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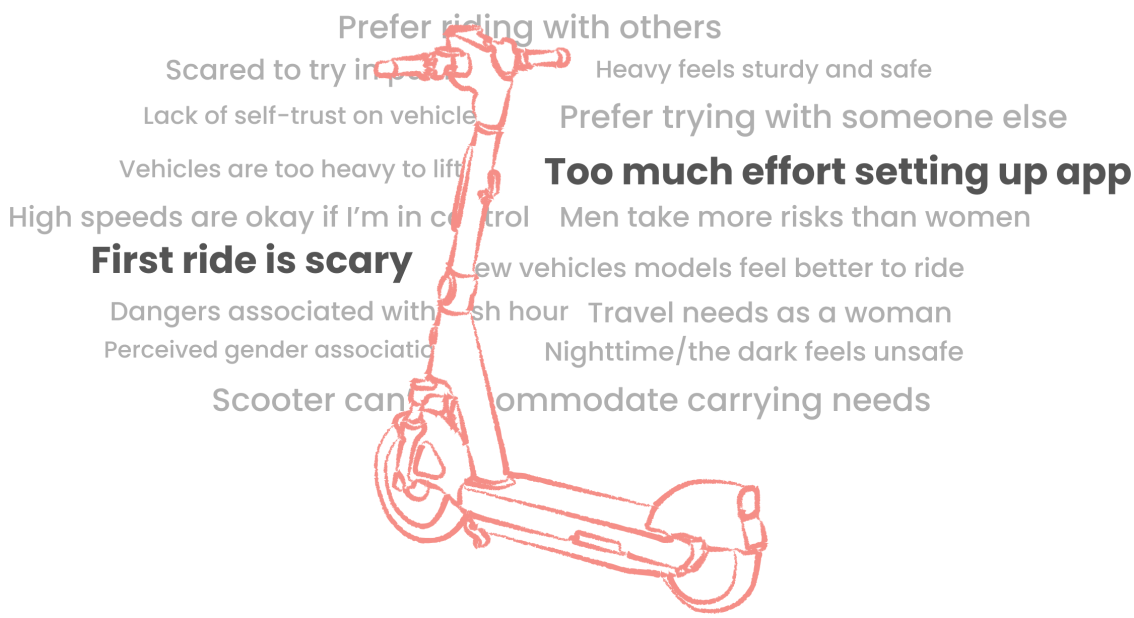

Designing to Bridge the Gender Gap in Micromobility

Investigating and Addressing Barriers to Women's Micromobility Adoption

Master's thesis in Computer science and engineering

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Gothenburg, Sweden 2025

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Cover: Illustrated Voi scooter with barrier sub-themes in the background.

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Abstract

Despite the popularity of micromobility services, there is a prominent gender gap in users of micromobility, where men who ride e-scooters and e-bikes greatly outnumber women. This master thesis project investigates the barriers to women's micromobility adoption that contribute to this gap, and subsequently proposes a design solution addressing these barriers. Adopting a user-centered approach, qualitative interviews were conducted with both user and non-user women to identify and understand their safety and accessibility needs. The primary barrier to women's adoption of micromobility solutions was found to be an interconnected network of personal safety concerns, gender stereotypes, varying travel needs, and negative preconceived notions surrounding micromobility. Taking into account these findings, solutions were ideated upon and evaluated. A high-fidelity prototype was created to exemplify how the discovered barriers may be addressed through design solutions. This resulting prototype was dubbed Training Mode, a free browser-based e-scooter training platform that addresses the participants' needs for more transparency and instruction on how to navigate the functions of an e-scooter. Initial evaluations suggest that Training Mode succeeds in enticing hesitant non-users to engage with e-scooters, prompting future work to investigate its potential to impact on female ridership.

Keywords: Gender gap, Micromobility, User Research, User-Centered Design, Mobile Interface.

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Alexander Can Zois & Bill Xerxes Falk, Gothenburg, 2025-06-16

Contents

List of Figures

1 Introduction

Nowadays, it is not hard to spot an e-scooter or an e-bike somewhere along local streets. Be it a group of them parked along a sidewalk, or just one lying sideways on the ground, they have become a part of city life in many European countries. In addition to becoming a new object in everyday scenery, they are particularly important as they provide a convenient and sustainable mode of transportation, compared to traditional fuel-based vehicles. As e-scooters and e-bikes run on electric battery power, their convenience and accessibility are important for reducing emissions in daily life, as they have been assessed as playing an important role in the decarbonization of transportation [1], [2]. Particularly for people who might usually use their car or motorbike to go to work, micromobility may offer a way to live a more environmentally friendly lifestyle. In cities that mostly use fuel-based busses, micromobility options may also help to reduce the daily emissions of those who primarily rely on public transport.

However, a large disparity exists between female and male micromobility usage. Men greatly outnumber women among users of e-scooters and e-bikes, which has often been attributed to men showing a higher likelihood of engaging in risky or unsafe behaviors [3]–[5]. This on its own may imply that women may place more value on safety when it comes to road behavior and micromobility use, yet the precise barriers that hinder women from using these services require more investigation. For this reason, this project was conducted in collaboration with Voi Technology AB to investigate why this gender gap exists and how it can be bridged. Voi's services target anyone who is in need of quick and sustainable transportation options, and do not seek to restrict their users to men only. On a marketing level, as women constitute half of the world's population, it is of interest to Voi and generally any other company to make sure their product is as far-reaching as possible. More concerningly, however, the potential disregard of an entire gender from a transportation service also carries detrimental implications on ongoing efforts to promote gender equality in all aspects of life. Especially in transportation, where convenience and time are precious, it is important that women are not inadvertently left at a disadvantage. In a similar vein, if society is to also progress in establishing a greener world with less carbon emissions and more widespread use of sustainable technology, it is necessary that all take part and get accustomed to leading a greener lifestyle.

1.1 Stakeholders

The first group of stakeholders in this project is us as the master students authoring this thesis: Alexander Can Zois and Bill Xerxes Falk. Next is Chalmers University of Technology as our supervising and examining body. Thirdly, Voi Technology AB as our industrial partner who are mentoring us during this project and seek to implement our findings in future iterations of their products. Lastly are micromobility users and non-users, particularly women who seek to benefit from having their voices heard, and micromobility operators who may also make use of our findings to better meet the needs of female riders.

1.2 Aim and Research Questions

Considering the concerns outlined above, this thesis project aims to contribute to bridging the gender gap in micromobility by investigating the barriers that hinder women from using e-scooters and e-bikes. The project subsequently aims to exemplify how these barriers may be translated into actionable design solutions, keeping in mind the end goal of increasing female micromobility ridership. The execution of this thesis project is therefore guided by and aims to answer the following primary research question and sub-question:

1. What are the primary barriers that prevent women from adopting micromobility solutions, particularly e-scooters and e-bikes?
    (a) How might these barriers be addressed through user-centered design solutions?

1.3 Ethical Considerations and Limitations

Given that this thesis focuses on how an entire gender relates to micromobility, an important ethical consideration lies in the authors' positionalities as male researchers. While the utmost care was taken to ensure a non-biased approach, where the investigated women's needs and concerns were gathered and analyzed in a scientifically sound manner, this positionality may have affected the results. There is always the risk that the responses of the female participants during the data intake stage could have been affected by the male researcher - female participant dynamic. Some women might feel uncomfortable and thereby restrict their responses when talking about a gender-charged topic, so this must be considered when interpreting the outcomes of this project.

This project is also not without its limitations. Firstly, the target of this project is shared e-scooters and e-bikes, specifically those used by Voi. Therefore, the findings of this thesis may not be generalizable to other types of micromobility vehicles, and it should be kept in mind that Voi's vehicles may differ from those of other micromobility services in terms of aesthetic choices and device specifications. Additionally, even though e-bike use was also targeted, it is important to note that Voi's e-bike market is only a fraction of the size of its e-scooter market, so an overwhelming majority of impressions gathered from users concerned e-scooter use.

As this master's thesis is primarily a design-related project, the focus was on ideating toward design-related solutions. Therefore, even though some findings may point towards, for example, a cost or societal issue, whereby possible solutions may involve marketing changes or social initiatives, the primary aim was to find the most viable solutions from an interaction design perspective.

Lastly, while further iterations and evaluations of the prototype are ideal, the timeline of the this project as a master's thesis imposes limitations on the duration and scope of the individual phases of the project. Furthermore, the evaluations of the low-fidelity and high-fidelity prototypes were only conducted in Sweden, which may have restricted the feedback to the proposed solutions to a singular demographic group.

2

Background

The aim of this thesis is to investigate and address the gender gap in micromobility in partnership with Voi Technology AB. This chapter discusses the current state of the gender gap and existing research into its possible reasons. It also shortly describes Voi and their services.

2.1 State of the Gender Gap

As touched upon in the previous section, this project was necessitated by the finding that men greatly outnumber female users when it comes to shared micromobility services. The gender gap in micromobility has already been identified and well documented by a number of micromobility services and independent studies, though it is important to mention that the magnitude of this gap has been decreasing. Back in 2018, in order to make an informed decision on how to manage e-scooter sharing services in their city, the City of Portland in Oregon USA conducted a pilot project to understand the safety and operational nature of e-scooters. The results of this project revealed that men not only comprised the overwhelming majority of e-scooter users (64%), but they also showed a higher frequency of use than women [6].

A bit later, in early 2021, Dott Mobility, which at the time operated in the United Kingdom, Italy, and France, conducted a survey to understand users' experiences of their e-scooter service. Their results revealed a substantial disparity between male and female users, whereby most users were revealed to be male with only 27% of riders being female in France and 21% in the UK and Italy each [7]. Their survey findings in France was echoed in a study conducted by a group of researchers from the University of Patras and Gustave Eiffel University, who found the proportion of female riders to be 32% [8]. Another survey by Neuron Mobility in 2023 targeting e-scooter riders in Canada, Australia, New Zealand, and the United Kingdom found a recurring pattern across these four markets, with the average global distribution of riders being 59% male and 40% female [9]. However, their findings showed an outlying market, namely the UK, where the proportion of female riders remains low at 23%. Other studies include a survey conducted in Istanbul, Türkiye, where the proportion of women riders within the sample was found to be 37% [10], while in Zurich, Switzerland, women constituted 32% of e-scooter riders [11].

2.1.1 Rider Behavior

A number of these studies also investigated differences in rider behavior, both in terms of gender and between e-scooters and bikes. An observational study by Younes, Noland, and Andrews employing traffic cameras in New Jersey, USA followed the riding behavior of both male and female cyclists and scooter riders [12]. They found that for helmet usage, a third of cyclists used a helmet but none of the e-scooter riders were observed to wear one. Among cyclists, men were more likely to wear a helmet. Men were also more likely than women to ride on the road, irrespective of vehicle, while women riders tended to prefer the sidewalk and avoid spaces with motor vehicles [3], [12], and were more likely to travel in a group than alone [12]. Other studies have also found that men are more likely to perform risky behaviors while riding, such as fast riding [3], [13], [14], riding after having consumed drugs or alcohol [15], using a smartphone while riding [15], and performing illegal traffic maneuvers [16].

In terms of ride length with bicycles, male cyclists have generally been found to take longer rides than women [12], [17]. While investigating this trend with e-scooter use, Cubells et al., found that female e-scooter riders tended to take shorter trips than men, and had a preference for shorter detours on dedicated cycling infrastructure when riding e-scooters and e-bikes [18]. Cubells, Miralles-Guasch, and Marquet showed that women only deviated from the shortest route when it meant reaching calmer streets to ride on or getting onto dedicated cycling paths [18]. Men tended to deviate from shorter paths to elude obstacles such as parked cars, even if it meant riding on pedestrianized streets. Women were also found to be less likely to use micromobility sharing services at nighttime. In a separate study, Cubells, Miralles-Guasch, and Marquet showed that female riders in Barcelona actively avoided travelling at night [3]. While both genders tended to travel faster at night, the speed difference between daytime and night time was more prominent among women. A study using GPS data from riders in Paris, France found that female riders were more likely to make use of micromobility services in the afternoon, after which their nighttime use of shared bikes was significantly lower than male riders' [15]. This finding was akin to results by Pellicer-Chenoll, Pans, Seifert, *et al.* in Valencia, Spain, where women and men both tended to show similar areas of travel during the afternoon [19]. At nighttime, however, women's travel area was restricted to the most central areas of the city, whereas men showed higher travel frequencies in the suburbs.

Differences in ride behavior suggest that the experiences of female and male riders are qualitatively different, whereby an e-scooter ride may be characterized by different safety and convenience needs as well as daily life patterns and goals. Implications of these findings and research looking into how different attitudes and behaviors may influence ridership are discussed in Chapter 3 of this report.

2.2 Voi Technology AB

Voi Technology AB is a Swedish micromobility company founded in 2018 that provides shared vehicle services in a wide range of European cities. With the mission of making transport in cities more sustainable, they offer electric scooters and e-bikes for hire using their mobile application. Their mission is rooted in the idea of a 15-minute city, where all amenities and necessities can be reached in 15 minutes [20], [21]. Users can approach any of their vehicles that have been parked outside and use their mobile application to scan the QR code on the vehicle in order to unlock and use it [22]. Usually, users are charged to unlock the vehicle and for every minute of riding, but it is also possible to make use of Voi's subscription models, whereby a set amount is paid to use their vehicles for as long as wanted for a given period of time. Voi's complete area of operations includes a range of cities in Austria, Belgium, Denmark, Finland, France, Germany, Italy, Norway, Spain, Sweden, Switzerland, and the United Kingdom [23]. Their primary vehicle is the e-scooter, as e-bikes have so far only been released in a limited number of markets.

Voi currently employs their Voiager line of e-scooters and their Explorer line of e-bikes [24]. While vehicle models are continually updated and upgraded with the goal of enhancing customer experience, it is important to note that in terms of physical dimensions, all vehicles are kept constant. This means that all markets, irrespective of differences in the average height or weight of their inhabitants, are offered the same size of vehicles.

2.3 The Current Project

Overall, the studies presented above support the existence of a prominent gender gap in micromobility, whereby the most prevalent user demographic appears to be young, urban dwelling, educated males without children [3], [11], [25]–[27]. The current project was proposed by Voi Technology AB when they themselves discovered trends in their data indicative of a gender gap within their own service. Despite there being an observed intention by women to try using e-scooters [10], [28] and the narrowing of the gap seen in the results discussed above, this trend has stagnated, which prompted Voi to initiate their own investigation into the matter. The relevance of this project lies in how past studies of the gender gap have investigated the reasons behind it without the end goal of coming up with a solution using design frameworks. Despite some survey reports concluding with recommendations [7], [9], to the best of the authors' knowledge, these proposed solutions have remained theoretical and have not resulted in any commercially successful implementations. This thesis project intended to contribute to bridging the gender gap via qualitative investigation into the gap followed by the demonstration of how the gap may be addressed with design solutions. In this way, it is the authors' hope that the presented results function as an inspiration and trigger for micromobility operators to design towards prioritizing women's mobility needs.

3

Theory

Women's reluctance to use micromobility services is related to numerous factors that may interact with each other to form even greater barriers to women's micromobility experience. This chapter describes these factors and how they function to hinder women from enjoying e-scooters and e-bikes the way men might do. Additionally, how this thesis work contributes to the field of design is discussed at the end of the chapter.

3.1 Barriers to Women's Micromobility Adoption

While these obstacles can be theoretically defined and described as individual phenomena, it is important to note that these potential barriers are dynamic and may exist to varying degrees depending on geographical and temporal context. The extent to which a single barrier may hinder women's adoption of micromobility is dependent on the location in which micromobility services are active, the nature of the ride, and the time of day during which the ride takes place [28]. Even though these barriers are divided into the proceeding subsections, they are highly interconnected and, for the most part, can be traced back to societal gender norms and stereotypes.

3.1.1 Gender Stereotypes

A prominent finding was that women tend to feel less confident in traffic situations that involve motorized vehicles and aggressive riders [3], [29], which has long been attributed to the simplified notion that men are fast riders and women are safety concerned. In truth, however, the underlying factors have been found to stem from societal gender norms, whereby the theory of embodiment provides insight into the way power dynamics on a cycle path or street are affected by how men utilize their physical presence while riding [30], [31]. Popan posits that fast riding is not merely a banal activity, but rather an embodied performance of normative masculinity, whereby the male agent seeks to assert spatial dominance on the traversed path [32]. Such male riders' attitudes end up affecting the ride behavior of those around them, as women cyclists in the presence of those exhibiting such "careless masculinity" [33] have reported a feeling of "being in the way" [34]. This has led women to adopt different strategies to cope with the behavior of aggressive male riders. For example, women have reported losing the drive to compete for their right to occupy bike lanes, instead altering their route or their ride schedules to avoid being exposed to careless masculinity [34], [35].

As another strategy, some female cyclists have reported engaging in mirroring practices, whereby they feel pressure to raise their cycling speed to match that of the male cyclists around them with the consequence that gender stereotypes are propagated. The theory of performativity describes how that which is deemed as stereotypical of a gender is not fixed, but instantiated and maintained through social actions [31], [36]. Male riders' carelessness and the resulting elicitation and internalization of the feeling of "being in the way" in female riders is a demonstration of these performative processes at play. Additionally, cliched views of e-scooters as masculine "boy's toys" [28] further exacerbate the issue by creating preconceptions of how gender relates to ride competency. Shahin and Elias found evidence for a societal bias against young female and elderly e-scooter riders, which is particularly relevant because such biases can quickly develop into public attitudes, which may become internalized and implicitly influence behavior [37]. They also suggest that it is these biases that negatively impact women's impressions of e-scooters and micromobility sharing services, which in turn diminishes their willingness to use them.

It is of course not all male riders who create unsafe riding environments, and not all female riders are affected by those that do, but as long as one gender exerts negative influence on the other, be it explicit or implicit, gender power dynamics and stereotypes must still be talked about and shown consideration when searching for user-centered solutions.

3.1.2 Risk Aversion and Harassment

Men have already been established to exhibit riskier behaviors in traffic [14], [15] and are more likely to ignore traffic rules [16]. Furthermore, they are much more likely to go on rides at night [15] and expand their rides into larger, more outlying areas [19]. This quite openly indicates that female and male riders possess different safety concerns. Such concerns are not only shaped by inherent differences in risk perception but by external societal factors as well, particularly the heightened risk of facing harassment in public and gender-related safety threats women often encounter. Past examinations into ride behavior suggested that women generally have heightened risk perception and are more risk averse than men. The reasons for this are varied, with Gustafson for instance attributing female risk aversion to traditional social roles of females as providers and caretakers, whereby it is advantageous for women to be more sensitive to health and safety risks [38]. This theory also paints males as the income earners and thereby more perceptive of economic risk compared to those of physical safety. Flynn, Slovic, and Mertz [39] and Finucane, Slovic, Mertz, *et al.* [40] also observed a higher tendency for males to disregard certain health hazards, primarily attributed to white males, who hold a privileged position in society. The generalizability of this finding was called into doubt, however, by Olofsson and Rashid, who examined risk perception as a function of social inequality [41]. They found that the absence of risk aversion in men is not related to one's status as a white male, what was previously known as the "white male effect". Rather, it is a function of how gender-equal the society in question is. More concretely, Olofsson and Rashid showed that when comparing the United States and Sweden, the latter of which is more gender-equal, the Swedish population showed no significant difference between men and women in their level of risk perception [41]. Nevertheless, while gender was not a significant marker of risk perception in a society with a higher level of gender-equality, they found that ethnicity mediated inequality, which in turn led to higher risk perception among minorities. Thus, they propose the societal inequality effect as an explainer for differences in risk perception among certain groups. This carries implications for the current project, where it may be of interest to examine micromobility users' risk perception according to their status as a minority in their country of residence.

Overall, given how social norms and roles are ever changing, these insights into gender-based risk aversion are themselves at risk of being dated, but it is no doubt that certain trends are still being observed. Among cyclists and e-scooter riders, women still show heightened risk perception [37]. It has been empirically confirmed that male cyclists consistently report lower risk perception of cycling yet continue to have a higher rate of bicycle crashes than female cyclists; a paradox that still holds true [42]. Graystone, Mitra, and Hess suggest, however, that there is no significant gender difference in fear of traffic collision and resulting injury, and that women's risk perception pertains more to the risk of being verbally abused and harassed by other cyclists and drivers, particularly males [43]. Ravensbergen, Buliung, and Laliberté outline the fear of injury and the fear for personal safety as two types of fear when cycling, whereby women's position in gender unequal societies instills in them a greater fear for their personal safety [44]. Given that car drivers may already exhibit impatience and an unwillingness to make space for those they deem to be "out of place" on the road (i.e., cyclists, scooters), women cyclists have an increased likelihood of being harassed or bullied, particularly by male drivers [35], [45]. Half of the women and non-binary cyclists surveyed by Cubells, Miralles-Guasch, and Marquet reported having experienced aggression due to their gender identity, 30% of which resort to changing their routes to avoid such encounters. It appears that it is such fears that may drive female micromobility users to greater risk aversion [3].

3.1.3 Nighttime Riding

This subsection is very much related to the previous one but necessitates independence due to some differences in potential solutions. While fear for personal safety is prevalent, a large obstacle facing women's desire to use micromobility is the specific fear of facing harassment or verbal and/or physical abuse in the dark of night. A survey by Lime investigating women's sense of safety while cycling at night found that 50% of female cyclists in the UK fear for their safety when cycling in the dark [29]. They reported feeling uncomfortable cycling on roads that were not lit up properly. TIER found that while 73% of female UK e-scooter riders felt comfortable using e-scooters during the day, this number dropped to only 3% at night [28]. Similar results were seen in Berlin, with 66% and 10% respectively. Cubells, Miralles-Guasch, and Marquet discovered a similar pattern in their comprehensive study of female e-scooter and e-bike riders in Barcelona, where during night hours, men were much more likely to use e-bikes than women [18]. They theorize that this is because e-bikes need to be docked at specific stations, which exposes women to increased visibility during their walk from the e-bike dock to their final destination. Additionally, the women in their study cycled faster at night, likely to compensate for their increased visibility. Thus, the perceived or expected danger of being harassed due to high visibility alters the spatial and temporal behavior of women using micromobility [18], [19]. Overall, such instances may correspond to what Ravensbergen, Buliung, and Laliberté describe as patriarchal elements in society exerting pressure on women to alter how they move and exist in urban spaces, such as streets and cycling infrastructure [31]. It is not the dark that women fear, but the vulnerability to harassment it imposes on them. Though it may be possible to propose and implement design solutions to increase safety and security, lasting change likely requires upheaval on a societal level.

3.1.4 Hesitation with New Technologies

Men have been found to adopt new technologies and integrate them into their daily lives more quickly than women [25], and women in turn prefer using technologies that have already been on the market for several years [46]. Kotzé, Anderson, and Summerfield attribute this to women's higher level of risk aversion and low degree of optimism when it comes to emerging technologies [47]. They also found that women have higher cognitive-processing than men when it comes to making purchase decisions for high-technology products.

3.1.5 Infrastructure

The call for better infrastructure and the extent to which it may lead to a higher willingness to use micromobility is highly dependent on the region, which necessitates localized solutions. In their study of cycling in six European countries, Prati, Fraboni, De Angelis, *et al.* found that participants from Italy reported the worst rating of cycling infrastructure, which correlated with a lower rate of cyclists in Italy [42]. This is similar to ratings in Istanbul, where traffic congestion is very prevalent [10]. The best ratings for quality and quantity of cycling were found among Dutch participants, who enjoy a more bicycle-centric society and highly-developed bike paths in the Netherlands. Overall, however, female participants were much more likely to feel discomfort while cycling in mixed traffic.

Even though the gender gap is much wider in areas that do not have adequate cycling infrastructure [48], [49], women in areas that do may still choose to avoid them. When given the opportunity to ride on cycling infrastructure, women using e-bikes chose not to use it, particularly when it also allowed for motorized vehicles like e-scooters [3]. The researchers theorized that this can be explained by a diminished desire to compete for their presence on the road and a low tolerance for reckless, especially male, riders. While much of women's infrastructure concerns relate to ensuring physical safety while operating a vehicle, these concerns are tightly connected with their heightened risk perception of verbal abuse and harassment on the street. Graystone, Mitra, and Hess explain that, while bicycle infrastructure can do little to directly reduce verbal abuse faced by women cyclists, establishing spaces for riders may gradually dissociate the cyclist identity' from that of the stereotypical white male. They theorize that over time, encouraging the use of cycling infrastructure by all genders may make drivers and male cyclists actively more aware of them, which may in turn make cycling more socially normalized and expand the cyclist identity to include all. Their hope is that this will reduce bullying of riders seen as the outgroup. Perhaps this effect may carry over into the realm of e-scooters as well.

3.1.6 Travel Patterns and Needs

Some have found that women's mobility choices and lack of micromobility usage are due to differences in travel patterns and resulting needs. In their study on mobility choices in Sicily, Campisi, Skoufas, Kaltsidis, *et al.* suggest that men's transportation needs are more easily covered by micromobility due to simpler motivations [25]. They describe women as more often needing to accompany a child or a relative, and therefore requiring more flexible modes of transportation that can transport more than one person, something that is not usually possible with e-scooters and e-bikes. In 2021, mos unpaid care work in Italy was found to be done by women, often located outside of city centers. Campisi, Skoufas, Kaltsidis, *et al.* theorize that this drives them to employ more varied modes of transport and take more complex routes, which would not be possible with micromobility. The percentage of women performing unpaid care varies by country, which once again highlights how use patterns and micromobility barriers are a function of location. In surveys on electric vehicle use patterns and needs, women from both the United States [50] and the United Kingdom [5] placed high value on being able to carry cargo and children with their vehicles. Other responses also indicated that some women may be discouraged from riding e-scooters or e-bikes due to appearance concerns, particularly how weather conditions and travel speed may adversely affect their groomed appearance [5], [7], [25]. Conversely, some women had positive views on using e-scooters with regards to choice of clothing as they found e-scooters more convenient for getting around while wearing restrictive clothes such as dresses or skirts [12]. While there are no results suggesting that the gender gap can be attributed to a mismatch between micromobility vehicle measurements and women's physical characteristics, Parnell, Merriman, and Plant underline the importance of considering differences in physical composition and size between female and male bodies when considering the ergonomic measurements of vehicles [5].

3.2 Design Output as a Means of Discovery

Though this master's thesis will follow the double diamond approach (see next chapter) and is not a direct instance of research through design, the output of this project can set the stage for further exploration via the proposed design solution, particularly due to the volatile social nature of the tackled problem. For one, the prototype that results from the ideation phase will not only be a design to optimize usability but will also embody the insights of the discovery phase and thereby represent the values and needs of women in the researched markets. Gaver explains that insights gained through designs provide more situated understandings of the researched area than a purely analytic approach would, which may be the case in this project, particularly if the final design is imbued with participant input via participatory design methods [51].

The end product of a project aims to communicate the current state of the problem and opens the door for further exploration [51]. The resulting design would merely be the designers' best judgment for how to tackle the issue at hand, which Gaver claims to be fruitful for future discovery as the ambiguity of a non-final solution can provide new perspectives to the problem area [51]. For instance, should the proposed design solution go in the direction of making women feel safer during nighttime riding or making rides more convenient via carriage space, it may facilitate new perceptions of and interactions with micromobility by altering the problem space. It is unknown whether these would be enough to bridge the gender gap (if it even is something to be fully bridged), but solutions may shift the focus onto new problems that require more attention or onto riders' needs that were previously obscured. Solving one problem may reveal one that carries more weight by scrutinizing the extent to which existing or found solutions can contribute to inclusivity. Overall, Gaver praises designs for their potential to be generative and not end at being the ultimate solution, which may hold true in a problem as complex as this, spanning from ergonomics to societal gender dynamics [51].

4

Methods

In this chapter, methods that were deemed valuable for the execution of this project are presented. While most were used, some were left out due to redundancy or lack of necessity.

4.1 Double Diamond

The double diamond model is a design process that outlines steps for approaching wicked problems from a design methodology perspective. It has become a widely adopted standard among designers, consequently being frequently taught and applied in educational settings as well [52]. The method is divided into two stages (problem and solution), with each stage consisting of a divergent phase followed by a convergent phase [53], shown in Figure 4.1.

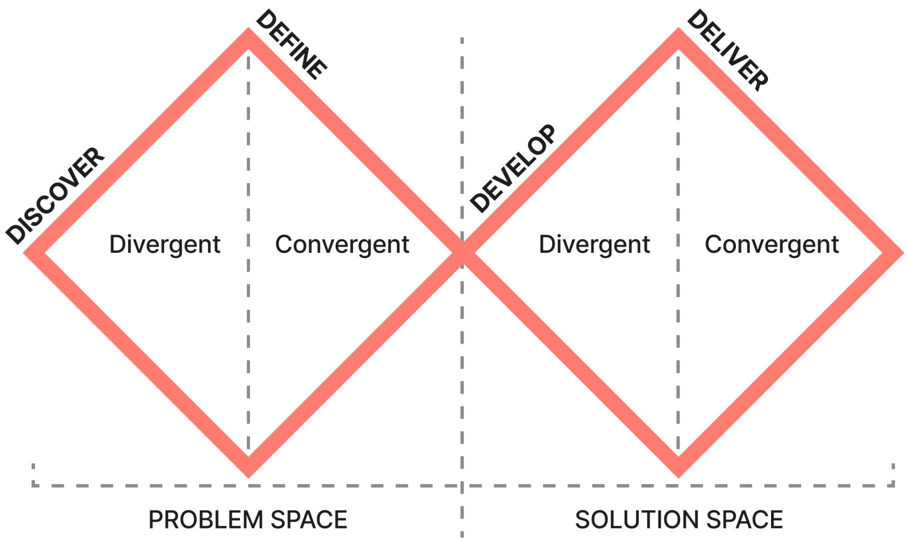

Figure 4.1: The Double Diamond model.

The first divergent phase is called *discover*, which entails expanding upon one's understanding of the problem in order to avoid assuming what the problem is. This involves conducting research into attempts at solving the problem and engaging with users to more closely understand their pain points [52]. During the subsequent convergent phase *define*, findings are analyzed and the most important aspects of the problem are extracted. In doing so, the wicked nature of the problem subsides, allowing the problem to be better defined. The solution stage consists of another divergent phase *develop*, in which designers are encouraged to formulate as many solutions to their clearly defined problem as possible. During this phase, it is also common practice to seek inspiration from other solutions or to involve users through various co-design activities. The final convergent phase, termed *deliver*, involves the rigorous testing and refinement of the most promising solution(s), ensuring that the final artifact effectively addresses the original problem [52], [53]. The double diamond was chosen as the design model for this project as it dedicates a substantial amount of the work towards breaking down and addressing the ambiguous nature of design-related research questions, so-called wicked problems.

4.2 Wicked Problems

Unlike other professions in which the steps required to complete a task are usually straightforward so long as the individual possesses the required skills, designers are often faced with more vague tasks, what Buchanan calls “wicked problems” [54]. Such tasks are described as “wicked” in nature because they lack definitive formulation, have no clear end goal that marks their completion, and have no solutions that can be labeled as right or wrong, only good or bad [54]. Because of this, a lot of the effort that goes into creating a successful design solution is spent discovering and expanding one’s understanding of the problem space [55]. Designers often involve users that are associated with the initial problem to better understand the underlying issues from their point of view. Similarly, they may carry out extensive research on concepts related to the problem, all in an attempt to define more clearly what the problem actually is.

4.3 Discover

This subsection introduces the methods that were utilized during the *discover* phase of the double diamond. As previously mentioned, they focus on widening one’s understanding of the wicked problem space and help uncover aspects of the issue that might not have been previously recognized. In doing so designers can also check for potential biases and assumptions as they get a deeper understanding of the user’s perspective [53].

4.3.1 Literature Review

A literature review is a long-established method of scanning previous research and extracting data from existing findings [56]. Literature reviews provide an overview of both past research on the current topic as well as other potentially interconnected areas of research. Past studies may highlight the use and viability of different methods, which may be applicable to current research as well. Calls for future work and points for consideration are also important to take into account when planning the execution of a new project.

4.3.2 Interviews

Interviews are a qualitative method for understanding and extracting user's subjective thoughts and needs on a topic. Hanington and Martin describe the method as fundamental when researching attitudes and opinions as it helps designers better understand the pain points and thought patterns of who they are designing for [57]. Interviews also allow designers to observe for signs of emotion and body language that would otherwise be hard to capture when analyzing survey or other quantitative data. Users are also given the opportunity to "speak in their own voice and express their own thoughts and feelings" [58], providing designers with a more accurate understanding of their pain points.

There are three primary types of interviews: unstructured, structured and semi-structured interviews [59]. The extent to which a type of interview is appropriate depends on the research context as they dictate the amount of control the interviewer holds over the dialog [60]. Unstructured interviews usually come off as informal and may be more comfortable for the interviewee as they have no predetermined structure (other than an initial plan) and allow both parties to steer the flow of the dialog in their desired direction. Naturally, it is still up to the researcher to try and guide the sessions somewhat, so that topics of interest are covered within the time constraints of the interview [57]. Structured interviews allow significantly less room for tangents as they rely on predetermined questions. This gives them a more formal tone, running the risk of making interviewees less comfortable, but in return standardizing the interviews for more structured data acquisition and analysis. They are also well-suited for shorter interviews as they tend to be quicker than the less structured alternatives [60]. Finally, semi-structured interviews act as a middle ground between the two, as they usually begin with an initial set of questions but also allow space for the interviewee to elaborate on their thoughts and potentially explore new points. Semi-structured interviews allow conversations to be dynamic, so long as the topic remains somewhat relevant to the problem space. Because of this, they are commonly used when the researcher has an initial understanding of a problem space but requires more elaboration [59].

4.4 Define

This chapter presents the methods used to interpret the data collected during the *discover* phase. The *define* phase involves the identification of the underlying issues that create the problem, from which actionable steps can be taken towards a solution [53]. When defining the problem it is important that designers attempt to do so from the perspective of the user rather than their own or that of a company. This prevents extraneous factors like corporate earnings or personal preferences from influencing the problem definition, to ensure it resembles the actual problem as closely as possible [61].

4.4.1 Personas & Storyboards

When designing for the purpose of accommodating or pleasing users, it is important that one takes into account how demographic factors, lifestyle choices, motivations, interests, and pain points influence the way in which they may perceive and interact with potential artifacts. Therefore, it has become common practice to construct descriptive models of the targeted users' characteristics, known as personas [62]. This is done with the purpose of helping designers make informed decisions during the ideation phase. Relatedly, storyboarding is a storytelling method which involves the creation of a narrative describing the user or problem context the user may find themselves in [63]. This method further serves to define users' life context and helps build a better understanding of the target user group's preferences, ensuring that the artifact remains something the user would like to interact with throughout all its iterations.

4.4.2 Thematic Analysis & Affinity Diagramming

Thematic analysis is one of the most frequently utilized methods by designers during the *define* phase [64]. It is used as a means to identify and describe both explicit and implicit ideas found within qualitative (mostly interview) data and gather these descriptions under "themes". These may be achieved by, for example, coding utterances in interview transcriptions according to their content and organizing coded data together into themes. Guest, MacQueen, and Namey describe how the method excels in identifying hints of intent found within written data, making the method suitable for qualitative data sets regardless of their size [64].

Affinity diagramming involves writing points of qualitative data down on sticky notes to be moved around on a surface. Sticky notes are clustered together according to content, thereby revealing patterns and forming theme clusters [64]. The method is highly effective for organizing large amounts of data into more easily understandable chunks, making it a useful tool for analyzing long lists of qualitative data [65]. Affinity diagramming is also a useful tool in ideation, for transforming ideas, as well as for decision-making cooperative work processes [65].

4.5 Develop

This chapter introduces the various ideation methods utilized as part of the *develop* phase of the project. These methods were used with the goal of of generating a large amount of ideas without immediate judgment, so as not to hinder the authors' creative output [66].

4.5.1 Iterative Design Process

Given the nature of wicked design problems, it is not always apparent when a solution should be considered finished. Therefore, designers exercise continuous iteration throughout all phases of the design process in order to adapt to changes within the problem space [67]. Introducing iteration into each phase also avoids inadvertently trying to create the perfect solution in the first attempt, instead encouraging designers to quickly produce a solution and test it with relevant users, giving them the opportunity to explore concepts, debug, and refine designs [68].

4.5.2 Sketching

Sketching enables designers to effectively communicate their ideas and concepts to their peers in a way that circumvents the potential for personal biases or misinterpretations [69]. It is a versatile tool in that the level of intricacy of the sketch communicates not only the clarity, but also hints towards an idea's completeness. As a designer it is important to acknowledge this characteristic and utilize it accordingly so as not to deter others from improving upon the idea if the goal is further ideation.

In the field of interaction design the method can be used across all stages of the design process to gather early feedback, providing opportunity to adjust the idea or design should it not resonate with users. The simplicity and cost effective nature of the method also allows it to be used for rapidly iterating upon ideas [70].

4.5.3 Crazy 8's

Crazy 8's is an ideation method created by Google, as part of their Design Sprint Kit [71]. It involves dividing a paper into eight parts, setting an eight minute timer, and trying to fill the rectangles with as many ideas as possible until time runs out. The intention is to create quick fledgling ideas that can be expanded upon later, rather than trying to come up with fully-fledged concepts within the set amount of time.

4.5.4 Brainstorming

Sharp, Preece, and Rogers describe brainstorming as a universal technique for the generation of ideas [60]. However, it can also be utilized to refine or add onto existing ideas. The method is typically executed in a group setting, benefiting from an unrestricted and non-judgmental environment, as emphasis is placed on the quantity of produced ideas rather than their quality. As the primary goal is "creativity itself" [72], participants are also encouraged to improve or add onto other members' ideas. Execution of the method involves simply verbalizing what comes to mind. However, members should be made aware of the topic or problem, what the goal is, and why it is important before starting to ensure the produced ideas are somewhat related. Overall, the method has garnered high praise for its simplicity, efficiency, and wide applicability [72].

4.5.5 Brainwriting & Braindrawing

Brainwriting exists as an alternative to brainstorming that prompts the designer to quickly document their ideas on paper instead of presenting them verbally [72]. Similar to brainstorming, the method is ideal for coming up with new solutions in a short window of time and is often used as it requires minimal set-up and cost. While it is not explicitly better than brainstorming, it is beneficial for groups that require silent focus to be creative. It also forces the practitioner to be more creative as ideas cannot be constantly gained from other members. The method is carried out by having a group of practitioners write down their ideas on paper during a set period of time. Papers are rotated across the table, giving members the opportunity to expand upon the previous writer's idea. This is done until the original paper returns, whereafter members discuss and note down the results [72]. In instances where participants feel more comfortable communicating their ideas through illustrations rather than writing they can utilize a variation of the method called brain drawing. It is carried out exactly the same as brain writing with the only discernible difference being that participants draw out their ideas rather than write them down [59]. In this project, brainwriting was utilized as an addition to Crazy 8's.

4.5.6 Focus Group

A focus group involves conducting a group interview with a sample of participants with a shared characteristic [73]. They have not been selected as representatives of a specific population, but rather on the basis that they are in some way affected by the problem being addressed by the researcher. The benefit of focus groups is that the group dynamic that emerges from social interactions between participants produces data that is richer and more in-depth than what would be acquired from a one-to-one interview [73]. This is because the group interview setting may allow conflicting ideas to emerge, highlighting differences in perspectives and ideas between the participants.

4.5.7 Co-Design

Co-design, also known as collaborative design, is about introducing collective creativity into the design process by collaborating with two or more users/customers [74], [75]. It is used to draw the collective experience and creativity of participants into the design process in order to end up with a result that more precisely solves or mitigates the original problem. The method aims to facilitate a more profound comprehension of the target demographic, enabling the designer to navigate the problem space with greater precision. Consequently, features can be prioritized based on their potential to enhance user satisfaction [75].

4.5.8 Design Workshop

Workshops are an umbrella method in participatory design in which designers facilitate one or more co-design methods to collaborate with participants [57]. They are viewed as a way of introducing a fun element into the design process by providing relevant stakeholders with an opportunity to help tackle the problem themselves. While they are usually resource-heavy to run, the scope and duration of a workshop can vary from only conducting one exercise to going through a short version of the entire design process, also known as a design sprint [76]. Design workshops also work as a tool for designers to introduce relevant stakeholders (without previous design experience) to the design process and its benefits, which can contribute to a better understanding between the two parties [57]. As the project was conducted in collaboration with Voi, planning a design workshop was a valuable way to give stakeholders a glimpse into the research and design process.

4.5.9 Prototyping

Hanington and Martin describe prototyping as a process in which ideas are tested through the creation of artifacts of varying resolutions [57]. The prototypes act as tangible representations of the research and ideation processes, and allow users to test out and evaluate the designers' solutions. In doing so, designers can get an idea of users' habits and behaviors surrounding the artifact as they get to try out a "real product" rather than merely attempting to guess what it would be like to use it [77].

A prototype's "completeness" or closeness to representing a final product is what determines its fidelity, whereby a prototype is usually classified as either a low or high-fidelity prototype [78]. Low-fidelity prototypes are not fully functional and are instead used as a medium for communication as they materialize a concept or interface layout. This makes them useful early on in the design process for helping guide the project. Moreover, the lack of required functionality allows designers to create them with minimal effort using rudimentary materials such as paper [57]. The demonstration of such a prototype has been shown to encourage users to propose more comprehensive ideas, as its unpolished nature suggests that there is more room for alteration [79]. High-fidelity prototypes are more refined, allowing for the testing of more nuanced details and asking users to compare them to similar products [78]. They also present users with the opportunity to comment on more peripheral aspects such as the aesthetics of the artifact or the nature of its interactivity [57].

4.5.10 Concept Testing

Concept testing is distinguished from usability testing in that it does not test an existing artifact. Instead, it is used to gauge a user's reaction and perception of a product idea before it is created [80]. It can therefore be used to determine whether the idea resonates with the targeted audience as well as if the initial idea needs more work [81]. Ultimately, this makes it a useful tool for deciding whether the current design idea needs pivoting.

4.6 Deliver

The section presents the methods used when evaluating the high fidelity prototype. The artifact may then either be iterated upon further based on the results, possibly resulting in another test [53], or the results of the evaluation may be noted down and reported as considerations for future work.

4.6.1 Think Aloud

Think aloud is a simple method that encourages the participant to verbalize their thoughts while they are trying to complete an assigned task [82]. Through its use, designers and researchers are able to achieve a more nuanced understanding of any concerns or questions that emerge during the process of testing. This is highly valuable as it allows designers to see whether these concerns result from the experience having been poorly designed. Participants are also asked to describe how they feel while the test is being conducted, providing further insight into their mental state and potentially indicating the parts of the experience that may require further iteration or rethinking [57].

4.6.2 Usability Testing

Usability tests involve the observation of one or more participants as they perform specific tasks involving a relevant artifact in a predetermined test environment [83]. The tasks usually represent end-user goals, requiring the participant to go through the entire experience. Participants can thereby highlight problems within the design, which indicates to the designer the part of the experience that prevents the user from achieving their goal [57]. To avoid false positives it is then imperative that the tasks themselves remain clear and concise, so as to avoid users struggling due to being ill-informed or having been given bad task instructions.

4.7 Software Tools

4.7.1 Figma

Figma is a software enabling collaboration on user interface designs, wireframes and prototypes. Over the years it has become an industry standard for designers, developers, and product managers to easily create and present ideas, and realize them as more complex designs [84]. The tool also offers versatility through a developer mode, presentation mode, and a whiteboard mode, making it a useful software in all stages of a project. Figma also includes a collaborative tool geared specifically towards brainstorming and diagramming, called FigJam [85]. Users can use basic shapes and drawing tools to create user flows and engage in quick brainstorming. The built-in timer tool makes it well-suited for timed methods, such as Crazy 8's.

4.7.2 Condens

Condens is an online data storage and analysis platform. Researchers can collaboratively transform and analyze raw qualitative data from various different sources (e.g., interview transcripts or customer feedback) and work on them as a team in real-time [86]. Researchers can precisely code transcript data and use the platform's built-in visualization tools to create charts and graphs. Condens also allows to create diagrams and mindmaps to show connections between data points and cluster data to derive new insights.

5

Process and Execution

In this chapter, the execution of the project using the methods outlined in the previous chapter is described. This process follows the four stages of the double-diamond model: (1) *discover*, (2) *define*, (3) *develop*, and (4) *deliver*. The *discover* and *define* sections describe the planning, execution, and analysis of qualitative interviews contributing to the answer of the primary research question. The *develop* and *deliver* sections describe the development of the design solution prototype based on the findings from the previous phases, aiming to answer the sub-question. As such, this chapter only discusses the execution of these processes, while detailed results of the interviews and the final prototype are presented in the next chapter.

5.1 Discover: Background and User Research

This phase of the project was characterized by the goal of becoming familiar with the problem space as well as setting the direction and scope of the project.

5.1.1 Voi Annual Global Survey

The project began with a review of Voi's internal user data, including the results of their annual global user survey sent out to all of their users. Voi only collects gender data in a single market, namely the United Kingdom, due to legal requirements for identity verification using a valid driver's license, so the majority of their gender-based data comes from users indicating their gender when responding to the global survey. The results of the global survey over the years do well to illustrate the development and current state of the gender gap (Figure 5.1), but a great shortcoming is in its inability to provide clues as to why non-respondent non-users may not be riding Voi. Nevertheless, this lack of relevant survey questions highlighted the need for more qualitative data from non-users, something that Voi has so far not looked into. It was therefore decided that a qualitative approach with interviews targeting non-users of micromobility would be well-suited to understand the extent to which Voi is failing to meet women's mobility needs, as well as other factors that are invisible in the survey data.

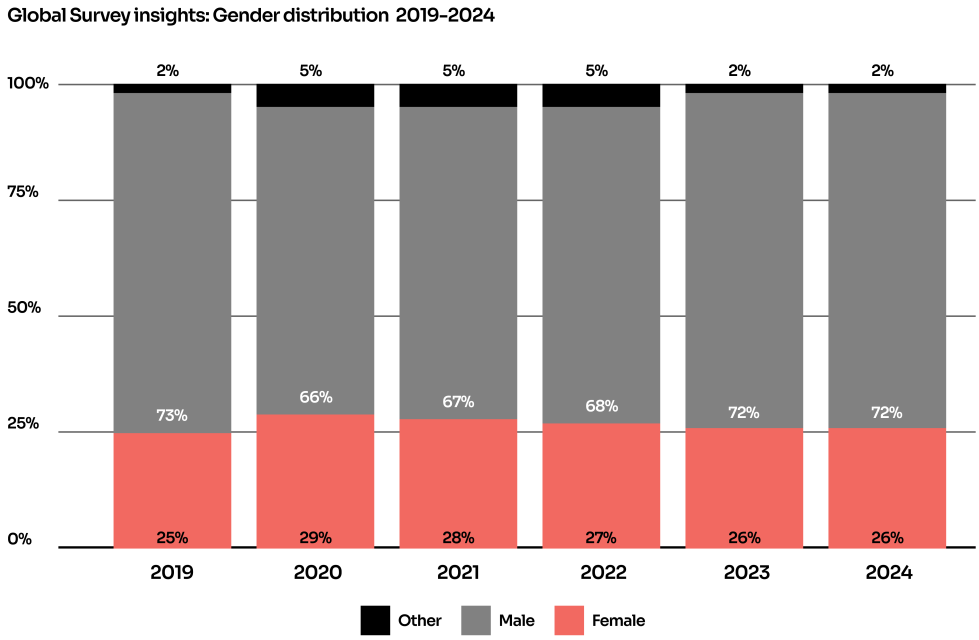

Figure 5.1: Gender distribution of Voi users from 2019 to 2024, as reported in the Voi Annual Global Survey.

5.1.2 Competitor Surveys

To get an broader overview of the micromobility market, available reports on female-focused surveys by competitor micromobility companies were also reviewed. These included data from a joint survey by Dott and Steer [7], Lime Micromobility [29], and TIER Mobility [28] (note that these were conducted before TIER merged with Dott). These surveys focused on the gender gap to varying degrees, with Dott-Steer and TIER having actively interviewed non-users, but Lime focusing only on cyclists. Overall, all three provided insights on female rider behavior and preferences. The results of these surveys were among the background and theory discussed in the previous Chapters 2 and 3.

5.1.3 Literature Review

Following the review of Voi and competitor data, an in-depth review of literature was conducted with the objective of finding existing research on the gender gap as well as results related to gender differences in other areas of mobility. The goal of this review was to find behavioral or social theories that might be connected to the gender gap, and may thereby form a starting point for constructing interview questions. The search was done on Google Scholar, using keywords such as "gender gap micro mobility", "gender differences e-scooter", and "gender differences cycling". In order to go beyond the topic of travel, the review also included behavioral research, such as "risk aversion", "new technology adoption", and "technology stereotypes" in connection with the keyword "gender". The results of this literature review were already presented and discussed previously in Chapter 3. Their role in this chapter is highlighted in the next section, where they contributed to constructing the interview questions.

5.1.4 Interviews

The findings of the literature review and the competitor surveys culminated in eight points of interest that may influence a person's willingness to engage with and use micromobility vehicles. These were (1) physical safety concerns, (2) the influence of gender stereotypes, (3) infrastructure needs, (4) vehicle design, (5) tendency towards adopting new technologies, (6) gender-specific needs during travel, (7) personal travel patterns, and (8) affordability concerns. Using these themes, a semi-structured interview was constructed. Questions were framed openly so as to allow for introspection and unbiased responses from participants, but more detailed sub-questions were formulated in order to guide the discussion if necessary. The main goal of the interview was to gather participants' impressions and opinions on micro mobility and how these related to their willingness to ride e-scooters and e-bikes. For the final version of the interview, see Appendix A.

5.1.4.1 Participants

The interview target was women, with no specific filtering by age, education level, or cultural background. The only requirement for participation was for the respondent to be residing in an area where micromobility services operate, i.e., for them to be exposed to vehicles in the wild and thereby have the option to ride them in daily life. As Voi operates in various markets in both Southern and Northern Europe, the aim was to cover their operational area by finding participants from these two regions. Though the gender gap exists in all markets, a further aim of the interview was to see whether geographical location would be reflected in the participants' responses. Sweden, the United Kingdom, and Spain were determined as target markets. Furthermore, in order to more accurately compare users and non-users, it was decided that active users would also be interviewed with the same questions so as to supplement the limited findings from the global survey. This would allow for more accurate comparisons between user and non-user women. Participants were acquired via various means, with users contacted through Voi's mailing service and non-users through acquaintance networks. In total, 13 women took part in the interviews. Nine were from Sweden, two from the United Kingdom, and two from Spain, due to response rate and availability reasons.

5.1.4.2 Process

The interviews took place online over Google Meet, where they were recorded and transcribed for further analysis. They lasted between 20 to 40 minutes each, depending on how much a given participant had to share. Participants were given the option to choose between a gift card with location-dependent value and Voi credits to be used for free rides. Every participant, regardless of user or not, opted for the gift card. The interviews were all conducted in English.

5.2 Define: Outlining Problem Spaces

The interviews were analyzed with a mixed methods approach combining the data coding part in thematic analysis with the clustering and forming of themes in affinity diagramming. Afterwards, personas were created to inspire the ideation stage later on. The results of these interviews and their implications contribute to answering the primary research question of this project.

5.2.1 Thematic Coding: Creating Interview Highlights

For qualitative analysis, interview transcriptions were uploaded to the data analysis platform Condens. In Condens, relevant utterances relating to the questions as well as valuable responses deviating from the questions were coded with custom tags. These tags reflected their contents, such as "reasons to ride", "outlook on micromobility", "ride deterrents", etc. Tagged utterances were collected as highlights, which could then be viewed and further analyzed by grouping highlights from across interviews on Condens.

5.2.2 Affinity Diagramming: Clustering Interview Highlights

The final versions of the coded highlights were then transferred to FigJam, onto virtual sticky notes, where they could be visually moved around and clustered. Highlights were initially color-coded and grouped together based on their Condens tag labels to form an initial set of themes (Figure 5.2). This served to provide an overview of the frequency of tag types and a rough idea of how big each theme was.

Afterwards, the highlights were visually clustered according to the precise content of the utterances, thereby re-organizing the previous groupings into a new set of themes with sub-themes (Figure 5.3). The emerging themes were (1) first ride deterrents, (2) physical aspects of vehicles, (3) gender, (4) pricing, (5) infrastructure, (6) time of day, (7) mid-ride and speed-related safety, (8) negative impressions, (9) reasons to ride, and (10) other reasons not to ride. Themes had varying numbers of sub-themes, such as "too much effort setting up the app" within the *first ride deterrents* theme or "bumpy roads are unpleasant" within the *infrastructure* theme. The sub-themes hinting at issues and concerns that hinder non-users from using micromobility thereby constituted potential problem spaces associated with the gender gap.

In order to narrow down the scope and decide on the problem space of focus for subsequent ideation, these established problem spaces were mapped onto a matrix where the X-axis indicated perceived solvability (given the scope and resources of the thesis project) and the Y-axis represented whether the issue could be addressed via interaction design tools and methods (based on quick brainstorming during the mapping process). This matrix can be viewed in Figure 5.4. An example is how "price is too high" is deemed solvable but via a more marketing or financial path rather than interaction design. The perception that "men take more risks, women are more conscious of safety" with regards to riding e-scooters is deemed unsolvable (i.e., not feasible to change) altogether due to it being rooted in societal perceptions of men as daring and the general finding that women are more risk averse.

Figure 5.2: Initial themes resulting from thematic coding in Condens, imported onto sticky notes in FigJam.

"Too much effort setting up the app" and "the first ride is scary and unfamiliar" were the two problem spaces deemed most solvable via interaction design methods, and they were selected to be ideated on in the next stage. For convenience, these problem spaces will be referred to as "app set-up" and "first ride" from now on. *App set-up* is characterized by the inconvenience of having to select a service, download the app, set up an account, and enter one's payment details before being able to use a vehicle. *First ride* represents non-users' comments on how the idea of riding a micromobility vehicle for the first time is scary and intimidating, and long-time users' remarks that they only took the plunge because there was another person persuading them to ride. Non-users spoke of a lack of confidence and trust in themselves. A large part of this problem space involves comments on the unfamiliarity of e-scooters and e-bikes, and the resulting ambiguity of how to use them and how well one can use them.

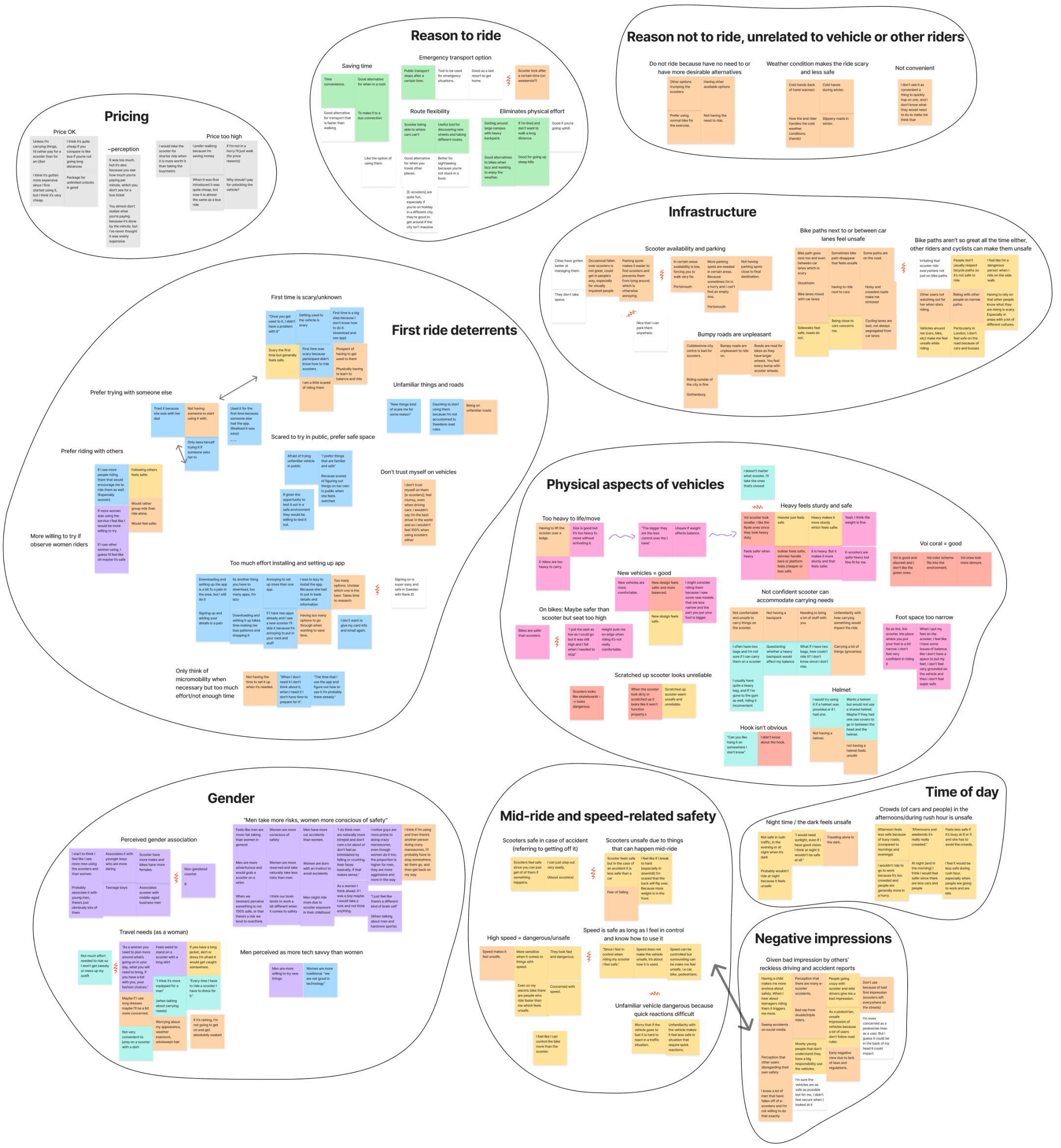

Figure 5.3: New theme clusters with sub-themes after affinity diagramming in FigJam.

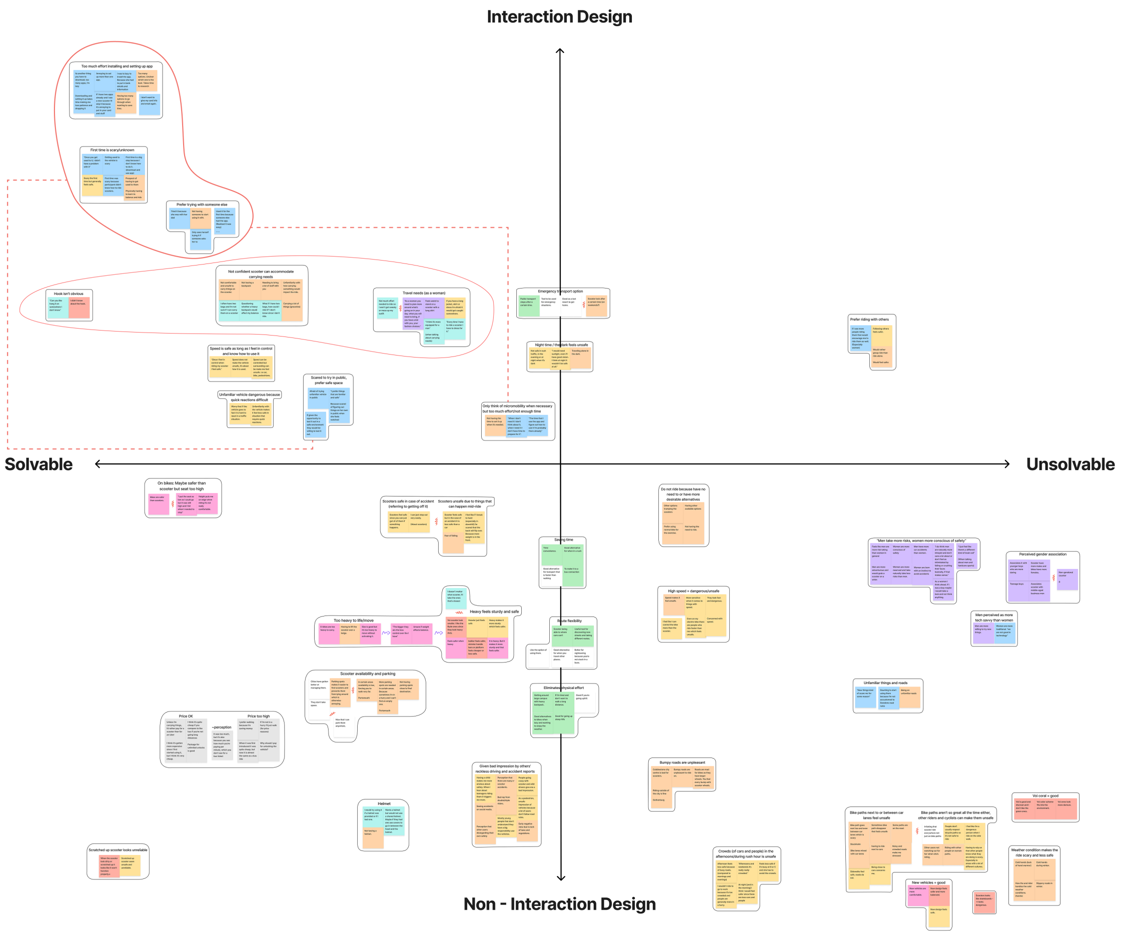

Figure 5.4: Matrix of perceived solvability and the extent to which the solution could be achieved with interaction design methods.

As the results of the interviews form the basis of the answer to the primary research question, the details of the resulting themes and related findings are presented and discussed in further detail in Chapters 6 (Results) and 7 (Discussion) of this report. See the Figma file linked in Appendix B.2 as well as the list in Appendix B.3 for an overview of all the themes and sub-themes. Figures 5.2, 5.3, and 5.4 can be found here in greater detail, where the highlights that formed the themes are all individually legible.

5.2.3 Personas

In order to further define the context in which potential female micromobility users might be hindered from riding, two personas and two storyboards with corresponding scenarios were created using the data gathered from the interviews. These personas are based on the *app set-up* and *first ride* problem spaces and are amalgamations of the different comments that were made on these topics.

Persona: Malin

Malin is 25 years old and has been living in the busiest part of the city center for as long as she can remember. She has therefore always relied on the subway as a means of transportation whenever she wants to meet up with friends. Unfortunately, recent construction in the city center has made the subway unreliable, forcing her to seek alternatives. She has never ridden an e-scooter before, neither has she really had experience with bicycles, but she has been curious about those vehicles she has been seeing on social media recently.

Storyboard: Malin

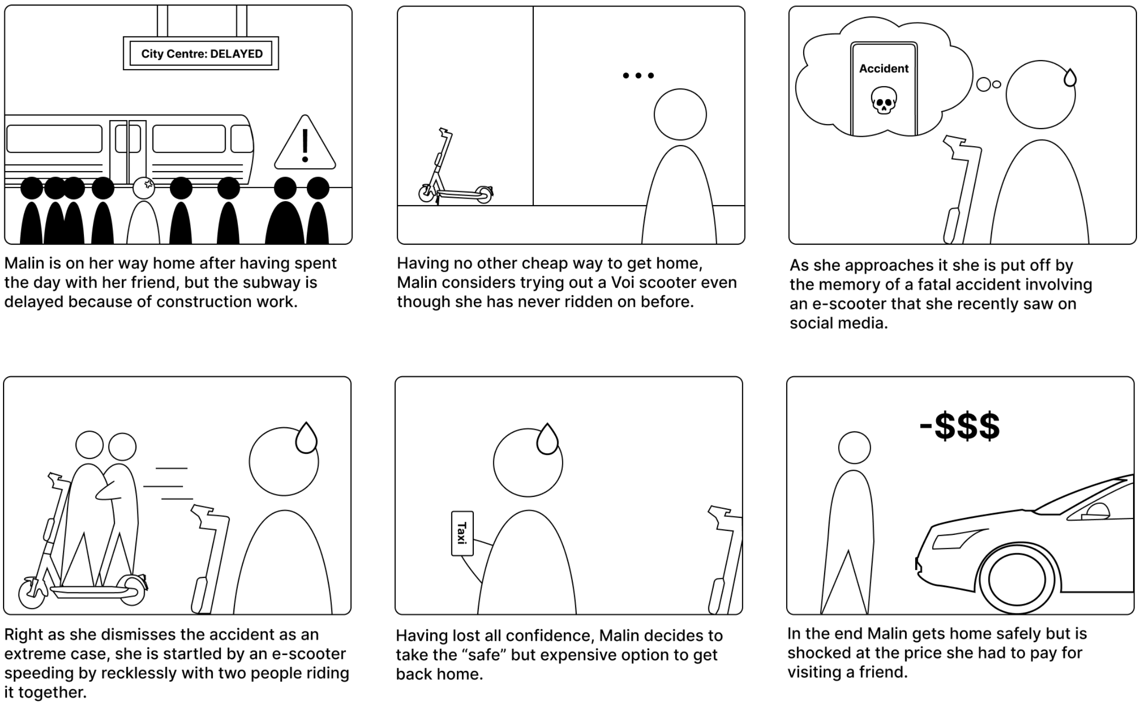

Figure 5.5: Malin’s storyboard illustrating the sub-theme *first ride is scary and unfamiliar.*

Persona: Zoe

Zoe is 41 years old and lives a hectic life trying to juggle two children and a demanding workplace. She is constantly under time pressure and reliant on the subway being on time, but is getting increasingly frustrated with how construction work in the city center keeps causing timetable delays. Because of this, she is often in need of a quick transport option. She sees Voi scooters parked around the city all the time, and has heard from friends that they are quite convenient to use.

Storyboard: Zoe

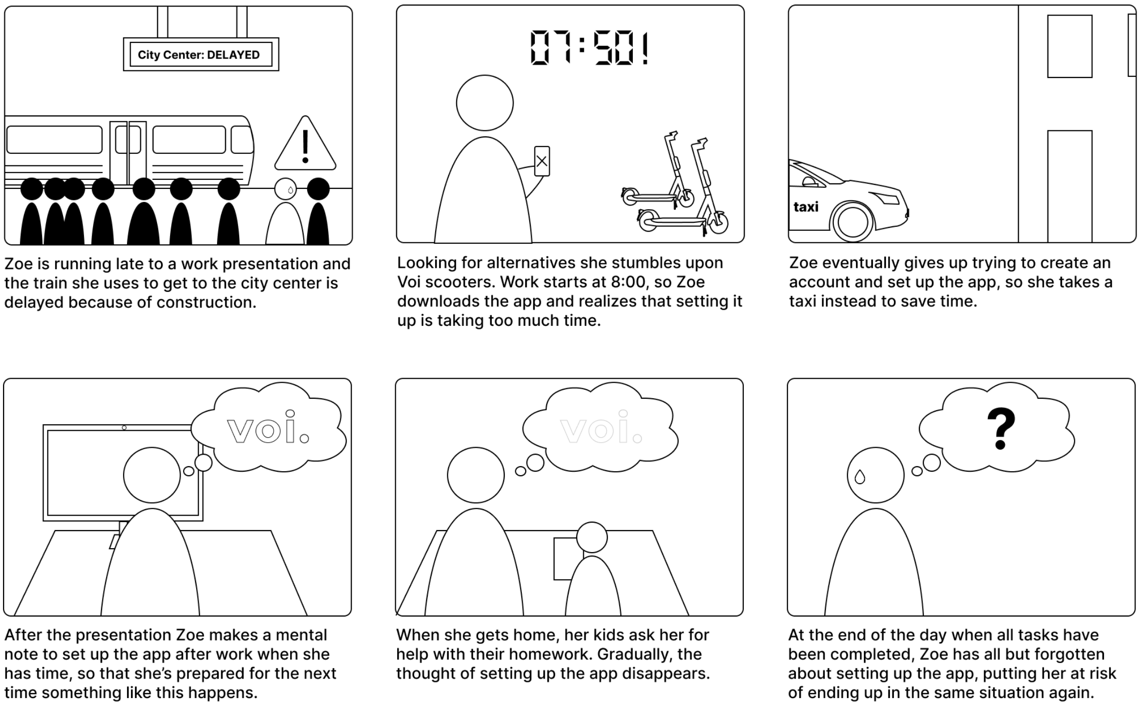

Figure 5.6: Zoe's storyboard illustrating the sub-theme *too much effort setting up the app.*

5.3 Develop: Ideation and Prototyping

Having decided on the problem spaces of focus, this section describes the ideation process, the selection of a solution, and the development of that solution over various prototype iterations.

5.3.1 Crazy 8's

Two rounds of crazy-eights were conducted, one per problem space. The execution of the method took place in Figma, with the goal of potentially using Voi assests and tools while sketching. Two 2x4 grids were created per problem space, so that each author would go through one crazy-eight round per problem. Instead of an eight-minute timer, two minutes were set for each grid adding up to sixteen minutes per round, in order to allow more time to contemplate ideas, given the breadth of the problem spaces. The created personas were pasted next to the Crazy 8 grids to serve as inspiration in case open-ended ideation lead to a mental dead-end. Examples of the grids can be seen in Figures 5.7 and 5.8.

Too much effort installing and setting up app
- Downloading the app requires too much effort, especially when entering payment details.
- New users often consider using Voi when in a rush which conflicts with a long set-up process
- To many micromobility apps makes it hard to decide

Use browser to login to the service
- Browser version of the service accessible through a QR code

User pay a monthly tab instead of per ride
- Avoiding the need to input payment information right away
- Users get the tab through Klarna or similar.

Integrating the service with public transport tickets
- Already exists in some markets but think about how one could make it a standard

Simplify the set up to only require certain information before first ride
- Potential free teaser rides
- Users provide a little information as possible (within law)

Remove the need for having an account to use the service
- No account at all

Add a screen with login capabilities on the scooter
- More elaborate screens on vehicles. Will be dependent on supplier

Master account in collaboration with other micromobility services
- Merging micromobility services into a singular service

Make accounts based on bank card and allow users to blip to ride
- Identification through payment card instead of having to use the app

Figure 5.7: Ideating within the *app set-up* problem space.

First time is scary/unfamiliar
Users prefer trying with someone else
- Users hesitate/are intimidated by riding the vehicle
- Lack of motivation and encouragement to use the scooter, low self-confidence and a fear of messing up or doing it wrong

First-time ride events to let people try scooters and e-bikes
- Planned events
- Instructors and a safe space to learn

Making current referral system more obvious and rewarding
- More salient referral program
- Credits as rewards

Grant users benefits for group riding with others
- More credits
- Unique groups ride credits

Gamifying riding with others
- Creating some sort of geo-location game
- Adding achievements that encourage users to try everything Voi has to offer

Create a community feature about helping each other learn
- Building a community through a mutual support system

Being able to trigger a form of training mode through the app
- Syncing with scooter to create educational tasks

Make the onboarding more explicitly encouraging
- More hand-holding
- More encouraging copy

Being able to request personal training sessions from Voi "trainers"
- Active instructor support
- Group sessions?

Figure 5.8: Ideating within the *first ride* problem space.

Brainwriting

As an addendum to the Crazy 8's, a brain-writing session was done in order to expand on Crazy 8 ideas that had not been contemplated on or described as deeply as others due to time or creativity constraints. Underdeveloped concepts were written down on pieces of paper, which were then alternated between authors several times. The authors continued to take turns expanding on an idea freely, without a timer, until they were satisfied with the achieved level of detail.

5.3.2 Design Workshop

To further support ideation, a design workshop was held with Voi's product design team. The goal for this workshop was to get further creative input on how experienced designers might choose to tackle these two problem spaces. In total, four members of the team plus the two authors participated. An overview of the workshop flow can be seen in Figure 5.9. The workshop began with the presentation of qualitative and quantitative findings from the review of Voi's data, the competitor surveys, the literature review, and the interviews. Afterwards, the *app set-up* and *first ride* problem spaces were introduced to the participants, and they were instructed to choose the one they resonated with most before moving onto the idea generation stage. Before starting with the method, participants were given 10 minutes to conduct an individual market analysis to search for similar problems and how they have been addressed by other companies, potentially outside of micromobility entirely. After everyone presented their findings, the idea generation stage began with a round of Crazy 8's, where participants ideated for eight minutes within their chosen problem space. At the end of the round, each participant selected their top two ideas and presented them to the others. Everyone then voted on their favorite idea within each problem space, and the winner from each problem space continued into the final ideation round. The goal of this step was to develop one of the two ideas further (either the *app set-up* or *first ride* solution), and participants were once again given the freedom to choose which one to work on. The most popular problem was *first ride*, i.e. the notion that the first ride is scary and intimidating. The full flow can be viewed in detail in the Figma file linked in Appendix B.2.

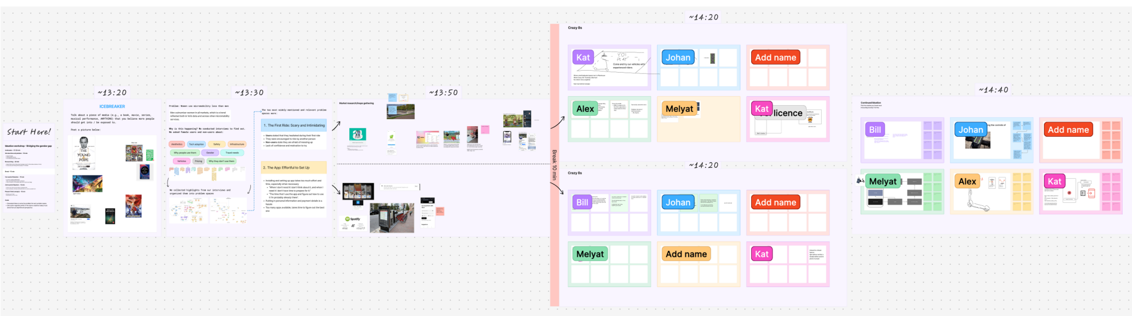

Figure 5.9: FigJam design file from the workshop.

5.3.3 Converging on an Idea

On concluding idea generation, the created ideas were compared and some merged due to similarity. The nine resulting ideas were then isolated, and the authors jointly discussed their potential value as well as risks and considerations that may be associated with them. The full descriptions of all nine ideas, including the unused ones, can be found in the Figma file linked in Appendix B.2. After each idea was individually scrutinized, they were given names and written as individual items in Figma for further visual mapping. In order to select the idea to focus on for this project, they were mapped onto several different graphs.

Desirability, Feasibility, Viability

Firstly, using the listed potential value points and considerations, ideas were placed on a trifecta of desirability, feasibility, and viability, a product prioritization method developed by IDEO [87]. Desirability was based on the extent to which the ideas were deemed to be addressing the problem spaces that resulted from the interviews, as well as what they could potentially add to the experience beyond what was requested by the participants. Feasibility refers to how technically achievable the solution is, with respect to available resources and the timeline of the project. Viability refers to the financial sustainability of the solution, and was assessed with reference to the authors' knowledge of ideas that Voi has attempted or considered in the past. This diagram is shown in Figure 5.10.

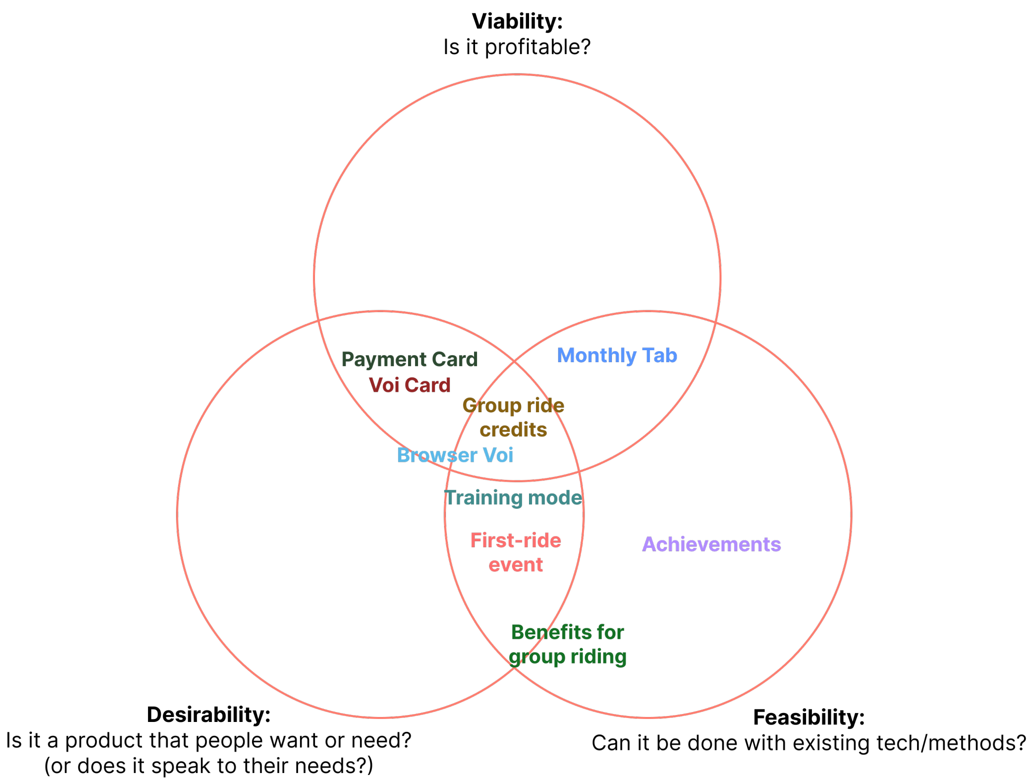

Figure 5.10: Solution ideas placed into the Desirability, Feasibility, Viability trifecta.

Impact on Female Ridership by Business Impact

Next, ideas were plotted on a two-dimensional impact graph, with business impact on the Y-axis and impact on female ridership on the X-axis (Figure 5.11). Assessment of business impact was again based on solutions that have been attempted or considered in the past. Impact on female ridership was assessed with reference to interview results, specifically the frequency and weight of the highlights and problem spaces that gave rise to the ideas themselves.

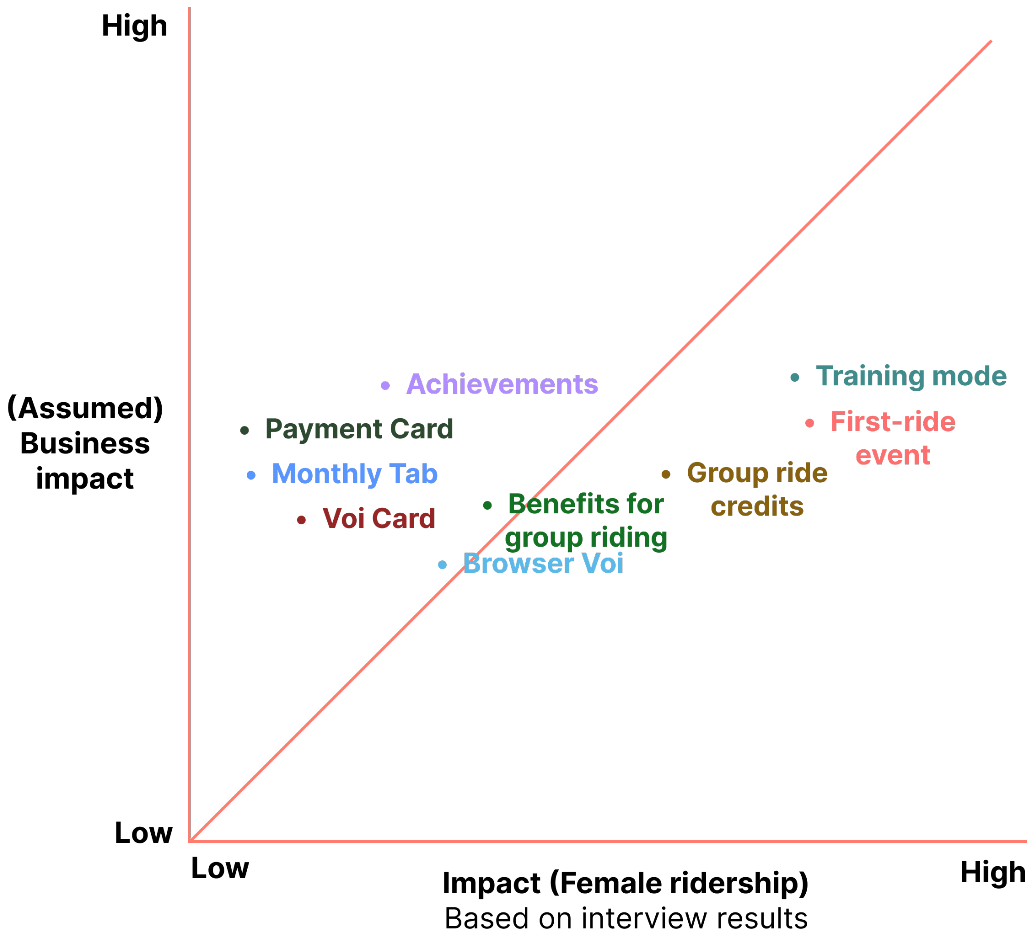

Figure 5.11: Solution ideas plotted on an impact graph with assumed business impact and impact on female ridership.

Complexity

Finally, ideas were ranked on a spectrum of high to low complexity, seen in Figure 5.12. Complexity was defined as how complex the development and evaluation of the idea would be with regards to the resources available and the timeframe of the thesis project.

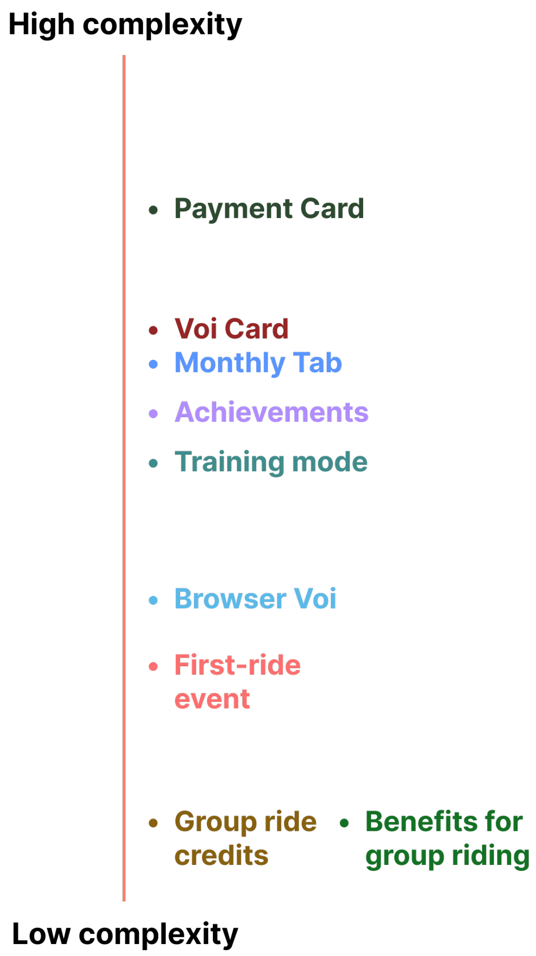

Figure 5.12: Solution ideas plotted on a complexity spectrum.

Result

Based on all of the evaluation above, two ideas were selected for low fidelity protoyping. The first addressed the *first ride* problem space, and was tentatively called Training Mode. This involved creating an in-app Training Mode that allows users to unlock an e-scooter for free with speed and area restrictions, during which the mobile application guides them through the e-scooter's capabilities and gives them tasks to complete, such as "try accelerating forward for 10 meters" or "test your brakes". The second idea addressed *app set-up* and is essentially a browser-based version of the Voi app, albeit with limited functionality. This browser version would allow a user to access the service and its vehicles without having to download an app, and would allow the first few rides without having to create an account, at the cost of not being able to unlock multiple e-scooters at once or have an activity score (both features that are currently available in the app).

5.3.4 Low-Fidelity Prototypes

Two low fidelity prototypes were constructed for the resulting ideas. The low fidelity is apparent in the Figma file, where crude screenshots of the Voi mobile application were cropped and pasted together as a base, and custom assets were created and added to illustrate the additions of the ideas. Official Voi assets and Figma components were used for the high-fidelity prototype later on. Even though interactive prototyping was not very feasible with this set-up, it served perfectly to illustrate and promote discussion on the two concepts. The lo-fi prototype for Training Mode is shown in Figure 5.13, where Training Mode is phrased as a ride instructor mode that can be toggled on and off, causing the next vehicle unlock to be in ride instructor mode. This mode includes tutorials with lessons and tasks that the user needs to complete with the vehicle. The prototype for a browser-based Voi service is shown in Figure 5.14. Here, the bottom navigation bar that is usually present in the app is removed, but the profile and help menus are maintained and moved into the segmented buttons list on the map. Browser-based Voi thereby has limited features but maintains the core functionality of the service while being accessible via a browser. Both lo-fi prototypes can be found in the Figma file linked in Appendix B.2.

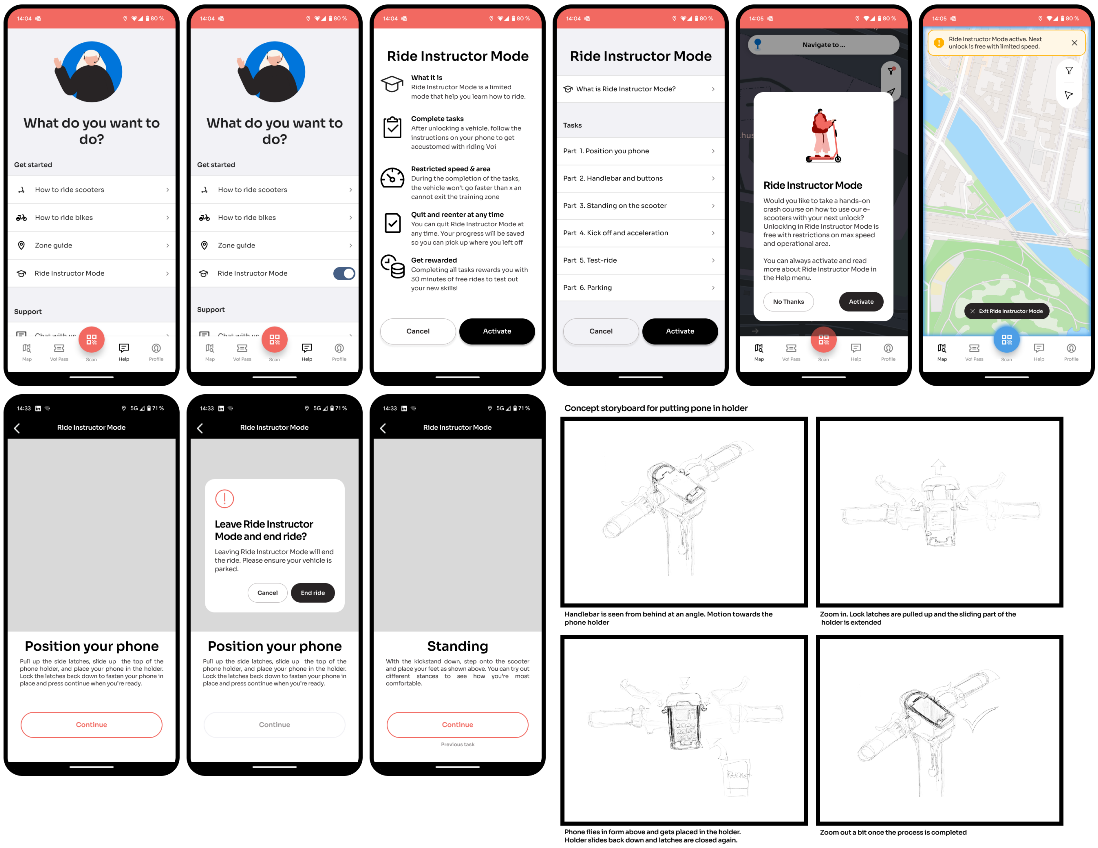

Figure 5.13: Low-fidelity prototype of an in-app Training Mode.

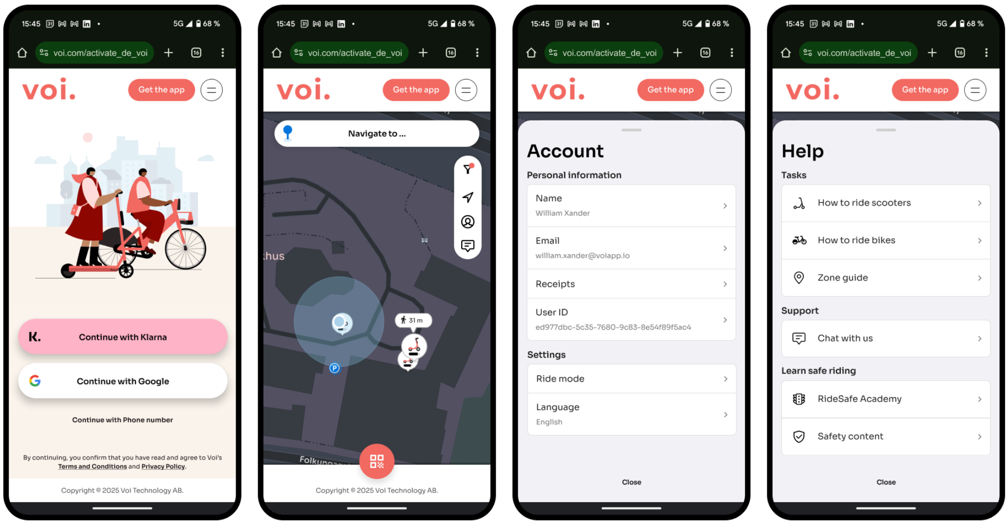

Figure 5.14: Low-fidelity prototype of a browser-based Voi application.

5.3.4.1 Stakeholder Feedback

The two lo-fi prototypes were presented to the product design team and mentor at Voi, with the aim of gathering feedback and gauging interest in the ideas from both a design and a business perspective. This was done over a Google Meet call where the lo-fi prototypes were shown and described. Both ideas were well-received conceptually, with a few points of constructive feedback. For one, it was suggested that the copywriting of the Training Mode be phrased in a kinder and more hand-holding way, to fit with the intention of replacing a human instructor. Additionally, a member of the team suggested that the two ideas (Training Mode and browser Voi) need not be mutually exclusive, and added that there may be value in providing people with a browser-accessible training version of the service as a free trial, potentially without even needing to create an account to access it. After having established that a Training Mode would be the main solution idea to pursue, the next step was to approach potential users once again and find out what they would wish to have included in a Training Mode.

5.3.4.2 Focus Group

In order to maximize the impact of a Training Mode, a focus group discussion was held with the aim of understanding what information non-users would like to be shown before using a micromobility vehicle. In this case, the focus was on e-scooters. This was done on Lindholmen campus in Gothenburg, and all five participants were students. Participants were recruited on the day of the interview, by approaching passersby, asking them whether they had ever ridden an e-scooter, and inviting them to a group session which included interacting with a e-scooter and a subsequent discussion. Through this approach, five female non-rider participants were amassed and gathered around a parked Voi scooter. The set-up was as follows:

1. Participants were shown the state of the app as well as its onboarding screens,

which is how the app currently shows users how to ride Voi vehicles and other ride rules.

2. Afterwards, participants were asked to approach and interact with the scooter. While doing so, the authors pointed out different parts of the vehicle and asked the participants:
   - "What do you believe this part is for?"
   - "How would you go about operating it?"
3. The scooter was unlocked and the participants were invited to try riding it for a short distance if they felt comfortable doing so.
4. After the last trial ride, everyone came together once again to talk about the experience.

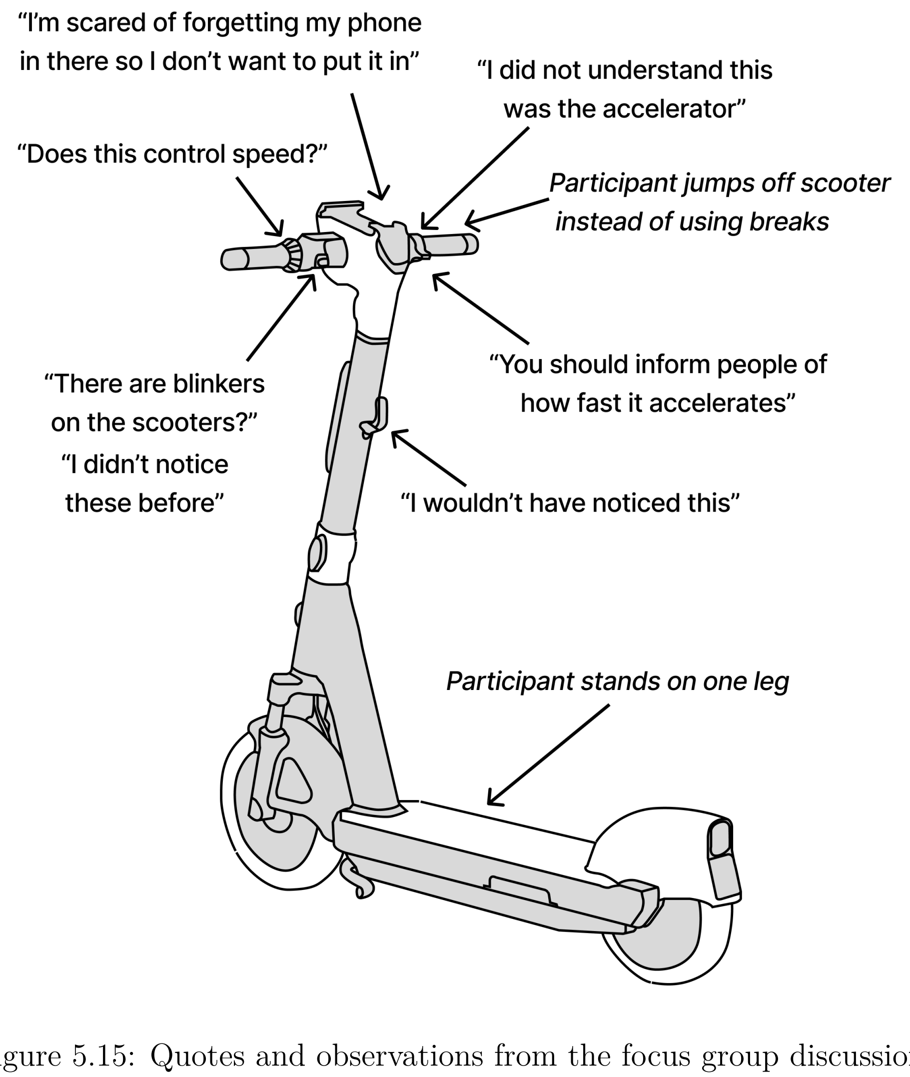

Figure 5.15: Quotes and observations from the focus group discussion.

An overview of the most prominent quotes and observations can be seen in Figure 5.15. The discussed points varied in frequency and weight, with comments about how the blinker buttons were ambiguous, the hook on the base bar was not noticeable, and that the bell on the left handlebar was confused with the throttle, due to preconceived notions of how throttles on two-wheeled vehicles are usually placed. The most talked about point was that none of the participants expected the scooter to accelerate so quickly, and that they were all startled by how quickly it reached its maximum speed. Two of them stated that they immediately felt unsafe and felt the need to get off of the vehicle. The participants stated that they were not aware that the speed of the scooter was proportional to how much the throttle was pressed, given how small the GO-button is. On the phone holder, a participant expressed that it required too much force to open, and that even if she could open it, she would likely not put her phone in it out of a fear of forgetting it after parking the vehicle. At the end of the discussion, the Training Mode concept was introduced to the participants to inquire as to whether they believe such a feature could better introduce them to the vehicle and prepare them to ride it. After verbally introducing it, the lo-fi prototype slides were also shown to provide a more tangible idea to discuss around. They all stated that if implemented properly, taking into account the concerns they highlighted in the previous discussion, such a mode may convince them to try riding. One point of concern was that if the existence of a Training Mode is not made obvious, they would never think to download the app and check for it themselves.

5.4 Deliver

This section entails the construction of the final, high-fidelity prototype as well as the subsequent pilot evaluation and usability test by non-users. The resulting design and its evaluation answer together answer the sub-question of the thesis. The pilot evaluation provided an initial assessment of whether the proposed concept truly exemplifies a design solution that can address barriers to women's micromobility adoption. It is not meant to prove the validity or generalizability of the concept, as this would require more extensive testing, as discussed in the next chapters.

5.4.1 High-Fidelity Prototype

After the feedback from the stakeholders and the participants of the focus group, Training Mode was decided on as the main solution to be made into a high-fidelity, functional prototype. However, elements from browser-based Voi that were praised by the stakeholders were mixed together with the previous Training Mode concept. The most prominent change was that Training Mode was decided to be available both in the existing app and via browser. In this final iteration, users do not need to download an app, nor do they need to create an account and input payment information to access Training Mode. It simply requires using one's smartphone camera to scan the existing QR code on the vehicle, which opens the phone's default browser application and directs the user to a browser-based training platform should the app not be installed already. On this platform, users are only able to activate the scanned scooter in Training Mode. This implies that the scooter will activate with a limited speed and range. The full final iteration is described and presented in detail in the next chapter.

5.4.2 Pilot Evaluation

After completing the high-fidelity prototype in Figma and setting up its interactivity, it was deemed ready for a pilot evaluation to gauge whether it is truly seen as a desirable and useful tool for non-users to get into micromobility and riding e-scooters. Participants were once again recruited by approaching people around Lindholmen campus and asking them if they would like to participate in the evaluation of an app prototype for micromobility. Recruitment was done on the condition that they were not micromobility users at that time, and that they had not previously ridden an e-scooter. Four participants were once again invited to stand next to a parked e-scooter, individually this time, and given a phone with the Training Mode prototype. They were instructed to simulate scanning the QR code on the scooter and then proceed by following the app's prompts and the tasks outlined by Training Mode. Participants were asked to think aloud while navigating the Figma prototype. The goal was to get an understanding of whether the constructed user flow matched their mental model of a Training Mode, but also whether they felt the interface and the copywriting matched their expectations for how a hand-holding Training Mode speaks to its user. After going through the full Training Mode flow, participants were asked questions on (1) the overall experience, (2) clarity and phrasing of the presented information, (3) usability of the interface, and (4) to what extent this Training Mode would convince them to start using micromobility. The full interview transcript can be found in Appendix C. The final iteration of the prototype as well as the results of this pilot evaluation are presented in the next chapter.

6

Results and Final Design

This chapter presents the results from the interviews conducted in the discover phase of the project as well as the final state of the solution prototype and its evaluation from the develop phase.

6.1 Barriers to Women's Micromobility Adoption

To recap what was mentioned previously, interviews were conducted with 13 women across three of Voi's micromobility markets (Sweden, Spain, and the United Kingdom), which included both native and immigrant participants. Nine participants were from Sweden, of which three were Swedish, two had immigrated from Mexico, two from China, one from Brazil, and one from Kazakhstan. The participants from the United Kingdom and Spain were native to their countries. In total, four participants were micromobility users and nine were non-users, of which three had tried using a micromobility vehicle in the past but chose not to continue riding them. The participants had an age range of 22 to 54 years. Transcripts were inductively coded in Condens and grouped together into themes via affinity diagramming in FigJam. The following overarching themes emerged from this analysis, with some of them having multiple sub-themes due to the complexity of their respective problem spaces. The extent to which cultural differences may have driven participants' replies varied across themes, where some responses may hold country or culture-related influences while others did not indicate anything of the sort.

6.1.1 First Ride Deterrents: The First Ride is Scary and Unfamiliar

A common observation across all participants was that the first ride is often a hurdle to overcome. What appeared to set users apart from most non-users was that users overcame the hurdle of the first ride and are now active riders. There were found to be several reasons for the first ride to constitute such an obstacle. A frequent comment that was made by non-users is that the prospect of riding an e-scooter is scary. This was attributed to a lack of knowledge on how to operate them, where non-users are intimidated by having to get used to the vehicle and physically learn to balance on and ride them. Various reasons were cited for this, such as one participant stating that she "doesn't trust [herself] on them; [that she feels] clumsy" and another speaking of a lack of confidence to ride. On the other hand, users made comments such as “once you get used to it, you don’t have a problem with it”, or “scary the first time, but generally feels safe”. These users also spoke about how their first ride was with an acquaintance or a family member. As such, non-users also expressed that they would be willing to try e-scooters if they were in a group or had someone to show them. One said that “if [she] were to see other women riding them [nearby], that would encourage her to try as well”. Along the same lines, they stated that they would try riding if they were in a safe, controlled space. This was stated to be due to a fear of trying out an unfamiliar vehicle in a public setting and having to figure out things on one’s own while others may be watching.

6.1.2 First Ride Deterrents: Too Much Effort Installing and Setting Up App

Another hurdle was related the necessity of having to install a micromobility application to use the service. A participant stated that she does not feel like putting time into researching which micromobility service is best, and that there are too many options. Users and non-users alike expressed that it is annoying to have to download yet another app and create yet another account, especially when it comes to having to put in payment details when rushing. Two non-users who had come close to using a micromobility service when in a hurry shared their thoughts on why they gave up in the end. They stated “when I don’t need it I don’t think about it, but when I need it I don’t have time to prepare for it” and “in the time that I set up the app and figure out how to use it I’m probably there already”. They recounted losing patience and going for an alternative mode of transport instead. Users also complained about the need to download and set up the app; that “it was a bit of a pain but [they] still did it” and that it was worth it in the end to be able to make use of the service.

6.1.3 Implicit Gender Associations

Eight of the thirteen participants stated that they did not associate micromobility vehicles and the act of riding an e-scooter or e-bike with any single gender. Of the remaining five, all of them associated e-scooters with males. More specifically, “younger boys who are more daring” and “middle-aged business men on their way to work”. One participant felt that e-scooters are ridden more by males, while more females can be observed on e-bikes. Overall, no location pattern was observed in the responses, in that the existence or non-existence of a mental association between gender and micromobility appeared to be subjective.

6.1.4 Perceived Gender Differences in Risk Aversion

Nearly all participants expressed the belief that men take more risks, and that women are more conscious of safety. When deciding whether to ride an e-scooter, according to one participant, women tend to “overthink” or “think ahead” on the possible risks and consequences of riding, while men may “take a look and not think anything” of it. Participants felt that men are “more adventurous” and would grab a scooter on a whim, and that “even though women do it too, the proportion [of men doing crazy manoeuvers and riding aggressively] is higher”. When talking about the prospect of falling while riding, a participant humorously stated that men probably “don’t feel as intimidated by falling or crushing their faces”. When thinking about the reasons as to why this belief persists, one participant suggested that men might ride more due to scooter exposure during childhoods. This notion was also believed to be biological, where one participant said “[she thinks women’s] brains tend to work a bit differently when it comes to safety”, and another stated that “[she feels] like there’s a different kind of brain cell [in men]” when talking about men and extreme sports.

6.1.5 Perceived Gender Differences in Technology Adoption

Closely tied to men’s more risk-taking nature, a participant expressed her thought that men are more willing to try new things, which she believe extends to a willingness to try micromobility vehicle without much forethought. Another participant quite simply stated that “new things kind of scare [her] for some reason”. Furthermore, one of the participants from Spain went as far as saying that women “are more traditional, [they] are not good in technology” when reflecting on how she usually gets her brother or father to help her with her computer issues. She believed that this could also be related to her hesitation to try out e-scooters.

6.1.6 Women’s Travel Needs

When talking about whether e-scooters can meet the participants’ travel needs, a commonly mentioned concern was related to women’s choice of clothing. A user stated that “every time [she has] to ride a scooter [she has] to dress for it”. Both users and non-users spoke about skirts and dresses, sharing that it “feels weird to stand on a scooter with a long skirt” and that it “is not very convenient to jump on a scooter with a skirt”. It was especially non-users who were questioning whether long dresses would pose a safety risk, with one of them “afraid that [a long jacket, skirt, or dress] would get caught somewhere” on the scooter while riding. Regarding exposure to the elements, a participant expressed that she is worried about how her physical appearance and hair style may be impacted by the wind. On the other hand, a participant expressed that she does not really worry about what she wears while riding, as “[there is] not much effort needed to ride, so [she] won’t get sweaty or mess up [her] outfit.” When asked about carrying needs, a participant felt that e-scooters are “more equipped for a man” when talking about how men usually have more pockets and may not carry around a purse or bag.

6.1.7 Physical Aspects of Vehicles

Thoughts on the weight of e-scooters constituted a large portion of this theme, where users and non-users once again had diverging opinions based on experience. For the most part, some non-users who had not ridden or interacted with a scooter before perceived them to look as if they are too heavy to move or control when riding them. One felt that “the bigger [the scooters] are, the less control over them [she] has”, which was spoken from perception rather than experience. Another was "unsure whether weight affects balance", which was enough to deter her from trying to ride one. Users on the other hand felt that heavier scooters are more reliable, echoing statements such as "heavier just feels safe" and "heavy makes it more sturdy which feels safer". Regarding the appearance of scooters, both users and non-users felt that a bulkier appearance made the vehicle feel safer, while skinnier handlebars or a narrow platform felt "cheap or less safe". Similarly, a non-user stated that scooters that have been scratched up or had their outer chassis worn out "look like [they] won't function properly".

Both users and non-users expressed low confidence that e-scooters can accommodate their carrying needs, where users were already used to traveling light and non-users being discouraged from riding due to their daily carrying decisions. They spoke of an "unfamiliarity of how carrying something would impact the ride", with one "questioning whether a heavy backpack would affect [her] balance". A common trait between some of the non-users was that they often travel with two bags, which they felt would not be compatible with an e-scooter.

There were also individual concerns related to specific parts of the e-scooter and the e-bikes, such as the foot space of the scooter being too narrow for one non-user who had tried riding in the past, or the carrying hook on the base of the scooter not being obvious enough. A user who normally rides e-scooters but wanted to try riding an e-bike recounted an experience where she "put the seat as low as it could go, but it was still [too] high and [she] fell when she needed to stop". Another said that the "[height of the seat] puts [her] on edge when riding [which is] not really comfortable". Regarding helmets, two non-users said that they felt unsafe without a helmet and would try riding if they were provided with one, but another spoke against shared helmets due to hygiene concerns.

6.1.8 Infrastructure

This theme is characterized by ride and safety concerns from an infrastructure perspective, and is in certain respects location-dependent. A user from a Swedish city expressed how unpleasant it is to have to ride an e-scooter on the cobblestone streets of the city center. A participant was displeased that city-center cycling paths are "made for bikes as they have larger wheels [since it's possible to feel] every bump with [small] scooter wheels". Users and non-users from another city in Sweden presented similar concerns related to their local cycling infrastructure having paths that run next to or between car lanes. Those who do ride stated that they, despite the risks associated with riding next to cars, have gotten accustomed to it, but the non-user participants stated being uncomfortable by the forced proximity to other motor vehicles. A participant expressed feeling "stressed [by] noisy and crowded roads", especially when riding on an unfamiliar vehicle. On the other hand, however, segregated bike lanes were also criticized. Both the user and non-user from Spain talked about pedestrians' disregard for bicycle paths and a consequent narrowing of ride space. The user expressed discomfort from having to share narrow spaces with pedestrians and other potentially reckless riders. This concern was echoed by a non-user who stated that “having to rely on other people to know what they are doing is scary”, in reference to cars, pedestrians, and other e-scooter riders. Scooter parking and availability was another commonly brought up infrastructure topic , where users and non-users presented different concerns. Some non-users found that it was “annoying” to find scooters lying around on the ground, which is a common sight in markets where vehicles can be parked freely in available zones. One user was concerned for visually impaired people, whose mobility may be disrupted by e-scooter and e-bikes that have been neglectfully parked on walking paths. Those that live in cities that have set parking spots praised them for preventing vehicle clutter around the city, though at the cost of vehicle availability. The user in the United Kingdom expressed being displeased with having set parking spaces for scooters, as it meant having to potentially walk an inconvenient distance to find a parking spot with enough empty space to put a scooter in it. Relatedly, she also complained about not being able to find an empty parking spot to leave her scooter when in a hurry.

6.1.9 Mid-Ride and Speed-related Safety Concerns

A user expressed that she felt relatively safe on an e-scooter when it comes to accidents with other vehicles, as she felt that she could easily jump off of it in an emergency situation. In contrast to this, non-users felt that they would be more exposed and vulnerable when standing on a scooter, making it more likely to get hurt in an accident. A non-user said that she was worried that if she were to ever find herself in a situation that requires quick reactions, her unfamiliarity with the vehicle and its behavior would pose a risk to her safety, compared to if she were riding her own bicycle. Many comments were made on speed, mostly by non-users, who had different perceptions of and feelings towards the speed and capabilities of e-scooters. Non-users that were quick to dismiss e-scooters as unsafe to use felt that high speed equals danger. One non-user expressed that “even on [her] electric bike, there are people who ride faster [than] her, which feels unsafe”, highlighting the perception of e-scooters as an unfamiliar, fast, and dangerous object. On the other hand, there were non-users who felt that having sufficient control over the vehicle ameliorated that feeling of speed-associated danger. A non-user proclaimed that “speed does not make the vehicle unsafe, it’s about how it is used”, with another user stating that “since [she feels] in control when riding [her] scooter, [she feels] safe”.

6.1.10 Time of Day

Agreement between users and non-users was found in that riding e-scooters in afternoons and rush-hour traffic is perceived as unsafe. This concern was characterized by a fear for safety when riding on crowded roads with people rushing to go to work as well as pedestrians who may fill up sidewalks and thereby block dedicated cycling paths. Users and non-users alike in Sweden and the UK mentioned not wanting to ride, especially alone, at night when it is dark. This contrasted with the user and non-user in Spain, who talked about seeing value in riding after local trains and buses stop operating late at night.

6.1.11 Negative Impressions

It became apparent through the interviews that a large force behind non-users' unwillingness to use micromobility vehicles stems from negative impressions they have been given by accident reports, footage and discussions on social media, and encounters with reckless riders on the street. While user participants acknowledged witnessing instances of reckless riding or road accidents, they were not bothered to the point where they felt they wanted to stop using micromobility services. Among non-users, however, several of them stated that they had a heighted perception that micromobility vehicles, especially e-scooters, are involved in many accidents. A commonly observed phenomenon by most participants is double or triple riding, involving two or three people riding the same e-scooter simultaneously, which goes against Voi's guidelines and road regulations. Being in the same space as such riders was enough to make participants uncomfortable as pedestrians, which they stated to be a factor discouraging them from engaging with the vehicles themselves. Two of the non-user participants were mothers, and both of them expressed that this fact heightened their anxiety and risk perception surrounding the use of e-scooters. One of them shared that "when [she] hears about teenagers riding [e-scooters], it triggers [her] more" simply because she has kids of her own. Personally knowing people who have been involved in e-scooter accidents was also mentioned as a reason for being unwilling to get on an e-scooter.

6.1.12 Pricing

Perceptions and thoughts on the affordability of the service were discussed. Opinions on pricing were quite mixed across both users and non-users, with no single consensus. Some felt that it was too expensive compared to the distance that can be covered with a bus ticket within the same amount of time, while others felt the price was worth it for micromobility vehicles' ability to go where buses cannot. Comparing it to other non-public transportation options, users said that they would rather pay for a scooter to reach their destination. Generally, however, non-users more often expressed the value they placed on walking over riding, stating that they would rather just save money by walking instead, especially if not in a hurry. On the topic of price perception, one participant commented that the price may feel high due to the fact that users see the price per minute, compared to a one-off cost of a bus ticket. This notion was challenged by another participant who expressed that the per minute business model makes the service seem cheaper. As such, this theme was characterized by mixed opinions.

6.1.13 Reasons to Ride

This theme emerged from explicit questions to users as to why they choose to use micromobility services. As such, this theme provides insight into the value users see in the availability of e-scooter and e-bikes in their cities, and potentially highlights that which non-users may not find so important or necessary in their daily lives.

A large topic within this theme is time convenience, specifically different use cases where micromobility vehicles have helped a user get somewhere when in a rush or when a user has needed to make it to a bus or train connection. Micromobility vehicles were also praised as an emergency transport option, where users talked about liking them for being able to use them after their city's public transportation hours, commonly as a last resort to get home. Student participants mentioned liking the option of using scooters on campus to eliminate the physical effort of having to walk around with a heavy backpack. In a similar vein, those users that live in cities with elevated areas mentioned using e-scooters as a low effort means of going up steep hills and streets. Route flexibility was also named as a reason to ride, as a user referred to e-scooters as a "useful tool for discovering new streets and taking different routes". Two other users talked about e-scooters as "fun, especially [when on] holiday" and as "better for sightseeing [than being] stuck on a bus".

6.1.14 Other Reasons Not to Ride

Aside from the aforementioned themes that may contribute to non-users' unwillingness to use micromobility services, there were also mentions of factors unrelated to the vehicle or act of riding that deter non-users from engaging with e-scooters and e-bikes. The biggest external factor was that non-users may have more desirable alternatives to shared micromobility, such as their own car or bicycle, consequently having no need for them. Relatedly, some non-users stated that they prefer using their own bicycles for the added physical exercise. Weather conditions were also named as a deterring factor, as non-users in Sweden and the United Kingdom were concerned about cold hands during the ride, as well slippery roads in the winter.

6.2 Addressing First Ride Deterrents with Training Mode

As described in the previous chapter, the solution that was decided upon based on the discovered data and acquired feedback was Training Mode, a free e-scooter tutorial that takes users through a step-by-step training flow. In this mode, users learn about the different functions of the e-scooter, and are given the opportunity to try out the vehicle at a restricted speed and operational range. This solution targets two of the main concerns spoken by the participants of the interviews, namely that (1) that first ride is intimidating due to unfamiliarity with the vehicle and how to ride it, and (2) that installing and setting up the mobile Voi application is too much effort. As such, the first solution that was constructed was a browser-based Training Mode that can be accessed without the app, without an account, and without inputting payment information. Users simply need to scan the existing QR code on the vehicle with their native phone camera to be directed to the Training Mode website in their default browser. To make the Training Mode accessible to existing users or those who do not mind installing and setting up the application, an in-app version was created. This was also done to have Training Mode easily accessible at any time, should anyone want to go through it again. In both cases, the first time completion of Training Mode awards the user with Voi credits, which can be used to take free rides. In the following subsections, these two versions are presented, followed by pilot evaluations of the concept and prototype. Live, interactive prototypes can be accessed through the Figma links in Appendix B.1.

6.2.1 Browser-Based Training Mode

To restate, this version came about from comments and concerns indicating that the effort required to install and set up Voi's mobile application may be a factor deterring some women from adopting the service when in a hurry. Browser-based Training Mode can be accessed by approaching a vehicle and scanning its QR code with a smartphone camera as shown in Figure 6.1A. This prompts the user to open their browser and directs them to the Training Mode page of the Voi website (Figure 6.1B). Here, users are given the option to unlock the scanned e-scooter for free in Training Mode. They are shown information concerning what Training Mode is and what restrictions it places on the vehicle (Figure 6.1C) and are then prompted to activate the vehicle. The first step in Training Mode is for the user to place their smartphone in the phone holder (Figure 6.1D). The user can thereby view the tutorial information hands-free and gains the freedom to interact with the vehicle simultaneously. Each animation must play through once before the user can press to move onto the next tutorial task.

From there, the user can begin re-enacting the actions shown in the various tutorial steps. The first one is seen in Figure 6.2E, giving the user suggestions on how to stand and balance on the vehicle while riding. Throughout each of these steps, the user self-checks whether they have completed the instructed task and moves onto the next. After balancing, the user is shown how to use the bell on the scooter (Figure 6.2F), how to light the blinkers (Figure 6.2G), and what information is shown on the two display screens built into the handlebar of the scooter (Figure 6.2H).

Afterwards, users are introduced to the mobility functions of the scooter. They are first shown how the brakes on the scooter work and which wheel they affect (Figure 6.3I). Next, they are introduced to the GO-button/throttle of the scooter (Figure 6.3J), where the animation shows how acceleration is tied to how much the user presses it. Pressing the GO-button alone does not cause the scooter to move. In the next step, users are shown exactly how to accelerate (Figure 6.3K). They are presented with time-matched animations showing how to use one leg to kick off to gain some speed and to follow up by quickly pressing the GO-button to accelerate. After completing all the tasks, users are brought to the completion page where they are given a redemption code for free Voi credits as a reward. Users can copy the code to save it elsewhere for later use, but are also prompted to redeem their reward in the app, which directs them to the Voi app's download page in their phone's app marketplace. Pressing the back button at point during the flow will cause the dialog box shown in Figure 6.3M to show up, informing the user that this will exit training mode and thereby also deactivate the e-scooter. The user is prompted to park the vehicle, and is given the option to download and experience Training Mode through the app should they not want to continue on browser.

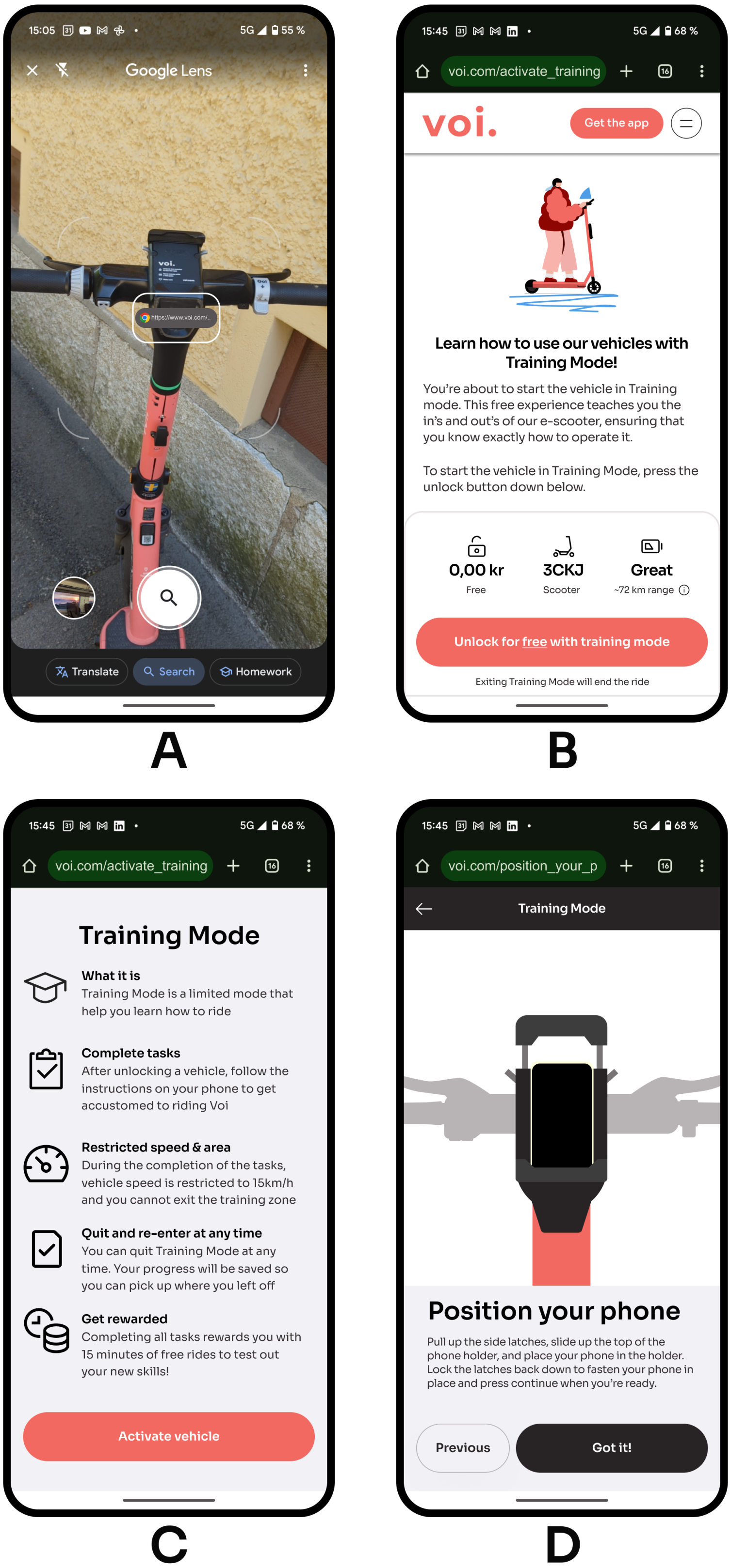

Figure 6.1: Browser-based Training Mode screens A to D.

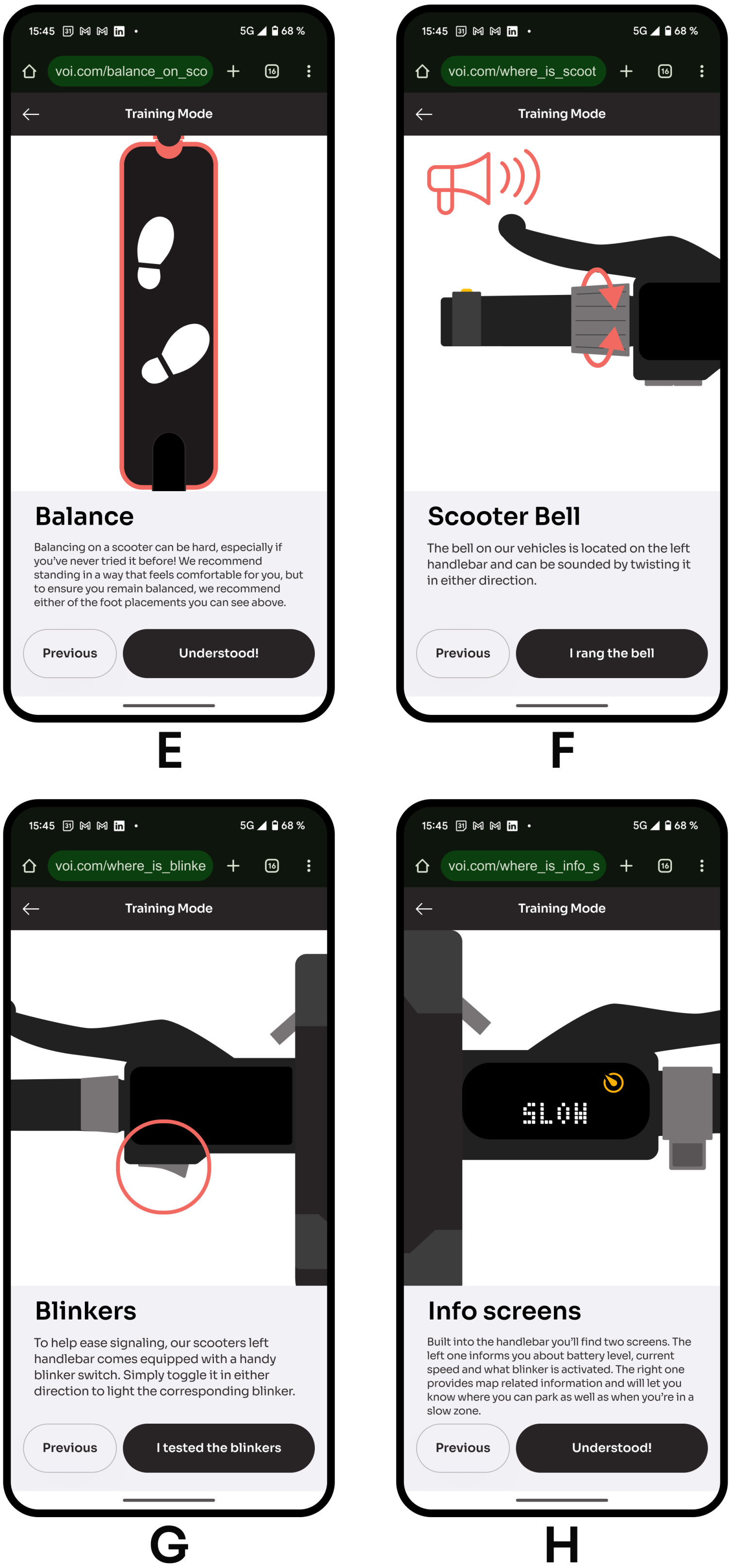

Figure 6.2: Browser-based Training Mode screens E to H.

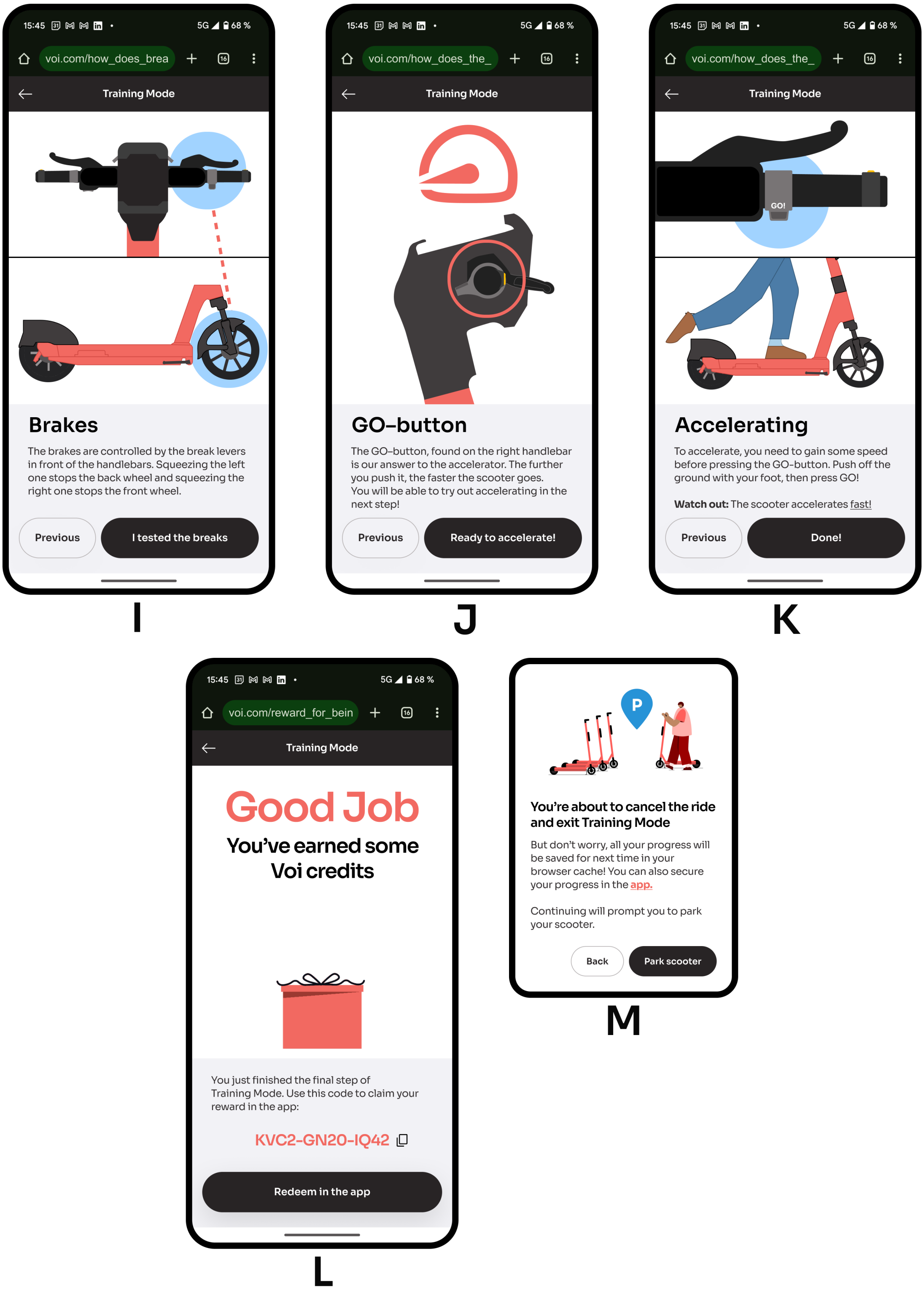

Figure 6.3: Browser-based Training Mode screens I to M.

6.2.2 In-App Training Mode

In order to make Training Mode accessible to long-time users of the app or those who do not mind downloading it, a second version of the prototype was made to show how Training Mode might look and be accessed through the mobile Voi application. Figure 6.4A shows a dialog box that appears right after a user creates an account and enters the app for the first time. They are asked if they would like to learn how to ride with Training Mode and are informed that it can always be found in the Help menu should they choose not to activate it now. Upon choosing to enter Training Mode (Figure 6.4B) they are shown its details and restrictions (Figure 6.5G), after which they can activate it and are directed to a blue-highlighted version of the app's usual map view, seen in Figure 6.4C. The blue highlights framing the screen and the blue coloring of the usually Voi-coral QR scan button at the bottom center indicate to the user that their next scan and unlock will start the e-scooter in Training Mode, with its speed and area restrictions. The user can then choose to directly activate a scooter or reserve it for 10 minutes (Figure 6.4D), a feature that Voi currently has but the authors chose to exclude from the browser version of Training Mode.

A scooter is then unlocked and users are taken to the first step of Training Mode, positioning the phone in the phone holder; the same as in the browser-based version (Figure 6.6I). From here on, the flow is essentially the same, as can be seen in Figures 6.6I-L and 6.7M-Q. At any point during the Training mode flow, users may use the back button in the top left to return to the map view (Figure 6.5E), where they can either choose to return to the current task or end the ride, which also ends Training Mode. Should a user decide to forgo Training Mode the first time they enter the app, they can access Training Mode through the Help menu (Figure 6.5F). Selecting it for the first time shows users the details and restrictions of Training Mode (Figure 6.5G). Leaving and selecting it again or going to it after having already completed some or all of it brings users to the task overview screen seen in Figure 6.5H, where users can choose to view its details again or select a tutorial to view without e-scooter activation.

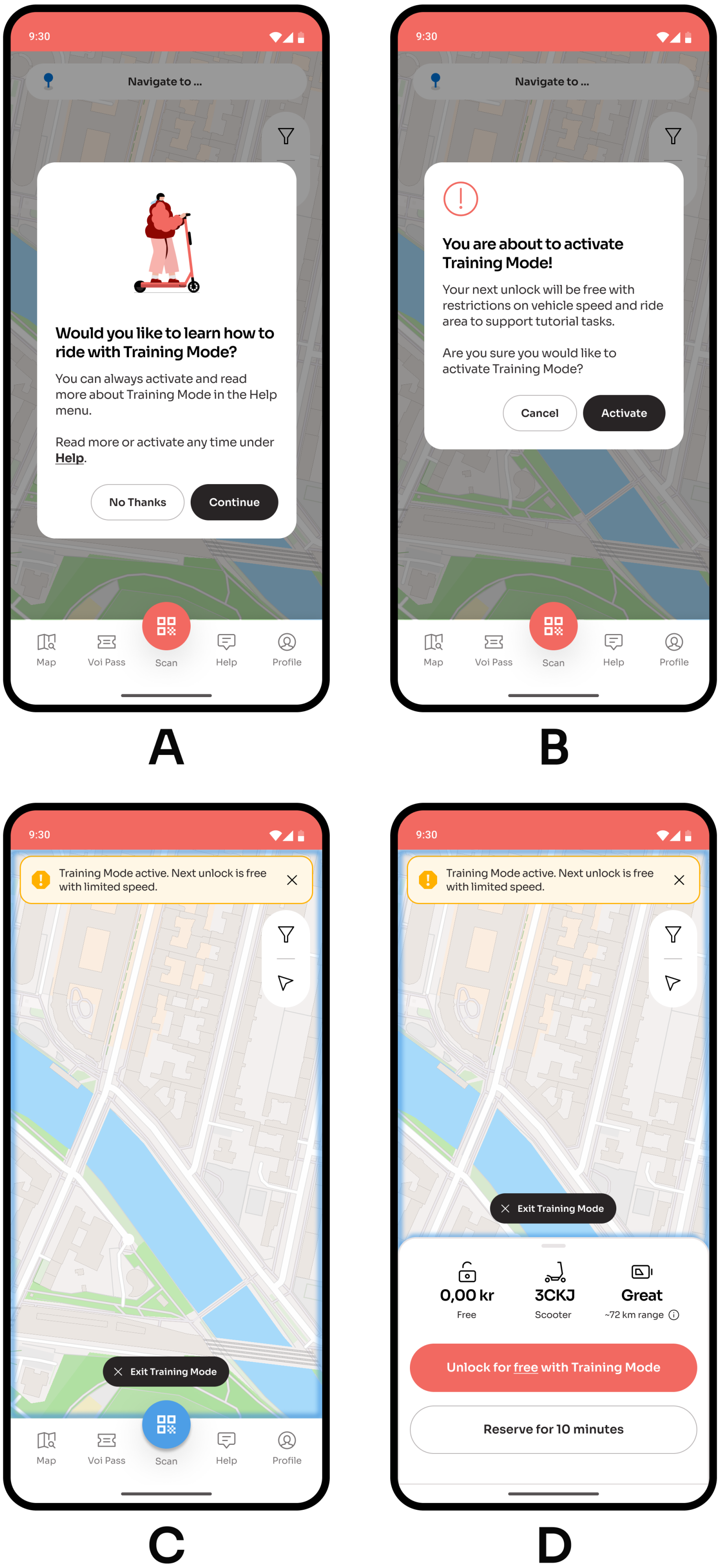

Figure 6.4: In-app Training Mode screens A to D.

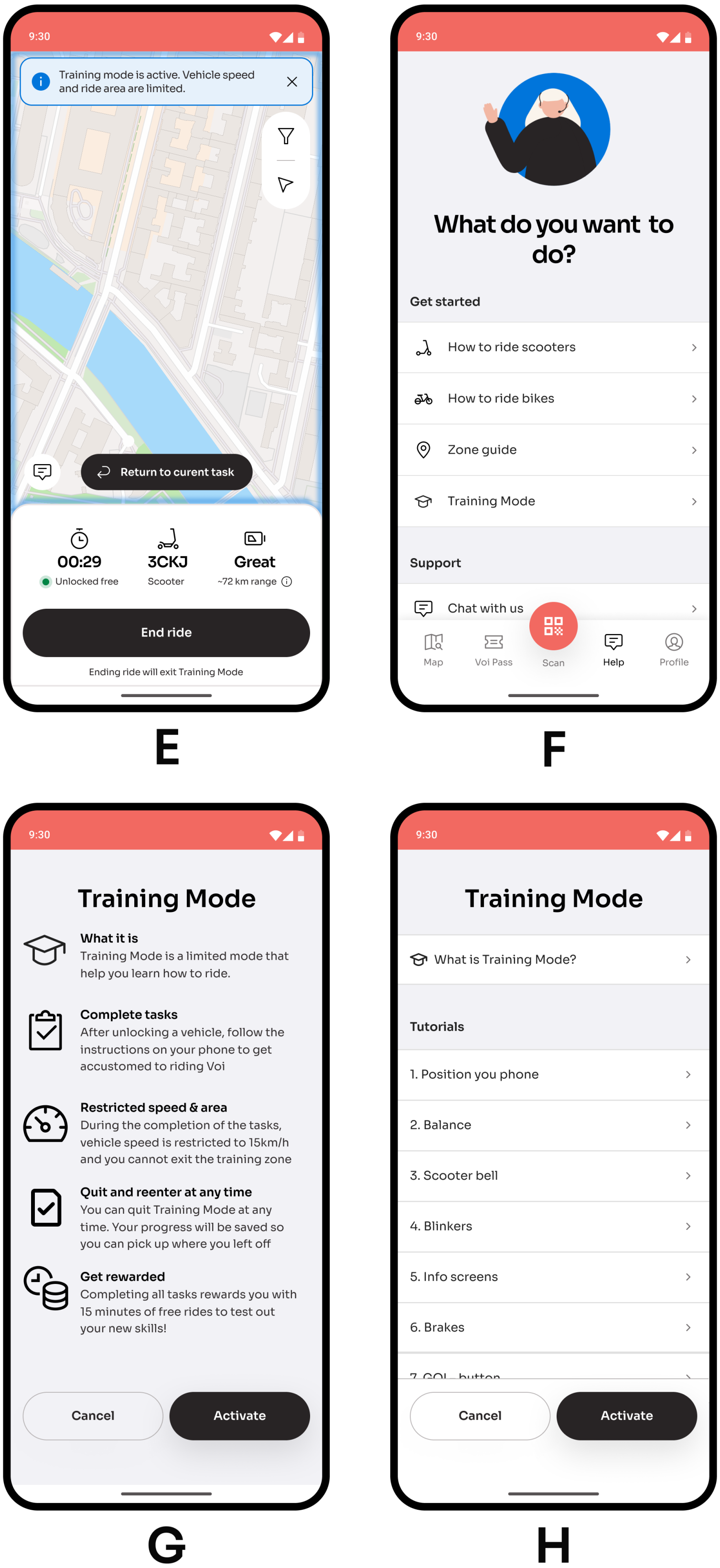

Figure 6.5: In-app Training Mode screens E to H.

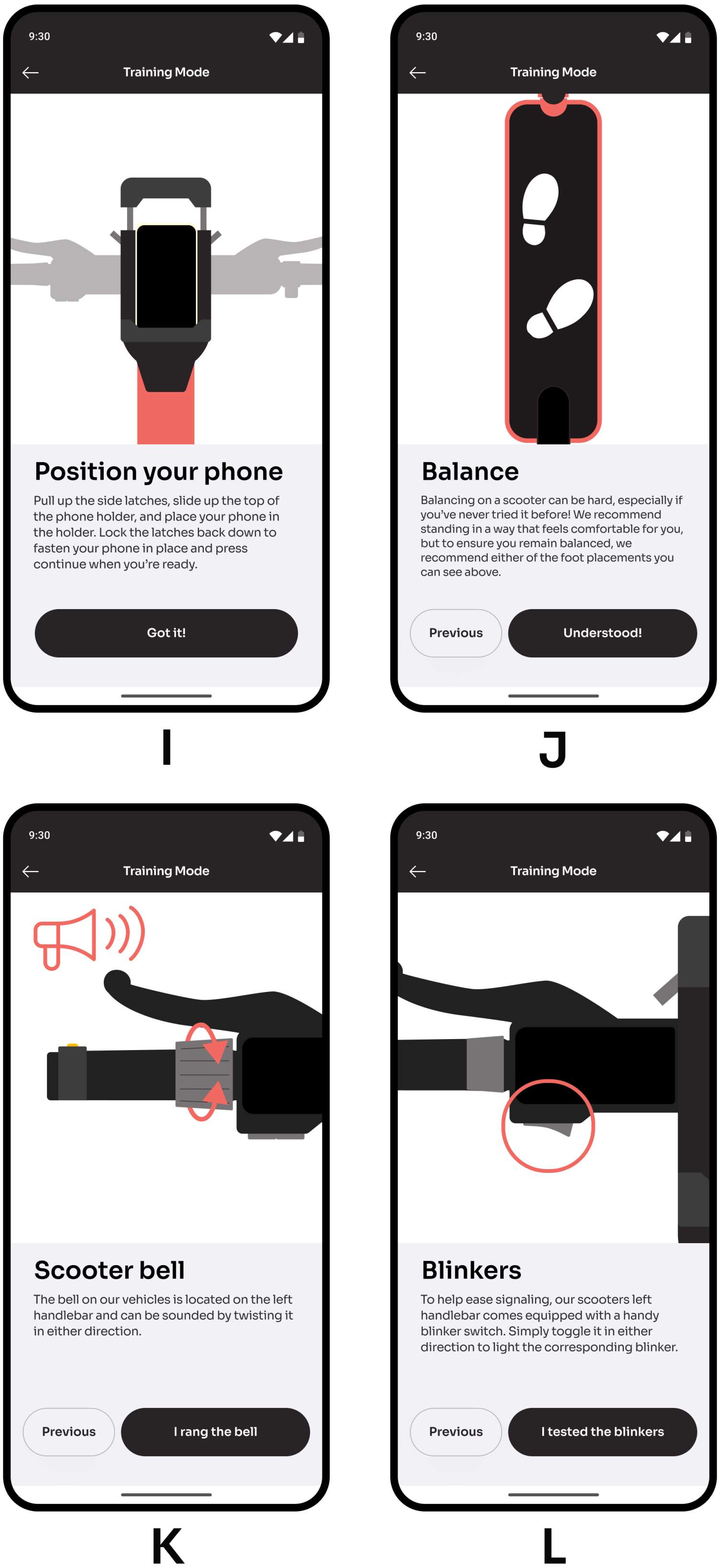

Figure 6.6: In-app Training Mode screens I to L.

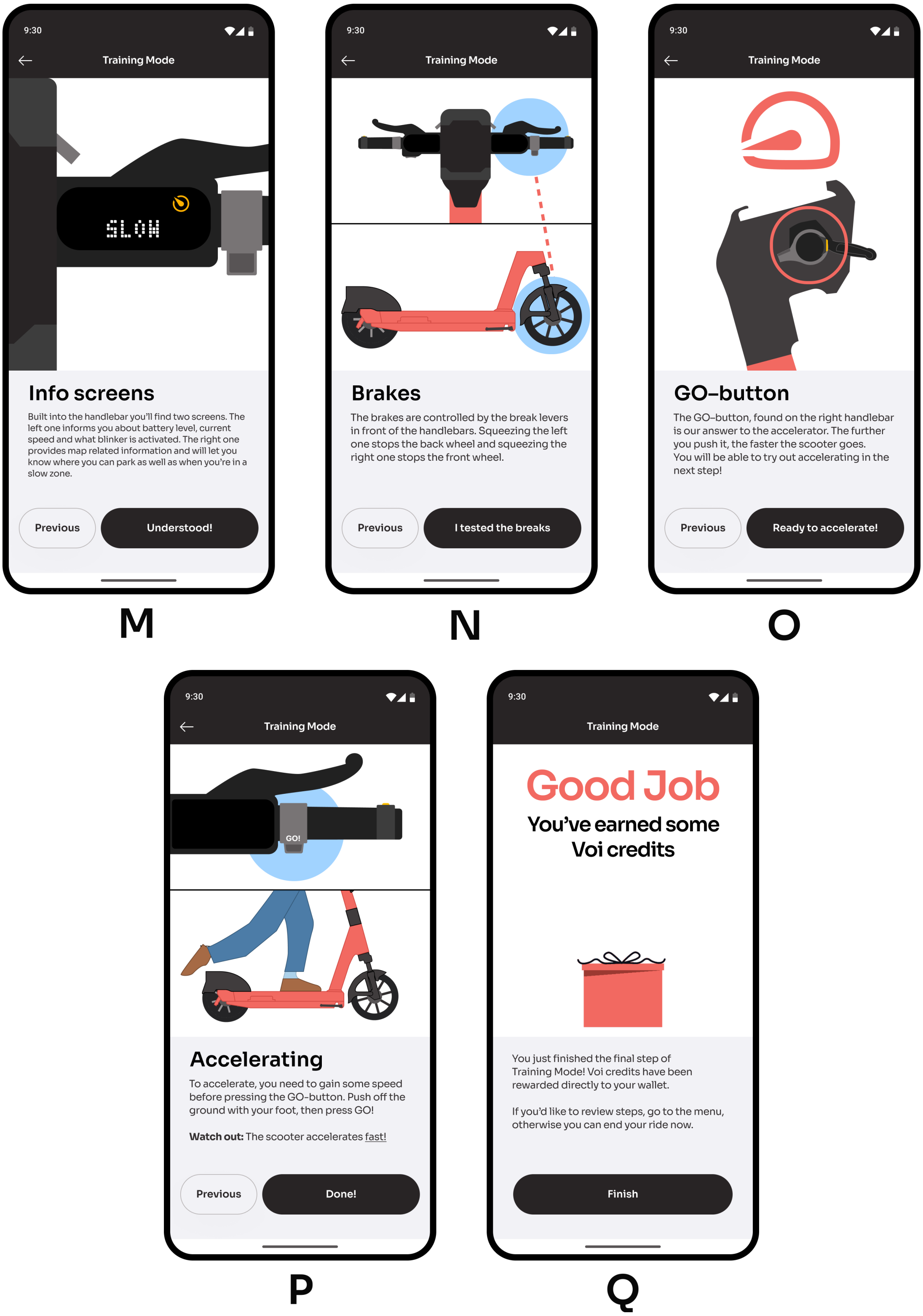

Figure 6.7: In-app Training Mode screens M to Q.

6.2.3 Pilot Evaluation Results

As mentioned previously four participants took part in the pilot evaluation. All participants were female univeristy students, and had not previously ridden an e-scooter. Generally, the participants happened to be individuals whose travel patterns and distances could not benefit much from the capabilities of e-scooters and micromobility services, which was reflected in their responses. Additionally, two of the four participants spoke of a fear and lack of self-trust when riding. Nevertheless, participants noted that not having to download the app in combination with the solution being free was enough to make them consider testing the scooter even if they did not see any use for it in their everyday life.

> *"I don't have a use for e-scooters but the odds that I'll try are better because I don't need to download an app." Participant 1*

The participant who doubted her ability to ride scooters and cited fear as a deterrent for herself also commented that the more detailed instruction and slow pace made them feel more likely to try riding.

> *"Feel like it really wants me to learn how to do it correctly, which makes me want to learn and try it too." Participant 2*

A common theme among participants was that, while they thought the prototype could be helpful, they would probably never notice it as they did not naturally pay attention to e-scooters or any tags or sticker that may be placed on them. They could not recall the content of any currently used stickers as they do not engage with the vehicles at all.

> *"I don't really pay attention to scooters so I would never know about this [Training Mode]." Participant 3*

Similarly, a participant talked about how she would likely only approach a parked e-scooter as an activity to pass the time with her friends, if she were to stumble upon one by coincidence. She also said that the presence of her friends would make her more likely to approach it.

> *"I would treat it more like an activity when out with friends, I'd approach it if we had nothing else to do." Participant 3*

Furthermore, participants mentioned that the idea of a prototype with full scooter integration would have piqued their interest, alluding to how learning to ride a scooter would be fun if it involved completing tasks. They appeared enticed by the framing of tasks.

> *"If the scooter could sense what I did before letting me go to the next step it would be very cool." Participant 1*

When questioned about the featured illustrations and animations, participants felt their clarity was greater than that of Voi's current onboarding slides, particularly for understanding how to accelerate with the vehicle. The more detailed appearance of the scooter was also brought up by one of the participants as a primary reason for the improved clarity.

> *"That is way better than the existing one for pushing off with a scooter!" Participant 4*

However, the order of the information was also commented on, where participants had different, conflicting opinions on the order of the tasks. A particularly popular one was the GO-button and acceleration, and whether or not they should be shown before or after the introduction of the handlebar functions.

> *"I like the order but I'm also unsure what I would think if it were real." Participant 2*

> *"Maybe put "how to go" before you explain the handlebar, I want to see the screens change while riding." Participant 4*

7

Discussion

In this chapter, the results from the interviews and the final prototype of the solution are discussed and reflected on. The ethical issues and limitations of this project are acknowledged at the end of this chapter.

7.1 Barriers to Women's Micromobility Adoption

The opinions and impressions expressed in the interviews largely matched the findings and theories discussed in Chapter 3. As suggested previously, barriers to women's micromobility adoption are highly interconnected, which was a finding in this study as well. While the participants spoke of different concerns surrounding ride-safe infrastructure, the weight of the vehicle, and the presence of other riders/drivers, these comments often related to views on gender differences in risk perception and the view of micromobility vehicles as fast and dangerous. The participants generally believed that men are more like to engage in adventurous or dangerous behavior, which is in line with previously discussed findings that men exhibit riskier traffic behavior than women [14] [15], hinting that the participants' impression of this likely stems from real-life observations. Both users and non-users felt that men are simply more likely to take risks and put themselves in harm's way. This was apparent in how non-user participants talked about how uncomfortable they felt having to ride on cycling infrastructure that runs between and next to car lanes, while simultaneously acknowledging for themselves that it is mostly men and younger boys riding e-scooters. Although it was also stated that this did not consciously affect their willingness to ride, it does call into question to what extent female ridership is negatively affected by the (perceived) presence of reckless male drivers.

This contrast between men and women was also spoken about with regards to men being more likely to engage with new and unknown technologies, a notion that has been proposed before [25], [46]. Some of the participants themselves related men's heightened likelihood to take risks to their tendency to try out new technologies without forethought, questioning whether this trait is what makes them more likely to use e-scooters on a whim. Gustafson suggested that women are inherently more risk averse [38], which was also an opinion that was shared by some of the participants who felt that men may simply be different from a biological perspective. The previous finding that women in caretaker roles may show higher risk aversion [38] was also seen in how the two mothers in the sample spoke of their enhanced perception of risk and consideration of dangers due to their status as parents. Apart from risk aversion however, the one Spanish participant's opinion that women may just be bad at technology and therefore hesitate using e-scooters, may indicate that a more internalized gender perspective is at play. She described how she usually approaches her male family members to fix her computer, citing her status as a woman as related to her lack of confidence in handling and solving technology-related problems. While the small sample size once again puts the external validity of the finding into question, it may provide a hint that societal perspectives of what is stereotypically male or female may also permeate into shared micromobility ridership via gender associations of the vehicles themselves. Other participants explicitly said that they do not associate the vehicle itself with a gender, but this point may require more investigation, ideally with a more balanced region comparison, as differences in countries' gender equality status [41] may influence the prevalence of such mindsets.

One of the most multifaceted findings from the interview was the notion of the first ride being intimidating. This intimidation was described by both non-users and users, where users stated that it was another person who motivated them to take the plunge, after which they became regular users. Non-users stated that they would be more willing to ride if someone were to be with them, with some even expressing that they did not trust themselves to operate the vehicle properly. This pattern of responses is in line with past results showing that women generally feel less confident in traffic situations [3], [29], and can potentially also be connected back to their sensitivity to safety risks [38]. An added gender perspective was found in how some non-users stated that they would be more willing to try if they could observe more women riding, suggesting that the gender gap also constitutes a vicious cycle where low female ridership and a resulting perceived lack of female riders in the wild obstructs non-using women from trying out the service. This cycle may also feed into the view of e-scooters as masculine objects [28], further distancing the idea of riding them from women who may feel that they are not the target user group. A less gender-focused finding was how the effort required to install and set up the application when in a hurry constituted an obstruction to the first ride, upheld by how the non-users who talked about this instance would not even think of the app when not in need of it. This problem appeared to be related to convenience, and any attempt to solve it may likely also hold value for non-women groups as well.

On travel needs pertaining to clothing. Younes, Noland, and Andrews had previously found that women who do ride e-scooters see them as more convenient for getting around with restrictive clothing like dresses or skirts [12], contrasting the non-user participants' concerns that long dresses or skirts may constitute a hazard. This may once again speak to the notion of the first ride being an intimidating or unknown experience, particularly if the capabilities and design of the scooter are unfamiliar to the person. The way clothing length is feared to pose a risk to safety may also be related to the dimensions of the scooter and how its parts are perceived to accommodate extra baggage or flowy clothing. Given that Voi acquires their scooters from an external supplier with very little control over the physical design of the vehicle, it is inevitable that some people will be excluded. As the current version of the vehicles all follow the same exact design, some data surrounding instances of exclusion was expected, but apart from thoughts on the weight of the e-scooter, no other comments were made. Some participants even specifically said that the vehicle was a good fit for them. Nevertheless, since the sample size was so small, it is entirely possible that the participants simply were not within any of the lower or higher percentiles of any body dimensions, and were therefore not affected by the current design. Since the interviews were all held over Google Meet, with participants only visible from the shoulders up, no height observations could be made either. Future investigations targeting non-users should likely explicitly check to what degree scooter dimensions are failing to accommodate certain groups.

Some of the interviews had hints of cultural differences influencing perceptions, such as when both participants from Spain spoken of their willingness to use scooters on their way home at night. The potential underlying factor here may be a cultural difference in the timeline of daily life activities, where in Spain dinner is eaten around 22:00 [88], offsetting sleep time and leading to more activity at night hours. Being outside at night may thus be more normalized in Spain, whereas the more northern countries of the sample had participants worried about facing danger or harassment in the dark of night. In a similar vein, the two participants who had immigrated to Sweden from Mexico spoke of a hesitation to carry bags with them on the vehicle due to a fear of them being snatched off of them mid-ride; a fear that they explained as stemming from past experiences in their hometowns. Those participants living in hilly towns, who cited e-scooters as an effective way of going up steep hills without exerting physical effort, may also be more likely to view micromobility as a beneficial service. The small sample size limits the generalizability of these comments, but they can be taken as points for further investigation.

7.1.1 Diversity of the Sample

As previously mentioned, Voi operates in various European markets, which was the reason why the initial aim of the interviews was to cover as many regions as possible while still respecting the timeframe and resources available for the thesis. One of the reasons for deciding upon this broad sample approach was to gather potentially region-specific data, in case there were any exclusively country or culture-based reasons why a certain group of women chose not to use micromobility services. For instance, participants from the northern markets expressed feeling unsafe in the dark, while the Spanish interviewees spoke openly of riding during the night. A further goal was to also see how varying demographic factors like age, occupation, or parental status may affect their willingness to ride or not ride. The findings resulting from this approach turned out to be very valuable as they revealed how different groups may have different outlooks on micromobility services and thereby differing concerns and needs to be addressed. An example here is the finding that participants who were mothers had a much more critical stance on micromobility vehicles as fast and dangerous objects, as the idea of their children riding them or being affected by other riders was especially triggering to them. Students may be more inclined to use e-scooters as a way of traversing campuses while carrying heavy loads or going to and from student events. Given the relatively small sample size however, it is not possible to draw any large conclusions about any single one of the groups represented by the participants. A more targeted and discreet sample could have provided more comparable and detailed knowledge on a single demographic group, which may have led to a better understanding of why that specific group chooses not to engage with micromobility vehicles. As such, the broad approach taken in this study and its results constitute an indication that women as a gender cannot simply be summarized under one target group. One can speak of a gender gap in micromobility by taking women and men as the contrasting groups, but the reasons for the gender gap may well be concealed within the breadth of variation within those two labels. An example from the male side can be seen in the attitude of the authors of this thesis, where one is an avid user of e-scooters as a means of time-efficient transportation, while the other actively chooses not to ride them at all. The results of this project may thereby serve as a starting point for micromobility companies to plan future investigations into the matter while taking into account that different women may have wholly different concerns and needs. A shortcoming of the interview stage however, is that the interviews explicitly targeted people identifying as women, so it is unclear what concerns or needs would be presented by individuals identifying as non-binary or other gender expressions who choose not to use micromobility services. Due to an absence of data, more precise and targeted investigations are necessary to understand non-women gender identities.

7.1.2 Acquiring Participants

While the interviews themselves provided highly valuable insights, they were ultimately limited by the sample size, which was held back by roadblocks during the participant acquisition process. Participants were acquired via two channels; Voi's mailing service for users and acquaintance networks for non-users, as Voi does not have direct access to non-users or third-party crowd sourcing services. Unfortunately, the participant acquisition process suffered from a response rate of 13% (i.e., out of total, only thirteen percent booked an interview time slot) and a no-show rate of 80% (i.e., eighty percent of participants who booked a time slot did not show up to it). Therefore, as touched upon above, while the resulting sample was diverse in the markets and nationalities it covered, a drawback was that the interview results could not say a whole lot about one single market's or nationality's experiences. Furthermore, comparing the different markets represented by the participants, which was one of the original goals of the interviews, was not possible due to an imbalance of this representation (as 9 participants were from Sweden while only 2 from the United Kingdom and Spain each). Not only did these bad response and no-show rates affect sample composition, but waiting for participants to respond and book a time slot only for them to not attend the time slot also extended the data acquisition and *discover* phase, thereby also delaying the subsequent parts of the thesis. While this did not have a hugely detrimental impact on the timeline of the project's execution, it did take up time that could have otherwise been used for further iteration and evaluation of the prototype.

7.2 Training Mode

Overall, impressions gathered through the final prototype's pilot evaluations indicate that Training Mode does well in teaching how to navigate the functions of a Voi e-scooter as well as how to accelerate and ride it. The participants stated that they found it much more comprehensive and helpful compared to Voi's current onboarding slides, which is limited in its educational capacity and the information it presents. Participants actively stated that they would be more likely to ride after being taught by Training Mode, which preliminarily shows that Training Mode succeeds in meeting the concerns outlined in the *first ride is scary and unfamiliar* problem space. Additionally, participants mentioned that they would be more likely to use it given that it is free and browser-based, further meeting the need for a more accessible service represented by the *too much effort setting up the app* problem space. The overall quality of the illustration and animations, as well as the placement and navigation of the interface was praised, with main points of feedback addressing the order in which the tasks are presented. Participants were unsure which tutorial they would prefer to see first. One talked about learning how to accelerate and how that would be better to know before learning about the information presented on the handlebar screens, while another participant felt that it was good to have the GO-button shown after all peripheral scooter functions had been covered. This point requires further testing, potentially after a more sophisticated, live prototype has been developed.

While Training Mode's different steps have been described as tasks, the current prototype does not actively impose delays or conditional steps that rely on the strict completion of any tasks. The prototype was not synchronized with a scooter at the time of testing, but Voi has confirmed that for future iterations, this could be a feasible feature. Voi's scooters are capable of detecting load weight on the board, blinker activation, whether brakes are being squeezed, and the pressing of the GO-button accelerator. Pairing the detection of these with the different steps of Training Mode could further ensure that the user actually manages to apply what they learn through the mode. The participants of the pilot evaluation indicated that full scooter integration would have piqued their interest as something cool to experience. This may suggest that the novelty of a fully realized Training Mode that synchronizes smartphone with scooter may also serve to attract people to the service out of a curiosity for the technology involved. A similar point was made when a participant mentioned that being together with friends might make her more likely to approach the scooter and try out Training Mode, as they would be mutually fueling each others' curiosities. She described how in that case, Training Mode would be an amusing group activity. Her comments highlighted that there is perhaps potential in attempting to attract users to the service by framing it as something fun and interesting to explore together.

Similarly, these aforementioned sensors could be used to set the maximum speed and operational area restrictions included in the current Training Mode concept. The idea is that the Training Mode user can realistically only use it as a practice tool, and not to reach any desireable destination. Voi has shared that they are able to remotely see how far their vehicles travel, and can also wirelessly exert some influence on its functions based on distance traveled. The operational area restriction of Training Mode could then be upheld by imposing a limit on how far the user-in-training travels while completing the tasks. The e-scooter would thereby warn the user that they are nearing the maximum travel distance of Training Mode. The goal of this is to avoid misuse and freeloading by using Training Mode to actually get somewhere. Distance traveled may be a better limit than putting a timer on Training Mode, to avoid placing time pressure on the user and negatively impacting their exploration of the vehicle. Additional restrictions could be placed on how often a single user can enter Training Mode in a given area or within a given period of time, to avoid them scooter-hopping every time one scooter reaches its Training Mode limit.

One of the main results from the *discover* phase was the suggestion that women are more risk averse and more conscious of their safety than men. Regardless of how men truly are, it appears that women tend to have higher safety standards, specifically the need to be informed on the technology they are about to interact with. In this case, the need for a deeper understanding of shared micromobility vehicles before choosing to actually ride them. The solution of Training Mode is thereby not overtly gender-specific, but targets concerns and values that have been spoken by women. Whether men who do not ride share these concerns is unknown. Nevertheless, it may very well be that Training Mode, most likely as a free feature, may also speak to the safety needs of men who do not use micromobility. Its true effect on ridership requires further study on a larger scale with both genders and live vehicles, but a pilot evaluation with men may also provide insight into how their safety needs might differ from women, which may help target women's needs in a more specialized way. The original intention for Training Mode stems from comments on how women who currently ride were convinced to ride for the first time by another person. Whether Training Mode can truly replace that convincing presence or provide that level of confidence requires further evaluation, perhaps with a live version.

An added point here is that while Training Mode targets non-user women's need for ride education for using an unfamiliar vehicle, it may also carry the potential to contribute to long-term change on women's outlook on micromobility. By adding an incentive for existing riders, who might match what the current study's participants had described as "reckless riders", to go through Training Mode, they might be equipped with newfound knowledge of the vehicles they have been riding, and maybe also a better awareness for how to really ride them. The hope here is that after going through Training Mode, they become safer individuals on the road. This might however require adding instructions for road rules or a narrative that evokes empathy for those around them. Empathy induction in traffic-awareness campaigns via the demonstration of dramatic narratives has shown to elicit an empathy response in drivers [89]. Such an addition to Training Mode paired with an incentive may thereby produce change in the minds of these reckless riders. The incentive could be in the form of Voi credits, allowing them a free ride or two. Setting Training Mode as a slow, task-oriented tutorial designed to elicit empathic response with no skip button may thereby, in theory, improve road safety and consequently also surrounding pedestrians' views on micromobility. From a business perspective, this might eventually make the service more attractive and recruit more riders. More importantly for the safety of communities, however, an incentivized Training Mode might serve to equip people with the necessary skills to ride e-scooters and e-bikes without assuming their prior ability to do so. This may well be a better alternative to the current method of simply giving anyone with a phone the opportunity to ride a motorized vehicle out in public.

This study has also shown that mere exposure to vehicles is insufficient to prompt curiosity and convince a passersby to become a micromobility user. Comments made during the pilot evaluation of the prototype indicate that even though Training Mode might make someone feel more confident about trying e-scooters, this would only be the case if they are actually aware of its existence, which is not immediately obvious. Furthermore, the focus group interviews demonstrated that even when a person puts aside their speculation and fear, neither the scooter nor the app succeed in informing the user of, for example, how quickly the e-scooter will accelerate. A lack of communication with non-users is present, which now begs the question of how best potential users can be made aware of the existence of a free, browser-accessible training. Voi does little to no marketing or advertising geared towards non-users, as their primary outlet is social media and in-app communication with their followers and users. During any sort of discount or ride campaign, Voi appears to rely on existing users for recruitment, with the hope that word-of-mouth will be sufficient to motivate non-users to ride. It is unclear, however, to what degree users would be able to market Training Mode to their acquaintance non-users. A medium that could therefore be utilized more is stickers and labels placed directly on their vehicles, which Voi currently uses to indicate free unlock or free ride campaigns. Stickers with colors that stand out, placed on areas of the vehicles that are most eye-catching could work to get people curious about what a free Training Mode might entail, but the pilot evaluations also place doubt on this. Participants' comments that they would not immediately think to approach a scooter out of their own volition calls into question how well stickers work. The use and success of stickers may therefore also require further evaluation. An additional point of consideration is that the QR codes on the scooters are currently only for reading using the app's own QR reader camera. Setting that QR code to be read directly with a smartphone's ordinary camera app and directing a person without the app to a browser with Training Mode would make the process much smoother, removing the need for new codes or ways to access the mode.

One of the discarded ideas from the ideation stage was the plan to set up a so-called first ride event. This would entail creating a safe space where anyone can walk up to, say, a Voi tent where employees hand out helmets and other merchandise and offer people the chance to try out their vehicles. Training Mode could also be used in conjunction with such an event, where live instructors for every participant may not be necessary. Letting individuals try out Training Mode together with an e-scooter on an established safe and uncrowded stretch of road may further warm people up to the idea of riding Voi. Another idea could be for Voi to recon areas of their market cities that have particularly quiet and flat roads, and mark them as suitable for using Training Mode. This may be attractive for people who live in more chaotic areas of the city and would like to try out e-scooters but do not know where to do so. Voi could also place scooters that are specifically meant for training in those areas so that potential users are not met with a lack of vehicles for training. There were many other ideas that emerged from the Crazy 8's that did not make it through the selection stage. These ideas, found in the Figma file linked in Appendix B, were not mixed into the final solution of this thesis, but still address opinions and concerns voiced by the participants. They may therefore carry value for future attempts to tackle the gender gap or explorations of new solutions.

More room for improvement may be found in the tonality of the service, and how shifting it could also work to attract more users. During the project, various people made off-hand comments on how the current vibe associated with Voi is quite tech-y and cold, a tone "characteristic of a stereotypical technology startup" as one individual put it. The copywriting in Training Mode attempts to ameliorate this by communicating with the users in a more patient, kind, and accommodating way, but Training Mode still follows Voi's general brand guidelines, including its color schemes and established user interface elements. While participants did not say anything negative about the color scheme or general tonality of the service, this does not exclude that a more human and cozily framed user experience could attract demographics who may place value on the presence of such elements. As per one suggestion, perhaps Voi could benefit from an in-app mascot like Microsoft Office's Clippy [90], or a generally more light-hearted, less-serious aesthetic style. These are all points for future research and discussion, but based on comments gathered throughout this project, there may be benefit in re-evaluating whether the sleek, tech startup tonality that Voi established years ago still holds as representative of their values. This question is especially justified now that they are beginning to place more focus on different target groups, such as women.

7.3 Ethical Issues and Limitations

As both authors identify as male, certain ethical considerations were in order, pertaining to the nature of this research as focusing on the role of gender in micromobility. Throughout all stages of this project, care was taken to acknowledge the authors' positionalities as male researchers investigating women's safety and accessibility concerns. Data intake and analysis were conducted in an unbiased way, ensuring that the results were based wholly on facts extrapolated from direct participant quotes. The supervisor of this project at Voi, a woman, oversaw and provided feedback where necessary over the course of the whole project. Despite all of this, an important limitation is found within the role of gender in the interviews. It is unknown whether any of our participants felt uncomfortable interacting with or being interviewed by a male researcher, especially given the topic of the thesis. Yager, Diedrichs, and Drummond showed that in studies on body image, female participants had a preference for female interviewers [91]. While the current project did not cover body image, the gender focus of this thesis and one of its core subject matters being women's embodied experience of riding micromobility vehicles may have influenced how the participants chose to express themselves to the authors.

While many valuable insights were gained, future work might benefit from female researchers tackling the same problem, both to probe for any undiscovered insights and to see whether a preference for researcher gender exists in this field.

Apart from the gender of the researchers, one of the main limitations of this project was its timeframe. This is of course attributed to its status as a master's thesis, but had there been more time to plan and spread out individual phases of this project, more potential insights could have been gained and more iterations of the prototype could have been realized. It is especially the data intake stage that suffered from this, as there was a considerable struggle to acquire participants. As previously mentioned, participant recruitment had a very low response rate and a high no-show rate. Perhaps if there were more time, a larger sample could have been gathered without having to compromise on demographic, ethnic, or location diversity. While the insights resulted in a feasible and well-received solution prototype, a more balanced sample could have provided more nuanced data and a clearer understanding of women as a target group. Furthermore, more time may have allowed for a more comprehensive evaluation of the interfaces, such as a heuristic analysis [92].

As for ideation and prototyping, there was only enough time for two iterations and pilot evaluations of the final Training Mode prototype. More time could have allowed for the incorporation of more feedback, and a more sophisticated version of Training Mode that could be paired with an actual e-scooter. This would have constituted the final round of testing, where the next step would be a live testing version of Training Mode to see how it actually affects ridership. Since female ridership is not a trend that can immediately be facilitated and observed, a longitudinal study would likely be necessary. This would be a rough long-term plan for the project, where this thesis's contribution to bridging the gender gap could potentially be observed and evaluated.

Finally, while the questions of the interviews aimed to gauge thoughts on both e-scooters and e-bikes, the answers of the participants related primarily to e-scooters. Nearly all concerns that were verbalized, be it the intimidation of the first ride, concerns for safety and speed, or a negative impression of micromobility, stemmed from impressions left by e-scooters and e-scooter riders. This is because not all micromobility markets have e-bikes, with Voi only recently increasing e-bike availability. Given that e-scooters are the most widespread and thus more salient of micromobility vehicles, the participants' responses were only natural. As such, the brainstorming and ideation stages focused primarily on how to increase e-scooter ridership. While the data intake stage constitutes an example for how research could target impressions of e-bikes as well, this was not the case for ideation. Training Mode, at least its current state, only trains users for how to use e-scooters. Calling back to timeframe limitations, a longer research period could have allowed time for investigations into e-bike markets with more targeted participants. Thus, future work in e-bike markets that also have a prominent gender gap might involve specifically investigating attitudes towards e-bikes, and how a potential Training Mode for them may impact ridership. A minor point to add is that the e-scooter depicted in the animations of the Training Mode prototype is based specifically off of Voi's Voiager 8 (V8) line of e-scooters. This type is different from its previous generations as it is currently the only one with a display screen, and has a slightly wider board as well. Therefore, the presented solution is only applicable to tests with V8 models. More time may have allowed for the creation of illustrations and animations that match other available scooter types as well.

8

Conclusion

This aim of was of this thesis was to contribute to bridging the gender gap in micromobility. Its goals were to investigate the barriers that hinder women from using e-scooters and e-bikes, and to exemplify how these barriers can be addressed with design solutions. The results were a qualitative list of themes and sub-themes outlining barriers to women's micromobility experience, and the Training Mode prototype, which aims to tackle the first ride and app set-up barriers. The research and development leading up to these results were guided by the following primary research question and sub-question:

1. What are the primary barriers that prevent women from adopting micromobility solutions, particularly e-scooters and e-bikes?
   (a) How might these barriers be addressed through user-centered design solutions?

To answer these research questions, this project followed the double diamond model. The answer to the primary research question was uncovered through the *discover* and *define* phases. In these phases, literature reviews on women's mobility concerns and the gender gap were conducted to prepare interview questions, which were then administered to users and non-users. The goal of these interviews was to understand participants' perceptions of micromobility and how they may relate to such services. Through qualitative analysis of the interview transcriptions using thematic coding and affinity diagramming, theme clusters were formed. These theme clusters outline and describe women's safety and accessibility concerns, and constitute the barriers to women's micromobility experience uncovered by this project. They are thereby also the problem spaces to be addressed by a solution. These theme clusters are:

- First ride deterrents
- Gender
- Physical aspects of vehicles
- Infrastructure
- Mid-ride and speed-related safety concerns
- Time of day
- Negative impressions

- Pricing
- Reasons to ride
- Other reasons not to ride

Thus, these themes collectively form the answer to the primary research question. The primary barrier to women's adoption of micromobility solutions is a complex interconnected network of personal safety concerns, gender stereotypes, varying travel needs, and negative preconceived notions surrounding micromobility. For a detailed description of each theme and their sub-themes, see Section 6.1. To view the visual theme clusters resulting from thematic coding and affinity diagramming, see the Figma file linked in Appendix B.

To decide on a problem space to focus on, the theme clusters deemed most solvable through interaction design methods were selected during the *define* phase. These were the *too much effort setting up the app* and *the first ride is scary and unfamiliar* problem spaces, which were then used to create two personas and corresponding storyboards. These served to further define the context of these problem spaces, and were used as inspiration for ideating solutions in the *develop* phase, starting with the Crazy 8 method. Further ideas were generated in a design workshop, after which all resulting ideas were assessed on the dimensions of feasibility, viability, desirability, impact, and complexity, in order to decide on the main solution. What emerged was a training mode and a browser version of the Voi application, which were then combined into a browser-based Training Mode during the *deliver* phase, after receiving stakeholder feedback. In its final iteration, Training Mode is a free, browser-based e-scooter training platform that users can access by scanning the QR code on a Voi e-scooter with their phone camera. They are directed to the Training Mode website where they can view and complete different tasks related to the various functions of the scooter. An in-app version was also created to ensure accessibility to Training Mode for existing users and those who do not mind downloading the app. Its initial evaluation suggests that it can entice non-users who are concerned about the safety and unfamiliarity of the vehicle to try riding an e-scooter. The interface itself and the concept were viewed as meaningful and useful, with constructive feedback mainly targeting the ordering of the tasks and how one would become aware of Training Mode's existence. The latter point is a critical one, as non-users' awareness of Training Mode or any other digital solution for that matter is required for any solution to have a meaningful impact on ridership. Future work requires testing new ways of reaching out to and communicating with non-users. Nevertheless, to answer the sub-question, Training Mode was deemed a successful example of how the discovered barriers may be addressed with a design solution, as the prototype was found to carry the potential to impact female ridership. The pilot evaluation suggests that the solution is likely to meet women's safety needs and thereby attract new female riders. For a comprehensive overview of Training Mode's functionality and its pilot evaluation, see Section 6.2.

As discussed in the previous chapter, there are several other important points for future work. Firstly, the size and diversity of the sample in this project were highly limited by difficulties during the data intake stage. Time limitations interacted with low response rates and high no-show rates to result in a less-than-ideal sample size and composition. Future investigations should take their time in acquiring participants to ensure that a broader group is covered at a greater accuracy, to gain clearer understandings of women's needs and to account for demographic differences. Including men in these investigations may also serve to highlight differences in female and male safety and accessibility concerns, potentially marking more areas for improvement. In a similar vein, a re-evaluation of Voi's current onboarding and tonality may also be beneficial to check the extent to which they still succeed in meeting users' and non-users' expectations of a micromobility service.

Future work may also entail performing more evaluations of the specific components of the prototype, to further test the usability of the interface as well as the desirability and usefulness of the Training Mode concept itself. For one, the interface could benefit from further usability testing and heuristic analysis, with more time put into adjustments and developing subsequent iterations. Different types of illustrations and animations could be tested to heighten clarity of information. The concept itself also requires more testing, to gather more impressions on its functionality and perceived usefulness, especially from women who do not ride because of their fear of riding an unfamiliar vehicle. Creating a version that is integrated and synchronized with an e-scooter would facilitate a more realistic simulation and testing of the concept. If successful, the next step would be to implement a live version in a longitudinal study, to see the degree to which Training Mode influences female ridership. However, this also requires more work in marketing Training Mode. Testing different advertisement methods may be necessary.

Lastly, though perhaps more relevant later on in the development process, a more comprehensive prototype including both e-bikes and other e-scooter models may also be beneficial to create. This would allow for further testing in markets that do not have all types of models and vehicles, which may also provide more location-specific information on different demographic and user groups.

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A

Interview Questions

Introduction

- Hi thank you for choosing to participate in our study. We are master's thesis students from Chalmers University of Technology who were tasked by Voi with assessing people's attitudes towards micromobility.
- For this interview we have outlined some dimensions of e-scooter/e-bike use that we would like to look into. The questions we will be asking in this interview will reflect those different dimensions, so you can expect to be asked about a number of different aspects of micromobility use.
- We are here to simply gather personal opinions, so we'd like to stress that there is no right or wrong answer. Please feel free to be as positively or negatively critical as you'd like, as honest answers are most valuable to our research.
- For the purpose of analyzing your replies later, is it okay for us to record the audio and video of this interview?
  - (If yes) Thank you.
  - (If no) In that case, is it alright for us to record the audio?
- Recording data will only be used for the purpose of analysis, and anything pertaining to your identity will be anonymized. We follow GDPR regulations so all of your data will be deleted after our thesis research is over.
- As a thank you for participating in our research, you will have the choice between Voi credits or a gift card after we're done.

Questions

1. **Travel patterns**
   - How do you normally travel around the city?
   - Does it change based on your needs?
   - Does micromobility fit into this?

- Are the capabilities of e-scooters/e-bikes compatible with your travel goals and destinations?
- What are your reasons for using / not currently using micromobility services?

2. **Safety**
    - How safe do you perceive e-scooters and e-bikes to be?
        - What is the difference between the two?
        - Why? (i.e. what makes you think they feel safe/unsafe)
    - Do you find that other riders are an obstacle to your willingness to ride?
    - Is there a particular time of day when you feel that using a micromobility vehicle would be less safe?
3. **Infrastructure**
    - To what extent do you think micromobility vehicles fit in a city space?
    - Do you find the current infrastructure in your city to be sufficient for micromobility?
        - Are (cycling) paths and roads adequate for e-scooters/e-bikes?
        - Are parking areas for micromobility vehicles well-built?
        - Are parking areas well-lit / usable at nighttime?
        - Do you feel that anything is missing?
4. **Physical dimensions and appearance**
    - Do you find the physical dimensions of vehicles (i.e., size and weight) appropriate to operate them?
        - What are your experiences / have you ever struggled with them?
    - What do you think of the aesthetics of (Voi's) vehicles?
        - 1. As far as you remember
        - 2. Based on an image [show image]
5. **New technology adoption**
    - Do you feel about having to start using micromobility services?
    - Is it the app or the vehicles themselves?
        - Do you find it complicated, or maybe bothersome...?
6. **Needs during travel**
    - Is traveling with micromobility vehicles compatible with your choice of clothing and baggage?

    - Do you find e-scooters or e-bikes restricting in any way?

7. **Affordability**
    - How do you feel about Voi's current pricing model? [show cost if necessary]
        - Does this influence your willingness to use Voi or any other micromobility service?
    - How do you compare the pricing of micromobility with other forms of transport in your city?
8. **Gender stereotypes**
    - Do you view micromobility vehicles as gendered objects?
        - Do you view e-scooters and e-bikes differently?
    - Do you view the act of riding a micromobility vehicle as gendered?
9. **General opinions**
    - Why do you think women use micromobility less than men?

Debriefing and Outro

- Alright, that was the last question. Thank you very much for participating. As was revealed at the end, our thesis is focusing on the gender gap in micromobility, and so we are investigating barriers that may hinder women from using micromobility. Before we end this interview, do you have any concerns you would still like to mention or any questions for us?
- As we mentioned earlier, your data will be handled with the utmost care and will not be traceable back to you, in accordance with GDPR regulations.
- As a thank you, you will receive [insert compensation] via [means of receiving compensation]. [If receiving Voi credits] is the email address you shared with us the same one you use for your Voi account?
- We think you brought forward some very valuable opinions today, which will help us contribute to improving the micromobility experience of women.

B

Figma Links: Final Prototype, Interview Results, and Unused Ideas

B.1 Interactive Prototypes

The final prototypes can be accessed via the following links:

- Browser-based Training Mode: Click here
  - Password: inBrowser-voithesis25
- In-app Training Mode: Click here
  - Password: inApp-voithesis25

B.2 Figma Design File

The following Figma file contains (1) themes and clusters resulting from the thematic coding and affinity diagramming of the interview transcriptions, (2) ideas generated during crazy 8's that were unused and did not make it into the final solution, (3) an overview of the design workshop, and (4) the lo-fi prototypes for the initial in-app Training Mode and browser-based Voi.

- Figma Design File: Click here
  - Password: AlexBill-voithesis25

B.3 Interview Results: Themes and Sub-Themes

The following themes and sub-themes, as well as the tagged interview bits that were clustered together to form them can all be found in the Figma file. For a quick overview of the sub-themes, please refer to this list:

- First-ride deterrents
  - First ride is scary and unfamiliar

  - Prefer trying with someone else
  - Prefer riding with others
  - More willing to try if observe women riders
  - Scared to try in public, prefer safe space
  - Unfamiliar things and roads
  - Lack of self-trust on vehicles
  - Too much effort installing and setting up app
  - Only think of micromobility when necessary, but too much effort/not enough time
- Gender
  - Perceived gender associations
  - Travel needs as a woman
  - Men take more risks, women are more conscious of safety
  - Men perceived as more tech savvy than women
- Physical aspects of vehicles
  - Vehicles are too heavy to lift/move
  - Heavy feels stury and safe
  - Not confident scooter can accommodate carrying needs
  - Bikes perceived as safer but seat too high
  - Scratched up scooter looks unreliable
  - New vehicle models are better
  - Voi's coral color is good
  - Hook is not obvious
  - Require a helmet
  - Foot space is too narrow
- Infrastructure
  - Scooter availability and parking
  - Bike paths next to or between car lanes feel unsafe
  - Bumpy roads are unpleasant
  - Other riders make bike paths feel unsafe
- Mid-ride and speed-related safety concerns

  - Scooters feel safe in case of accidents
  - Scooters feel unsafe in case of accidents
  - Higher speeds are dangerous/unsafe
  - High speed is safe as long as one is in control
  - Unfamiliarity with vehicles make them dangerous
- Time of day
  - Night time/the dark feels unsafe
  - Dangers associated with crowds and traffic during rush hour
- Negative impressions
  - Bad impressions caused by others' reckless driving and accident reports
- Pricing
  - Price is okay
  - Price is too high
- Reasons to ride
  - Saving time
  - Route flexibility
  - Used as emergency transport option
  - Eliminates physical effort
- Other reasons not to ride
  - Not needed/more desireable alternatives
  - Weather conditions make rides difficult or more unsafe
  - Not convenient enough

C

Evaluation Questions

Introduction

- Thank you for participating in this prototype evaluation. We are masters thesis students from Chalmers University of Technology who were tasked by Voi to understand people's safety and accessibility needs when it comes to micromobility, and propose a design solution to meet those needs. Based on the data we've collected, we've created an interactive prototype for what we've dubbed Training Mode, which we would like you to test today.
- The goal of today's test is for you to run through two prototype flows; one browser-based and one in-app version. We would encourage you to think aloud as you are interacting with the prototype and going through the various steps of Training Mode. Afterwards, we will ask you a few questions about the experience. Your data will be anonymized and untraceable back to you.
- Before presenting the prototype, we would like to show you how the Voi application currently handles onboarding. [show in-app tutorials on how to ride e-scooters]
- Do you have any questions before we begin?

Demo and Questions

- We will now introduce you to the two prototypes via two scenarios. We would like you to experience both of them.
  - **Browser-based Training Mode:** You are outside on a walk and you notice that there are tags hanging on Voi e-scooters advertising a free browser-based training mode for how to ride their e-scooters. One catches your attention so you walk up to it and decide to scan the QR code on the scooter. Please go through Training Mode until its completion.
  - **In-app Training Mode:** You've just downloaded the Voi app and after setting up your account, you're faced with a dialog box asking you whether you'd like to learn how to ride e-scooters with a free Training Mode. Please activate Training Mode, scan a scooter, and go through Training Mode until its completion.

- While completing the tasks, please externalize your thought process verbally.
- What are your overall thoughts on the experience?
- Were the illustration and animations easy to follow?
  - Were they in line with your expectations for a tutorial mode such as this?
- Were the phrasings of the instructions clear?
  - Were they in line with your expectations for how a tutorial mode would present instructional information?
  - Did the tonality feel appropriate?
- How did you perceive the usability of the interface?
  - Did anything feel redundant?
  - What was missing?
- To what extent do you feel that the option of this free training mode would influence your willingness to use micromobility?

Outro

- That was our last question, thank you so much for your input. Is there anything you would still like to share or feel has been left out?
- As stated, your data will be anonymized and will not be traceable to you in any way. Do you have any questions before we end this session?