feasibility remains uncertain with limited space in the city center.

In conclusion, integrating delivery e-bikes and scooters into Groningen's urban transportation system requires a multi-faceted approach that considers infrastructure improvements, policy adjustments, and user behaviour. Best practices from other cities, along with the opinions of Groningen residents, provide valuable insights for enhancing pedestrian safety. Further research is needed to address safety concerns in high-risk areas and ensure that integration practices align with the city's unique spatial constraints.

6. Conclusion

In conclusion, this research explored the impact of the rise of delivery e-bikes and scooters on pedestrian safety and infrastructure satisfaction in the city of Groningen. The findings shed light on several key aspects related to the topic. Firstly, the study identified a notable increase in delivery drivers and pedestrians in Groningen, reflecting the city's expanding population and catering industry. This amplified the likelihood of accidents and diminished the perceived safety for pedestrians and satisfaction with the infrastructure. Secondly, it has become clear that Groningen's infrastructure, known for its pedestrian-friendly nature, has faced challenges due to the surge in delivery vehicles, leading to concerns about pedestrian safety by municipalities and residents. The study looked at the behaviour of delivery e-bike drivers and scooter riders to maintain Groningen's status as a pleasant and walkable city. As well as, looking into the factors that contributing to the perception of safety for pedestrians and infrastructure satisfaction.

The research also examined the perceived safety perspective of pedestrians in the inner-city of Groningen. As it was found that the perceived efficacy of current policies played a significant role in shaping pedestrians' perceptions of safety, perception of risks and actual risk, indicating the importance of effective policies. However, the perceived need for enhanced infrastructure did not directly influence pedestrians' safety perceptions or actual risk. This suggests the presence of other factors beyond infrastructure improvements that contribute to pedestrian safety and risk perceptions. Additionally, individual characteristics such as gender and habitual behaviours like the frequency of walking were found to influence the pedestrian experience with e-bikes and scooters.

Comparisons with other research results revealed that Groningen's accident rate involving delivery e-bikes and scooters was relatively low compared to other cities. The study highlighted the need for stronger enforcement of rules on delivery drivers to enhance pedestrians' perceived safety according to pedestrians and the possibility for permits and insurance companies to step in. Conversely, much of what the pedestrians want to see implemented may not or is not feasible in the city center.

Furthermore, it is hard to compare the findings of this study with the results of other research as the subject is relatively young and more research needs to be done to be able to compare.

The strength of this thesis lies in its focus on the specific context of Groningen and the inclusion of pedestrians. The research provides valuable insights into the challenges and opportunities associated with the rise of delivery e-bikes and scooters in Groningen. Some limitations, however, must also be acknowledged. The sample size of the survey respondents may not be representative of the entire population of Groningen, limiting the generalizability of the findings. Future research could benefit from larger and more diverse samples. Additionally, future research can explore the feasibility to implement infrastructure changes/policies in inner cities and how to further enhance e-bike safety.

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8. Appendix

Survey questions

Survey Questions

What is your age?

What is your gender?

How many days do you walk in the city of Groningen - average weekly?

How satisfied are you with the overall pedestrian infrastructure and facilities in Groningen?

Have you ever had a close encounter with a delivery e-bike or scooter while walking in Groningen?

How safe do you feel when walking in areas where delivery e-bikes and scooters are present?

How often do you witness delivery e-bikes and scooters violating traffic rules or engaging in reckless behaviors while on the road?

Do you feel that delivery e-bike and scooter riders are generally respectful of pedestrian safety in Groningen?

In your opinion, how common are pedestrian accidents involving delivery e-bikes and scooters in Groningen?

Which of the following areas do you believe are most prone to pedestrian accidents involving delivery e-bikes and scooters in Groningen? (Select all that apply)

Do you know about zones in Groningen that are for pedestrians only? If so, do you feel safer here?

In your opinion, are the delivery drivers respectful of the pedestrian areas?

Should the municipality of Groningen introduce more designated zones or areas specifically for pedestrians? Please indicate your level of agreement or disagreement with the following statement on a scale of 1 to 5, where 1 represents "strongly disagree" and 5 represents "strongly agree":

Do you believe that the integration of delivery e-bikes and scooters into the urban transportation system has provided any benefits to the city of Groningen? (Select all that apply)

Do you believe that the benefits of integrating delivery e-bikes and scooters into the urban transportation system in Groningen outweigh the potential negatives? Please rate each benefit and negative factor on a scale of 1 to 5, with 1 being "strongly disagree" and 5 being "strongly agree."

Have you ever seen any signs or other indications about policies and regulations in Groningen regarding delivery e-bikes and scooters?

Do you think stricter enforcement of existing regulations is necessary to improve pedestrian safety in relation to delivery e-bikes and scooters?

Based on your observations or experiences, what additional measures do you think could be implemented to enhance pedestrian safety in Groningen? (Select all that apply)

How feasible do you think it would be to implement separated bike lanes or designated areas for delivery e-bikes and scooters to improve pedestrian safety in Groningen?

The categories

Question Number	Question Category
Question 1	**Participant Demographics**
Question 2	**Participant Demographics**
Question 3	**Participant Demographics**
Question 4	**Pedestrian Safety and Delivery E-bikes/Scooters**
Question 5	**Pedestrian Safety and Delivery E-bikes/Scooters**
Question 6	**Pedestrian Safety and Delivery E-bikes/Scooters**
Question 7	**Pedestrian Safety and Delivery E-bikes/Scooters**

Question 8	**Pedestrian Safety and Delivery E-bikes/Scooters**
Question 9	**Pedestrian Safety and Delivery E-bikes/Scooters**
Question 10	**Pedestrian Safety and Delivery E-bikes/Scooters**
Question 11	**Pedestrian Safety and Delivery E-bikes/Scooters**
Question 12	**Pedestrian Safety and Delivery E-bikes/Scooters**
Question 13	**Pedestrian Safety and Delivery E-bikes/Scooters**
Question 14	**Pedestrian Safety and Delivery E-bikes/Scooters**
Question 15	**Pedestrian Safety and Delivery E-bikes/Scooters**
Question 16	**Policies and Regulations**
Question 17	**Policies and Regulations**
Question 18	**Possible Solutions according to citizens**
Question 19	**Possible Solutions according to citizens**

Number	Question	Measurement level	Answer option	Aim of question
1	What is your age?	Ordinal	• Under 18 • 18-25 • 25-34 • 34-44 • 45-54 • 55-64 • Above 64	Socio-demographic data that represents the population under study
2	What is your gender?	Nominal	• Male • Female • Other	Socio-demographic data that represents the population under study
3	How many days do you walk in the city of Groningen - average weekly	Ordinal	• Less than once a week • 1-2 days a week • 3-4 days a week • 5-6 days a week • Every day	Data determining the amount of time spent as pedestrians
4	How satisfied are you with the overall pedestrian infrastructure and facilities in Groningen?	Ordinal	• Very satisfied • Somewhat satisfied • Neutral • Somewhat dissatisfied • Very dissatisfied	Data determining satisfaction of pedestrians
5	Have you ever had a close encounter with a delivery e-bike or scooter while walking in Groningen?	Ordinal	• Yes, multiple times • Yes, once or twice • No, never • I'm not sure	Data determining the danger pedestrians experience
6	How safe do you feel when walking in areas where delivery e-bikes and scooters are present?	Ordinal	• Very safe • Somewhat safe • Neutral • Somewhat unsafe • Very unsafe	Data determining the safety pedestrians experience
7	How often do you witness delivery e-bikes and scooters violating traffic rules or engaging in reckless behaviors while on the road?	Ordinal	• Never • Rarely • Sometimes • Often • Very often	Data determining the perception pedestrians have of delivery drivers
8	Do you feel that delivery e-bike and scooter riders are	Nominal	• Yes, they are generally respectful	Data determining the perception pedestrians have of delivery drivers

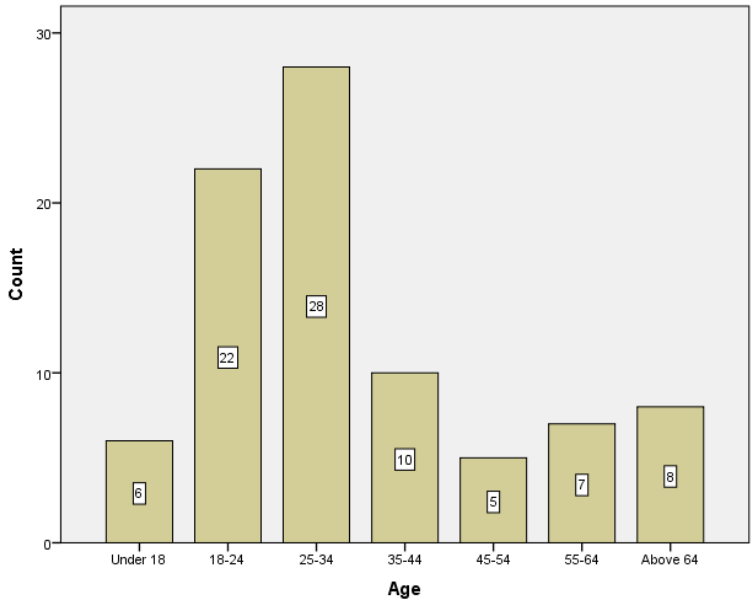
	generally respectful of pedestrian safety in Groningen?		• No, they are generally not respectful • I'm not sure	
9	In your opinion, how common are pedestrian accidents involving delivery e-bikes and scooters in Groningen?	Ordinal	• Very common • Common • Uncommon	Data determining the perception pedestrians have of delivery drivers
10	Which of the following areas do you believe are most prone to pedestrian accidents involving delivery e-bikes and scooters?	Nominal	• Busy intersections • Sidewalks • Pedestrian-only zones • Residential areas	Data determining the perception pedestrians have of danger points
11	Do you know about zones in Groningen that are for pedestrians only? If so, do you feel safer here?	Nominal	• Yes, much safer • Yes, safer • No difference • I don't know about it	Data determining the perception pedestrians have of danger points
12	In your opinion, are the delivery drivers respectful of the pedestrian areas?	Nominal	• Yes, delivery drivers are respectful of pedestrian areas • No, delivery drivers are not respectful of pedestrian areas • I am unsure or have no opinion	Data determining the perception pedestrians have of delivery drivers
13	Should the municipality of Groningen introduce more designated zones or areas specifically for pedestrians?	Ordinal	• Strongly disagree • Disagree • Neutral • Agree • Strongly agree	Data determining the perception pedestrians have of municipality rules and regulations
14	Do you believe that the integration of delivery e-bikes and scooters into the urban transportation system has provided any benefits to the city of Groningen?	Nominal	• Reduced traffic congestion • Enhanced environmental sustainability • Increased mobility options for residents • No benefits observed	Data determining the perception pedestrians have of delivery drivers

			• Not sure	
15	Do you believe that the benefits of integrating delivery e-bikes and scooters into the urban transportation system in Groningen outweigh the potential negatives?	Ordinal	• Strongly disagree • Disagree • Neutral • Agree • Strongly agree	Data determining the perception pedestrians have of delivery drivers
16	Have you ever seen any signs or other indications about policies and regulations in Groningen regarding delivery e-bikes and scooters?	Nominal	• Yes • No • I'm not sure	Data determining the perception pedestrians have of municipality rules and regulations
17	Do you think stricter enforcement of existing regulations is necessary to improve pedestrian safety in relation to delivery e-bikes and scooters?	Nominal	• Yes, stricter enforcement is needed • No, the current level of enforcement is sufficient • Not sure	Data determining the perception pedestrians have of municipality rules and regulations
18	Based on your observations or experiences, what additional measures do you think could be implemented to enhance pedestrian safety in Groningen?	Nominal	• Improved infrastructure for pedestrians and cyclists • Enhanced education and awareness campaigns • Speed limit restrictions for delivery e-bikes and scooters • Increased penalties for traffic violations • E-bike and scooter free zones • Creating separate lanes or routes for pedestrians and delivery vehicles	Data determining solutions according to pedestrians
19	How feasible do you think it would be to implement separated	Ordinal	• Very feasible • Somewhat feasible • Not feasible	Data determining solutions according to pe

bike lanes or designated areas for delivery e-bikes and scooters to improve pedestrian safety in Groningen?	• Not sure

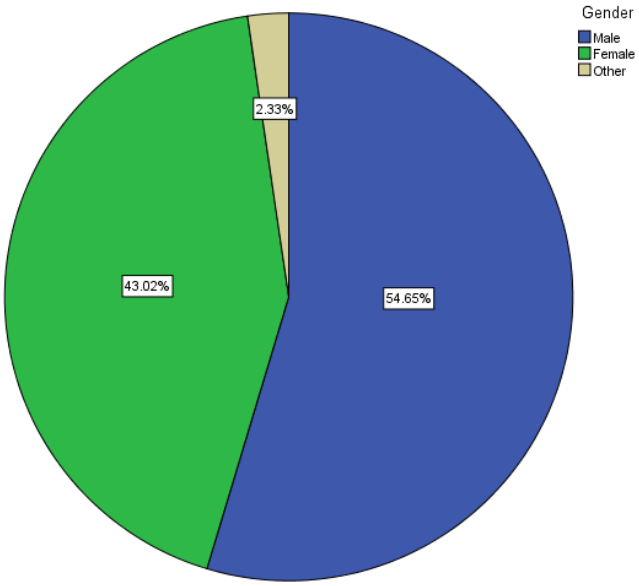
Spss- general

Age Distribution



According to the above bar chart, the majority of the respondents are in the age group of 25-34 years, followed by 18- 24 years. The lowest number of respondents belong to the age group of 45- 54 years.

Gender Distribution



The above pie chart shows the gender distribution of the respondents. 54.65% of the respondents are male, while 43.02% are females. 2.33% of the respondents have mentioned other as the gender.

Age and perceived safety

H_0: Mean perceived safety for all age groups are equal

H_1: At least one age group's mean perceived safety is different from the other groups

ANOVA

Perceived_Safety

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	10.388	6	1.731	1.978	.079
Within Groups	69.144	79	.875		
Total	79.532	85			

The P value is 0.079 and it is greater than 0.05. Hence H_0 cannot be rejected. Therefore, it can be concluded that the mean perceived safety for all age groups is equal at 5% level of significance.

Gender and perceived safety

H_0: Mean perceived safety is equal between males and female

H_1: Mean perceived safety is different between males and female

Group Statistics

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Perceived_Safety	Male	47	4.8553	.90020	.13131
	Female	37	4.3730	1.01725	.16724

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Perceived_Safety	Equal variances assumed	.035	.852	2.302	82	.024	.48235	.20953	.06552	.89917
	Equal variances not assumed			2.269	72.504	.026	.48235	.21262	.05854	.90616

The P value is 0.024 and it is less than 0.05. Hence H_0 can be rejected. Therefore, it can be concluded that the mean perceived safety is different between males and female at 5% level of significance.

Frequency of walking and perceived safety

H_0: Mean perceived safety for all groups (according to frequency of walking) are equal

H_1: At least one group's mean perceived safety is different from the other groups

ANOVA

Perceived_Safety

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7.498	4	1.874	2.108	.087
Within Groups	72.035	81	.889		
Total	79.532	85			

The P value is 0.087 and it is greater than 0.05. Hence H_0 cannot be rejected. Therefore, it can be concluded that the mean perceived safety for all age groups (according to frequency of walking) are equal at 5% level of significance.

Perceived safety with perceived need for enhanced infrastructure and perceived efficacy of current policies

H_0: The linear model is not statistically significant

H_1: The linear model is statistically significant

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13.053	2	6.527	8.149	.001[a]
	Residual	66.479	83	.801		
	Total	79.532	85			

a. Predictors: (Constant), Perceived_efficacy_of_current_policies, Perceived_need_for_enhances_infrastructure

b. Dependent Variable: Perceived_Safety

The P value is 0.001 and it is less than 0.05. Hence H_0 can be rejected. Therefore, it can be concluded that the linear model is statistically significant at 5% level of significance.

H_{0I}: There is no linear relationship between perceived safety and perceived need for enhanced infrastructure

H_{1I}: There is a linear relationship between perceived safety and perceived need for enhanced infrastructure

H_{0E}: There is no linear relationship between perceived safety and perceived efficacy of current policies

H_{1E}: There is a linear relationship between perceived safety and perceived efficacy of current policies

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.916	.461		8.503	.000
	Perceived_need_for_enhances_infrastructure	-.147	.128	-.116	-1.152	.253
	Perceived_efficacy_of_current_policies	.690	.175	.396	3.939	.000

a. Dependent Variable: Perceived_Safety

The P value for perceived efficacy of current policies is 0.000 and it is less than 0.05. Hence H_0 can be rejected. Therefore, it can be concluded that there is a linear relationship between perceived safety and perceived efficacy of current policies at 5% level of significance.

The P value for perceived need for enhanced infrastructure is 0.253 and it is greater than 0.05. Hence H_0 cannot be rejected. Therefore, it can be concluded that there is no linear relationship between perceived safety and perceived need for enhanced infrastructure at 5% level of significance.

The Regression models

Perceived safety = 3.916 - 0.147 (Perceived need for enhanced infrastructure) + 0.690 (Perceived efficacy of current policies)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.405[a]	.164	.144	.89496

a. Predictors: (Constant), Perceived_efficacy_of_current_policies, Perceived_need_for_enhances_infrastructure

The R^2 value is 0.164. This illustrates that 16.4% variation in perceived safety is explained from this model. Since it is a low percentage, this is not a very good model to be used for predictions.

Perceived risk with perceived need for enhanced infrastructure and perceived efficacy of current policies

H_0: The linear model is not statistically significant

H_1: The linear model is statistically significant

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.249	2	1.124	6.651	.002[a]
	Residual	14.032	83	.169		
	Total	16.281	85			

a. Predictors: (Constant), Perceived_efficacy_of_current_policies, Perceived_need_for_enhances_infrastructure

b. Dependent Variable: Perceived_Risk

The P value is 0.002 and it is less than 0.05. Hence H_0 can be rejected. Therefore, it can be concluded that the linear model is statistically significant at 5% level of significance.

H_{0I}: There is no linear relationship between perceived risk and perceived need for enhanced infrastructure

H_{1I}: There is a linear relationship between perceived risk and perceived need for enhanced infrastructure

H_{0E}: There is no linear relationship between perceived risk and perceived efficacy of current policies

H_{1E}: There is a linear relationship between perceived risk and perceived efficacy of current policies

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.751	.212		8.276	.000

	Perceived_need_for_enhances_infrastructure	.000	.059	-.001	-.005	.996
	Perceived_efficacy_of_current_policies	.293	.080	.372	3.639	.000

a. Dependent Variable: Perceived_Risk

The P value for perceived efficacy of current policies is 0.000 and it is less than 0.05. Hence H_0 can be rejected. Therefore, it can be concluded that there is a linear relationship between perceived risk and perceived efficacy of current policies at 5% level of significance.

The P value for perceived need for enhanced infrastructure is 0.996 and it is greater than 0.05. Hence H_0 cannot be rejected. Therefore, it can be concluded that there is no linear relationship between perceived risk and perceived need for enhanced infrastructure at 5% level of significance.

The Regression models

Perceived risk = 1.751 + 0.293 (Perceived efficacy of current policies)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.372[a]	.138	.117	.41117

a. Predictors: (Constant), Perceived_efficacy_of_current_policies, Perceived_need_for_enhances_infrastructure

The R^2 value is 0.138. This illustrates that 13.8% variation in perceived risk is explained from this model. Since it is a low percentage, this is not a very good model to be used for predictions.

Actual risk with perceived need for enhanced infrastructure and perceived efficacy of current policies

H_0: The linear model is not statistically significant

H_1: The linear model is statistically significant

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.912	2	2.456	4.306	.017[a]
	Residual	47.344	83	.570		
	Total	52.256	85			

a. Predictors: (Constant), Perceived_efficacy_of_current_policies, Perceived_need_for_enhances_infrastructure

b. Dependent Variable: Actual_Risk

The P value is 0.017 and it is less than 0.05. Hence H_0 can be rejected. Therefore, it can be concluded that the linear model is statistically significant at 5% level of significance.

H_{0I}: There is no linear relationship between actual risk and perceived need for enhanced infrastructure

H_{1I}: There is a linear relationship between actual risk and perceived need for enhanced infrastructure

H_{0E}: There is no linear relationship between actual risk and perceived efficacy of current policies

H_{1E}: There is a linear relationship between actual risk and perceived efficacy of current policies

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.165	.389		5.570	.000
	Perceived_need_for_enhances_infrastructure	-.147	.108	-.143	-1.362	.177
	Perceived_efficacy_of_current_policies	.397	.148	.281	2.686	.009

a. Dependent Variable: Actual_Risk

The P value for perceived efficacy of current policies is 0.009 and it is less than 0.05. Hence H_0 can be rejected. Therefore, it can be concluded that there is a linear relationship between actual risk and perceived efficacy of current policies at 5% level of significance.

The P value for perceived need for enhanced infrastructure is 0.177 and it is greater than 0.05. Hence H_0 cannot be rejected. Therefore, it can be concluded that there is no linear relationship between actual risk and perceived need for enhanced infrastructure at 5% level of significance.

The Regression models

Actual risk = 2.165 – 0.147 (Perceived need for enhanced infrastructure) + 0.397 (Perceived efficacy of current policies)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.307[a]	.094	.072	.75525

a. Predictors: (Constant), Perceived_efficacy_of_current_policies, Perceived_need_for_enhances_infrastructure

The R^2 value is 0.094. This illustrates that 9.4% variation in actual risk is explained from this model. Since it is a low percentage, this is not a very good model to be used for predictions.

Association between frequency of walking and satisfaction with pedestrian infrastructure

H_0: There is no association between frequency of walking and satisfaction with pedestrian infrastructure

H_1: There is an association between frequency of walking and satisfaction with pedestrian infrastructure

Days_walk_in_the_city_of_Groningen * How satisfied are you with the overall pedestrian infrastructure and facilities in Groningen?

Crosstabulation

Count

		How satisfied are you with the overall pedestrian infrastructure and facilities in Groningen?					
		Very dissatisfied	Somewhat dissatisfied	Neutral	Somewhat satisfied	Very satisfied	Total
Days_walk_in_the_city_of_Groningen	Less than once a week	1	0	1	2	1	5
	1-2 days a week	1	0	3	4	0	8

	3-4 days a week	2	5	2	5	0	14
	5-6 days a week	4	12	10	18	0	44
	Everyday	2	4	1	4	4	15
Total		10	21	17	33	5	86

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	25.447[a]	16	.062
Likelihood Ratio	26.589	16	.046
Linear-by-Linear Association	.013	1	.908
N of Valid Cases	86		

a. 19 cells (76.0%) have expected count less than 5. The minimum expected count is .29.

The P value is 0.062 and it is greater than 0.05. Hence H_0 cannot be rejected. Therefore, it can be concluded that there is no association between frequency of walking and satisfaction with pedestrian infrastructure at 5% level of significance.

Frequency of walking and encounters with delivery vehicles

H_0: There is no association between frequency of walking and encounters with delivery vehicles

H_1: There is an association between frequency of walking and encounters with delivery vehicles

Days_walk_in_the_city_of_Groningen * Have you ever had a close encounter with a delivery e-bike or scooter while walking in Groningen? Crosstabulation

Count

		Have you ever had a close encounter with a delivery e-bike or scooter while walking in Groningen?				
		Yes, multiple times	Yes, once or twice	I'm not sure	No, Never	Total
Days_walk_in_the_city_of_Groningen	Less than once a week	1	2	0	2	5
	1-2 days a week	1	1	0	6	8
	3-4 days a week	1	9	1	3	14
	5-6 days a week	6	32	1	5	44
	Everyday	6	5	0	4	15

Total	15	49	2	20	86

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	26.906[a]	12	.008
Likelihood Ratio	24.673	12	.016
Linear-by-Linear Association	6.577	1	.010
N of Valid Cases	86		

a. 15 cells (75.0%) have expected count less than 5. The minimum expected count is .12.

The P value is 0.008 and it is less than 0.05. Hence H_0 can be rejected. Therefore, it can be concluded that there is an association between frequency of walking and encounters with delivery vehicles at 5% level of significance.