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Identifying perspectives on micromobility sharing concepts: A Q-study in Graz, Austria

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Abstract

Transport is a significant contributor to greenhouse gas emissions and poses major challenges for cities, including air and noise pollution, traffic congestion, and accidents. Micromobility sharing provides a sustainable alternative by offering flexible, short-term access to lightweight vehicles, helping to bridge gaps in public transport and reduce reliance on private cars. This approach has gained considerable attention, presenting both opportunities and challenges for urban transportation. Key topics of public discussion include mobility and transit integration, environmental sustainability, social sustainability, urban identity and attractiveness, management and organization, as well as the use of public space.

This study aims to explore the various social perspectives on micromobility sharing in Graz, Austria. Using the Q-method, diverse viewpoints were revealed, identifying four factors: the public transport complementors, the e-scooter opponents, the regulation advocates, and the context-conscious supporters. Each group demonstrates distinct values and priorities regarding micromobility. For instance, some individuals believe that these systems will inevitably lead to congestion in public spaces, while others feel that effective regulation and technological innovations can mitigate such issues.

The findings, along with future quantitative data, will allow for meaningful segmentation of the population, aiding in the decision to implement micromobility systems in Graz. The results and recommendations can also inform the sustainable introduction of these systems.

Keywords: micromobility sharing, social perspectives, Q-method, sustainability

Zusammenfassung

Der Verkehr trägt erheblich zu den Treibhausgasemissionen bei und stellt Städte vor große Herausforderungen, darunter Luftverschmutzung, Lärmbelästigung, Verkehrsstaus und Unfälle. Mikromobilitäts-Sharing bietet eine nachhaltige Alternative, indem es flexiblen, kurzfristigen Zugang zu leichten Fahrzeugen ermöglicht, Lücken im öffentlichen Nahverkehr schließt und die Abhängigkeit vom privaten Pkw verringert. Dieser Ansatz hat große Aufmerksamkeit auf sich gezogen und birgt sowohl Chancen als auch Herausforderungen für den städtischen Verkehr. Zu den wichtigsten Themen der öffentlichen Diskussion gehören Mobilitäts- und Verkehrsintegration, ökologische Nachhaltigkeit, soziale Nachhaltigkeit, städtische Identität und Attraktivität, Management und Organisation sowie die Nutzung des öffentlichen Raums.

Diese Studie zielt darauf ab, die verschiedenen sozialen Perspektiven zum Mikromobilitäts-Sharing in Graz, Österreich, zu untersuchen. Mithilfe der Q-Methode wurden unterschiedliche Standpunkte ermittelt und vier Faktoren identifiziert: die „Ergänzer des öffentlichen Nahverkehrs", die „Gegner von E-scootern", die „Befürworter von Regulierung" und die „kontextbewussten Befürworter". Jede Gruppe hat unterschiedliche Werte und Prioritäten in Bezug auf Mikromobilität. Einige Personen sind beispielsweise der Meinung, dass diese Systeme unweigerlich zu einer Überlastung des öffentlichen Raums führen werden, während andere der Ansicht sind, dass wirksame Regulierung und technologische Innovationen solche Probleme mindern können.

Die Ergebnisse werden zusammen mit zukünftigen quantitativen Daten eine aussagekräftige Segmentierung der Bevölkerung ermöglichen und so die Entscheidung über die Einführung von Mikromobilitätssystemen in Graz erleichtern. Die Ergebnisse und Empfehlungen können auch in die nachhaltige Einführung dieser Systeme einfließen.

Schlagworte: Mikromobilitäts-Sharing, soziale Perspektiven, Q-Methode, Nachhaltigkeit

Statement on the use of artificial intelligence-based tools

Artificial intelligence tools were used in selected stages of this thesis to support the research process. Specifically, ChatGPT was employed to assist in structuring ideas, categorizing Q-statements for improved clarity, and identifying potentially relevant stakeholders. Language tools such as DeepL and Microsoft Word were used to enhance the linguistic quality of the text. At all times, the author retained full control over the content and critically reviewed all outputs. The accuracy, interpretation, and conclusions presented in this thesis are entirely the responsibility of the author.

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List of abbreviations

BS	Bike sharing
CBS	Cargo bike sharing
CO_2	Carbon dioxide
EBS	E-bike sharing
ESS	E-scooter sharing
FF	Free-floating
FM/LM	First and last mile
GHG	Greenhouse gas
PCA	Principal component analysis
PPP	Public private partnership
PT	Public transport
SB	Station-based
TNEI	Total normalized environmental impact

1 Introduction

Transport is responsible for around 15% of the greenhouse gas (GHG) burden worldwide, in Austria even for 28.3% (Umweltbundesamt, 2024). Cars account for the largest share of transport-related GHG emissions at more than 50% (BMIMI INFOTHEK, 2023). This has damaging effects on cities, like air and noise pollution as well as accidents (Papaix et al., 2023). However, travel demand is high and often cannot be covered by public transport (PT) only due to limited coverage, inconsistent service levels or overcrowding (Chi et al., 2023). Thus, sustainable urban mobility is an important topic for policymakers and can be achieved by supporting active mobility (IPCC, 2023) as well as sharing mobility (Kwiatkowski, 2021). According to Mubiru and Westerholt (2024), sharing mobility is about providing transport access without ownership, whereby the most common form is vehicle sharing. This involves short-term rentals with self-service booking and payment and includes both car-based services and micromobility, which refers to human-powered or electric vehicles like bikes and scooters, usually under 25 km/h (Mubiru & Westerholt, 2024).

As of 2023, shared micromobility systems are present in 15 regions and 452 cities worldwide, facilitating over 87,000 trips per day (Cui & Zhang, 2024). However, according to a McKinsey analysis, which examined data from over 2,800 cities, the shared mobility market is growing and is expected to continue expanding, with a particular emphasis on micromobility (Heineke et al., 2023). A notable trend shows consumers shifting from larger to smaller vehicles due to parking and traffic challenges (Heineke et al., 2023). 70% of participants in a 2021 McKinsey survey said they would be open to using micromobility for transportation (Heineke et al., 2021). By 2030, shared micromobility could comprise up to 10% of the whole shared mobility market (Heineke et al., 2023). Although e-scooters are currently the most popular form of shared micromobility in Europe (Fluctuo, 2024a), bike sharing (BS) saw significant growth in 2023 compared to 2022, with a 54% increase in free-floating (FF) bikes and a 13% rise in station-based (SB) bikes (Fluctuo, 2024b). This rise of shared micromobility is in line with general efforts to promote sustainable urban mobility as outlined in international frameworks such as the European Green Deal and the Sustainable and Smart Mobility Strategy (European Comission, 2021).

Despite the potential benefits, the rapid expansion of shared micromobility has also generated considerable debate, both in media (Y. Li et al., 2024) and academic circles

(Cui & Zhang, 2024). A striking feature of this debate is not only the media attention it attracts but also the discussions it generates within local politics (Homem de Gouveia et al., 2023). For local and regional authorities, it represents a governance challenge with many contradictions: “it's about sustainability, but also about safety; innovation, but also disruption; enforcement of rules, but also negotiation; decisions, but also effective follow-through” (Homem de Gouveia et al., 2023, p. 1). As a result, cities worldwide are confronted with the challenge of regulating shared micromobility (Homem de Gouveia et al., 2023). According to Homem de Gouveia et al. (2023), the critical aspect of this governance dilemma lies in the diverse responsibilities undertaken by local authorities when managing shared micromobility services. In their survey the authors found that setting up regulations and monitoring, street infrastructure improvements, legal rules enforcement, and data collection and management are the most frequently cited responsibilities. It is evident that local governments are charged with a multifaceted role in ensuring the balanced consideration of the benefits and challenges associated with micromobility systems. A well-known example of this governance challenge is Paris. Although with the introduction of an e-scooter sharing system in 2020 car use in Greater Paris declined for the first time, problems with e-scooters increased (Dickinson, 2024), especially due to user behavior and safety concerns (Carey, 2024). To improve the situation, one of the world's most stringent laws was implemented in Paris, which limited the number of e-scooter operators and set a 20 km/h speed restriction (Carey, 2024). However, since this did not lead to improvement, a referendum was held in 2023 to decide whether e-scooter sharing systems should stay or not, leading to a total ban for public rental e-scooters (Dickinson, 2024). While Paris has opted for strict regulations and ultimately a ban, other cities continue to use e-scooter sharing (Fluctuo, 2024a).

To understand the impact shared mobility has and how cities address these upcoming challenges, existing research has analyzed various aspects of micromobility sharing. Much of this research has focused on environmental impacts, such as CO_2 emissions (Arbeláez Vélez, 2024; Y. Chen et al., 2024). Others explore user behavior (Gkavra et al., 2025; Oeschger et al., 2025) and changes in mobility behavior, like first and last mile (FM/LM) connectivity (Cui & Zhang, 2024; Ye et al., 2024). Social aspects (An et al., 2024; F. Jin et al., 2024) and safety aspects (Hardinghaus et al., 2024; Naaseh et al., 2024) are also analyzed. At the same time, regulatory challenges are widely discussed, including infrastructure needs, and governance issues (Bach et al., 2023;

Naaseh et al., 2024). Despite growing research on micromobility sharing, most of these studies take a quantitative approach. In addition, stakeholder perspectives seem to be underexplored. Some qualitative studies address this gap: Y. Li et al. (2024) analyzed media discourse on shared mobility. Macioszek et al. (2023) examined stakeholder roles in the development of e-scooter sharing services in Poland. König et al. (2022) studied e-scooter introduction strategies in Germany and Kwiatkowski (2021) examined the objectives of integrating individual municipalities into a Polish metropolitan BS system. While these studies provide valuable insights, they focus on specific modes rather than shared micromobility as a whole. In addition, several authors draw attention to research gaps: Macioszek et al. (2023) call for more work on system planning, König (2022) stresses the need to study stakeholder collaboration, and Meshulam et al. (2024) emphasize understanding cities' roles in the sharing economy. Mubiru and Westerholt (2024) state that greater emphasis should be placed on the adverse aspects of mobility services, while Roaf et al. (2024) advocate for the investigation of strategies to build public and governmental support for extensive active travel initiatives. To address these gaps, it is important to examine how urban stakeholders, such as local policymakers, planners, and advocacy groups, view the introduction of shared micromobility schemes.

Therefore, social perspectives should be uncovered by examining the narratives that actors construct and the arguments they use. These perspectives influence how urban mobility is framed and guide specific policies, strategies, and interventions (Bauer, 2018). Understanding such viewpoints is particularly relevant in the context of complex and uncertain issues, where dominant actors can shape political outcomes (Bauer, 2018). Consequently, the aim of this study is to analyze how different actors shape the debate on shared micromobility. Accordingly, it seeks to answer the research question: *What social perspectives exist regarding micromobility sharing in Graz?*

To address the research question, this study employs Q-methodology, with Graz, Austria, as the case study. The following two subchapters explain the rationale for selecting the chosen method and case for this study. The remainder of this thesis is structured as follows: In Chapter 2, an overview of the topic of micromobility sharing is presented, with a focus on the identification of key opportunities and challenges. Additionally, a review of extant Q-studies in the field of mobility is conducted. The third chapter provides a detailed description of the methodological approach. The findings of the study are presented in Chapter 4 and then discussed in Chapter 5. This includes policy recommendations, contributions to academic literature, as well as limitations and directions for future research. The thesis concludes with a summary of the main insights in Chapter 6.

1.1 Q as a method

Q-methodology is a mixed-methods approach that seeks to identify patterns in the individual subjective perspectives of various stakeholders and thus uncover broader social viewpoints (Webler et al., 2009; Zabala et al., 2018). In other words, Q-methodology identifies and categorizes perspectives, referred to in the literature as "operant subjectivities", and systematically examines subjective opinions, beliefs or viewpoints (Zabala et al., 2018). This makes it possible to deduce the underlying reasons for these perspectives (van Duin et al., 2018). Q-methodology differs from traditional discourse analysis, which is rooted in historical and political theory, by using an empirical, abductive approach to examine discourse (Hermwille, 2016). Therefore, it offers a promising approach, enabling a holistic assessment of individual worldviews through the stories told (Hermwille, 2016). In contrast to conventional surveys that focus on measuring the frequency of specific beliefs within large populations, Q-methodology involves fewer participants and uncovers how individuals connect various themes (Watts & Stenner, 2005). By combining the structure of surveys with the depth of qualitative insights (Zabala et al., 2018), it makes subjective viewpoints directly comparable while maintaining contextual depth (Webler et al., 2009). This understanding can help to overcome practical challenges (Zabala, 2014) and is often used to evaluate policies, understand decision-making, and address issues of public concern (Watts & Stenner, 2005; Zabala, 2014). Moreover, it helps to explore and make sense of highly complex and socially contested concepts (Watts & Stenner, 2005). Given the socially contested and complex nature of micromobility sharing, involving multiple stakeholders with differing priorities, Q-methodology is a suitable research approach for this study. It allows for a systematic exploration of how different actors perceive micromobility sharing, what arguments shape their positions, and what factors influence local decision-making. As a result, this approach provides valuable insights into the opportunities and barriers affecting shared micromobility in Graz, offering a deeper understanding of the reasoning behind various stakeholder perspectives.

1.2 Graz, Austria, as a case study

Graz is a large city in Austria with 343,461 inhabitants in 2025 (Stadtportal der Landeshauptstadt Graz, 2025b) including 63,000 students as of 2023 (Stadtportal der Landeshauptstadt Graz, 2023). As of 2023, the proportion of cyclists in Graz is 20% (Radoffensive, 2024). A study comparing mobility data in 35 German cities shows that the average cycling share in large cities is 24% (Agora Verkehrswende, 2020). These figures also vary among cities with a comparable number of inhabitants and a comparable proportion of students, such as Graz. For example, the proportion of cyclists in Aachen is 11%, in Freiburg im Breisgau 23% and in Karlsruhe 24%. In contrast to Aachen, both Freiburg and Karlsruhe have a BS system with around 400 bikes (Agora Verkehrswende, 2020). Karlsruhe is even ranked 17th out of 148 European cities that have been recognized as leaders in the areas of urban mobility and climate change (Zukunft Fahrrad e.V., 2024). A striking feature among these cities is the BS system, which is linked to local PT (Zukunft Fahrrad e.V., 2024). With 20%, Graz is therefore already among the cities with the highest share of bikes in the modal split. The city also describes itself as the bicycle capital of Austria (Stadtportal der Landeshauptstadt Graz, 2025a) and aims to become one of Europe's leading cycling cities by increasing the cycling share to 30% by 2030 (Bendiks et al., 2021). To achieve this, the Styrian state government and the city of Graz launched Austria's largest cycling initiative in 2019, committing €100 million to develop cycling infrastructure, including new bike lanes, parking facilities, and other supportive measures (Bendiks et al., 2021). These plans were formalized in the *Masterplan Radoffensive 2030,* which was presented in 2021 and specifically aims to improve cycling (Bendiks et al., 2021). In addition, there is the *Mobility Plan Graz 2040*, which is a broader strategy for a sustainable transport system across the whole city (Stadt Graz Abteilung für Verkehrsplanung, 2025). Its goal is to make Graz quieter, greener, healthier, and more livable by ensuring cycling is accessible to everyone, streets are safe for children, and areas are barrier-free for people with limited mobility. In addition, the modal split is to increase from approximately 60% ecomobility and 40% motorized individual transport in 2021 to 80% and 20% respectively in 2040 (Stadt Graz Abteilung für Verkehrsplanung, 2025). To achieve this, one measure mentioned in this plan is sharing mobility.

To date, there is currently only one provider for sharing mobility in Graz: tim, which stands for "*täglich.intelligent.mobil*" (daily.intelligent.mobile). At tim locations, users can rent SB (e-)cars and cargo bikes for short-term use, and hail e-taxis. They are easily accessible by PT, on foot or by bike and at many locations in Graz and central Styria (Graz, 2024). In addition to tim, since 2020 cargo bikes can also be rented in various locations for free through one of various partners like bike stores or companies during opening hours (Graz Holding, 2024; Hecke, 2020). However, there is currently no other form of shared micromobility than cargo bikes, either through tim or other providers, despite extensive discussions. BS has been a subject of debate for over 20 years, undergoing various planning phases (Winter-Pölsler, 2021): In 2012, a system called "Graz Bike" was introduced for the first time in Graz, making it possible to rent one of 150 shared bikes at 13 different locations via a booking platform ("Verleihsystem "Graz Bike" startet", 2012). However, it was not a fully automated system, as the bikes could only be picked up via partners such as student residences or bike stores and had to be returned to the same location (""Graz Bike" bietet Verleih über Buchungsplattform", 2016). In 2014, there were renewed discussions about launching the so-called "Citybike", a SB automated BS system with 30 locations, operated by Graz Holding (Kleine Zeitung, 2016). In 2017, talks were held with large Chinese BS companies, with the aim of signing a contract to launch BS in spring 2018 (Winter-Pölsler, 2017a, 2017c). However, after all, this did not happen for reasons that were not made public (Winter-Pölsler, 2017b). In 2019, the topic was revisited after the city had spent over a year developing a detailed concept and regulations for a BS and e-scooter sharing (ESS) system ("Ist Graz reif für ein Radverleihsystem?", 2019). ESS was ultimately rejected by the black-blue government and legally prohibited. And BS was not introduced either ("Ist Graz reif für ein Radverleihsystem?", 2019). In 2021, a new attempt was made to introduce the "Smart City Regional Bike" with locations around the List-Halle and the Science Tower (Winter-Pölsler, 2021). However, the one-year planning phase seemed to end in nothing. Now, the discussion has been reignited in the last year, after the topic was brought before the municipal council again in May 2024 and March 2025 (Miedl-Rissner, 2025; Winter-Pölsler, 2024). The deputy mayor now wants the relevant departments to review the issue again (Miedl-Rissner, 2025), which could potentially lead to a turning point.

Due to years of heated debate on the topic, the ban on e-scooters in 2019 and recent events, the city provides a relevant context to examine the attitudes and perspectives of various stakeholders on the topic of micromobility sharing. Graz is therefore ideally suited as a case study for the present work.

2 Literature review

This literature review provides an overview of micromobility sharing systems and systematically examines their strengths and weaknesses. The primary source of academic literature was the SCOPUS research database. Studies were selected based on relevance, publication date, and peer-reviewed status to ensure academic rigor. To provide an up-to-date and comprehensive perspective, particular emphasis was placed on recent studies and meta-analyses. The selection process is outlined in a detailed flowchart, which can be found in appendix A.1.

2.1 Overview of micromobility sharing and other relevant concepts

According to Mubiru and Westerholt (2024) shared mobility services in general refer to the idea of providing access to transportation services for multiple users, rather than individual ownership. Vehicle sharing, being the most prominent sharing system, is about short-term renting with a self-service system of reservation, pick up and return with automated payment. It can be divided into car-based mobility services, relying on heavy types of vehicles and micromobility (Mubiru & Westerholt, 2024). The term "micro" can be used to describe both the kind of vehicle (light, small footprint) and the distance traveled (typically brief) (Bozzi & Aguilera, 2021). Micromobility sharing includes small, lightweight vehicles like bikes, cargo bikes and scooters, that are either human-powered or electric, typically operating at speeds below 25 km/h (Institute for Transportation and Development Policy, 2024).

For the purposes of this study, shared micromobility systems for bicycles, e-bikes, e-scooters and cargo bikes are examined, as these are the best-known sharing systems. Hereby an e-scooter is defined as a “two-wheeled vehicle that is designed with a standing deck where the rider stands, a front handlebar, and it is powered by an electric battery” (Mubiru & Westerholt 2024, p.9). Usually they weigh less than 35kg, are slower than 25km/h and are designed for a single rider (Bozzi & Aguilera, 2021). According to Becker and Rudolf (2018) cargo bikes are bicycles built to carry goods and children. They are available in a variety of forms, sizes, and features, including electric pedal-assist systems (Becker & Rudolf, 2018). For none of the vehicles under study, a driving license is needed to operate them (Bozzi & Aguilera, 2021).

Micromobility sharing is usually offered in two different ways of operation (Mubiru & Westerholt, 2024). First, in the form of SB vehicles, which means that vehicles can only be accessed in and dropped off at specific stations. Either the exact same station (round-trip format) or another station (one-way format). Second, in the form of FF vehicles, where vehicles can be accessed and dropped anywhere within a specific area of operation (Mubiru & Westerholt, 2024). In recent years, a third model has increased its popularity: “The hybrid model combines elements of both [SB] and [FF]. In a hybrid model, users can rent from and return devices to docking stations or park them in designated areas such as public bike racks within the service zone” (S. T. Jin & Sui, 2024, p. 2). While BS is offered in all three forms, e-scooters are usually offered in the FF-system (Mubiru & Westerholt, 2024). Cargo bike sharing (CBS) usually is a round-trip format SB model (Marincek et al., 2024).

According to Bozzi and Aguilera (2021) these micromobility sharing systems usually work with an app provided by the operating company where customers can see the nearest available vehicle or station via GPS. After selecting a payment option, users can unlock the vehicle by scanning a QR code. When the ride is completed, users can park the vehicle and end the trip on the app (Bozzi & Aguilera, 2021).

2.2 Opportunities and challenges in micromobility sharing systems

In recent years, micromobility sharing systems have gained considerable attention, presenting both opportunities and challenges for urban transportation. By reviewing the existing literature, six key themes have emerged: Mobility and transit integration; environmental sustainability; social sustainability; urban identity and attractiveness; management and organization; space, order and traffic. Table 1 offers an overview of the key aspects related to each main theme. The following chapter will examine these aspects in greater depth, presenting a balanced discussion of the benefits, limitations, and trade-offs associated with micromobility sharing.

Table 1: Overview of opportunities and challenges

Opportunities	Challenges
Mobility and transit integration	
- First/last mile solution *(Cui & Zhang, 2024; Yu et al., 2024)*	- May replace rather than complement public transport *(Ye et al., 2024; Chi et al., 2023)*
- Supports sustainable mobility *(Zhao et al., 2024; Ye et al., 2024)*	- Effectiveness varies by time, place, and system type *(Saltykova et al., 2022; Yin et al., 2024; Cheng et al., 2023)*
- Enhances system resilience *(Ye et al., 2024)*	- Safety issues and infrastructure gaps *(Drimlová et al., 2024; Filipe Teixeira et al., 2023)*
- Potential to connect suburbs to PT *(Soltani et al., 2022; Chi et al., 2023)*	- Weak integration with transport networks *(Filipe Teixeira et al., 2023)*

Environmental sustainability	
- Reduces emissions if replacing car trips *(Y. Chen et al., 2022; Saltykova et al., 2022)* - E-bikes and shared bikes lower energy use and CO_2 *(Bozzi & Aguilera, 2021; Y. Chen et al., 2022)* - Renewable energy can boost sustainability *(Finke et al., 2022)*	- Environmental gains depend on replaced mode (e.g., bus vs. car) *(Y. Chen et al., 2022).* - Short vehicle lifespan limits benefits *(Bozzi & Aguilera, 2021)*
Social sustainability	
- Affordable and flexible option (in crises) *(Cui & Zhang, 2024)* - Boosts inclusion: accessible without a car *(Chi et al., 2023; Storme et al., 2021)* - Fosters social capital and community ties *(An et al., 2024)* - Supports youth and non-drivers *(Giuffrida et al., 2023)* - Health benefits *(Giuffrida et al., 2023; Kwiatkowski, 2021)*	- Limited access for people with disabilities *(Goralzik et al., 2022)* - Digital barriers for older adults *(Mubiru & Westerholt, 2024)* - Uneven service distribution urban vs. rural *(J. Gao & Li, 2024)*
Urban identity and attractiveness	
- Enhances city image and appeal *(Hurtubia et al., 2021)* - Integration into tourism *(Yang et al., 2021; Kwiatkowski, 2021)* - Positive public perception of bike sharing *(Hurtubia et al., 2021)*	- Depends on demographics and cycling culture *(Jaber & Csonka, 2024)*
Management and organization	
- Business opportunities and efficiency *(Storme et al., 2021)* - Enables data-driven planning *(Brown et al., 2020)* - Cost-effective in underserved areas *(J. Gao & Li, 2024)* - Public support enables effective regulation *(Bach et al., 2023; L. Zhang et al., 2015)*	- High setup and operating costs *(K. Gao et al., 2021; Papaix et al., 2023; Mubiru & Westerholt, 2024)* - Complex fleet and demand management *(Krauss et al., 2022; Zhu et al., 2022)* - Legal and logistical hurdles; unclear governance *(Krauss et al., 2022)* - Relies on political backing and funding *(Bach et al., 2023)*
Space, order and traffic	
- Drives infrastructure reform *(Bozzi & Aguilera, 2021; Y. Zhang et al., 2023)* - Safer than cars in terms of fatalities *(Bozzi & Aguilera, 2021)* - Urban order possible through regulation *(Krauss et al., 2022)*	- Clutters sidewalks; visual nuisance *(Brown et al., 2020)* - Unsafe parking behavior *(Hardinghaus et al., 2024; Papaix et al., 2023)* - Risk to all road users, especially at intersections *(Naaseh et al., 2024; Hardinghaus et al., 2024)* - Tightening regulation; bans in some cities *(An et al., 2024)*

2.2.1 Mobility and transit integration

Studies on mobility behavior and transit integration show mixed results regarding the role of micromobility in urban transportation. Some studies argue that shared micromobility can rival PT (Munkácsy et al., 2024), while others show that users integrate both types of transportation in their mobility behavior (Cui & Zhang, 2024; Roig-Costa et al., 2024). Here, shared micromobility is often cited to provide a solution to the FM/LM problem, as it helps users bridge the gap between their homes or workplaces and PT stops (Cui & Zhang, 2024; Yin et al., 2024). Looking at BS only, a systematic review from last year by Ye et al. (2024) also concludes that BS has a mixed impact on PT. While it increases commuter train ridership, it reduces walking and bus ridership. Although there seems to be a shift: This substitution for PT is decreasing while the replacement of car trips is increasing (Ye et al., 2024).

However, studies show that whether shared micromobility supplements or replaces PT depends on several factors, including the type of vehicle, the type of system, the time of day, the location, trip purpose and length of the trip and users' personalities. These factors are explained in more detail below. Unfortunately, studies are not available for all aspects and vehicle types.

First, the relationship between BS and PT varies by context**.** On weekdays, BS and PT are primarily complementary, particularly for commuting, whereas on weekends, they tend to function as substitutes (Ye et al., 2024). According to Saltykova et al. (2022), whether BS supplements or replaces the PT system also depends on the time of day. Substitute trips are mostly made during active daytime hours between 6:00 am and 9:00 pm, while complementary trips are made before 6:00 am and after 9:00 pm when PT is limited (Saltykova et al., 2022). Yu et al. (2024) have also shown that BS is used at night to reach the last or first PT. Or to avoid the longer waiting times due to the lower frequency of PT at night. However, if there are no PT systems available in cities at night, BS is a safe and cost-effective substitute for getting home. Cabs are usually very expensive. In addition, cycling offers more personal safety than walking (Yu et al., 2024).

Second, location also influences whether micromobility sharing supplements or replaces PT. Chi et al. (2023) highlight that in densely populated urban areas, BS often replaces short bus trips, competing with PT. In contrast, in suburban or less densely populated regions, BS enhances transit connectivity by improving FM/LM access to bus and rail lines (Chi et al., 2023). In city centers, e-scooters are used for connections to PT or for the journey to school or work. Although this does not apply to suburban areas as the number of e-scooter trips tends to decrease the further one moves away from the city center (Yin et al., 2024). However, interest in micromobility sharing is high in suburban areas (Soltani et al., 2022). Hence, encouraging this mode of travel could improve the extent to which it integrates with PT by linking important locations like stations and schools (Soltani et al., 2022) and thus increase the transit systems' catchment area (Chi et al., 2023). Thus, while BS may discourage PT use in cities with shorter trip lengths, it can strengthen transit networks in suburban settings (Chi et al., 2023).

Third, the integration of shared micromobility into the PT system also depends on the system type. Cheng et al. (2023) found that FF BS is used more frequently than SB BS as a feeder mode to the metro, though they note this may be influenced by differences in the scale of the systems examined. According to F. Jin et al. (2024), FF BS represents a paradigm shift by providing more flexible, end-to-end connections that bridge gaps in PT networks. They discovered that a 1% increase in FF bike rides results in a 0.35% rise in subway traffic, demonstrating its complementary role. By addressing the FM/LM problem, FF BS makes PT more appealing and encourages greener mobility options (F. Jin et al., 2024). In addition, BS improves the resilience of urban transport in the event of unexpected rail service disruptions (Ye et al., 2024).

Regarding the purpose and length of trips, there seem to be differences regarding the type of vehicle. While BS is mostly used for commuting and the FM/LM (A. Li et al., 2022; Ye et al., 2024), e-scooters seem to be used for leisure, recreation and sightseeing activities (Bozzi & Aguilera, 2021; A. Li et al., 2022). Roig-Costa et al. (2024) in general found that shared vehicles are used more for leisure trips and private ones for commutes due to the unpredictability of shared vehicle availability. Regarding the trip length, research shows that bikes and e-scooters are especially useful for short-distance travel (Mubiru & Westerholt, 2024). E-bikes on the other hand, are predominantly utilized for extended trips and time with an increased frequency of use and a greater network resulting in higher utilization and turnover rates (Q. Li et al., 2024). Bozzi and Aguilera (2021), who looked closer at e-scooter trip lengths showed that these distances are usually too short to call a cab or use PT, but also too long to walk. Shared e-scooters could therefore fill a gap in environmentally friendly short-distance transportation, which is currently largely covered by car (Bozzi & Aguilera, 2021).

Lastly, the use of micromobility sharing also depends on personal preferences, values and sociodemographic characteristics. Gkavra et al. (2025) discovered that the majority of shared micromobility users had fewer limitations on mode preferences, as they use both private and shared vehicles for both motorized and active travel as well as PT and desire diversity. This group, called the *mobility chameleons*, accounts for around 30% of the population (Gkavra et al., 2025). In general, BS is appreciated for its convenience of transportation and users typically regard themselves as mindful of the environment (Guo et al., 2023). Therefore, BS helps their goal of decreasing both traffic congestion and emissions (Zhao et al., 2024). Users are knowledgeable about technology (Zhao et al., 2024) and seem to value fitness (Soltani et al., 2022). Whereby e-scooters are also suitable for people who are unable or unwilling to exert themselves physically, which can attract new users to the shared use of micromobility (Bozzi & Aguilera, 2021). Regarding socio-demographic characteristics Soltani et al. (2022) and Guo et al. (2023) came to similar conclusions: regardless of gender, people with low incomes and high levels of education, possibly students, are the main users of BS programs. On the other hand, the study by Zhao et al. (2024) found that high-income respondents are more likely to use BS consistently, with a high level of education still being an important factor for usage. Furthermore, Guo et al. (2023) found that female users are more likely to use BS for combined trips with PT than for single trips (Guo et al., 2023). ESS users differ from BS users in that they are predominantly young men (Oeschger et al., 2025) with a high level of education (Bozzi & Aguilera, 2021). A survey conducted in Braga, Czech Republic, as well, revealed that gender significantly impacts shared e-scooter utilization, particularly in contexts where mobility conditions are constrained, leading to a decline in female ridership (Dias et al., 2024). One potential explanation for this gender disparity is differing attitudes toward safety (Drimlová et al., 2024). Drimlová et al. (2024) found that e-scooter users generally feel safe, whereas non-users, who often perceive e-scooters as unsafe, tend to be deterred from using them. This discrepancy may stem from the fact that young men, the predominant users of e-scooters, typically have a lower perception of risk, while non-users, lacking experience, may feel more uncertain. Furthermore, the unpredictable nature of e-scooters switching between different traffic categories, in conjunction with adverse experiences as pedestrians or drivers, can serve to reinforce safety concerns (Drimlová et al., 2024). Consequently, individuals who place a high value on safety are more likely to opt for PT or private vehicles instead (Soltani et al., 2022). These safety concerns are not limited to e-scooters. A broader analysis of shared mobility systems found that non-users of both BS and ESS frequently cite external factors as barriers, particularly inadequate infrastructure and the perceived convenience of other forms of transport (Filipe Teixeira et al., 2023). According to the authors, key deterrents include safety risks associated with riding in mixed traffic, poor road conditions, and the lack of dedicated bike lanes. These factors are particularly pronounced in car-dominated cities, where shared micromobility users often feel vulnerable in the absence of protected infrastructure (Filipe Teixeira et al., 2023). While the general barriers to both BS and ESS are similar, e-scooters are more often perceived negatively. Respondents describe them as expensive, impractical for carrying goods, and dangerous (Filipe Teixeira et al., 2023). This resistance may be attributed to the relative novelty of ESS, which has yet to be fully integrated into existing transport networks and led to calls for restrictions or bans (Filipe Teixeira et al., 2023). Consequently, to enhance the utilization of e-scooter usage, the implementation of dedicated infrastructure is necessary (Dias et al., 2024). In addition to this, the creation of zones where micromobility is prioritized over automobiles is essential (Dias et al., 2024). Furthermore, the augmentation of parking facilities for e-scooters must be considered (Dias et al., 2024).

Research shows that CBS leads to different mobility behavior and does not seem to be dependent on these aspects. Since they fulfill different needs by enabling people to carry goods, they can fill important gaps in the sustainable transport market (Marincek et al., 2024). Marincek et al. (2024) found that cargo bikes were used mainly to reduce car use, carry children and as a health-promoting activity. According to Bissel and Becker (2024) CBS offer cost savings, convenience and environmental benefits. CBS users perceive cargo bikes as superior in terms of price, flexibility, symbolic value (e.g. being part of a movement, social recognition) and affective benefits (e.g. less stress, greater freedom). Thus, they have been found to reduce car ownership by 7.4% to 18.1%. However, the car is still favored for reasons of road safety, speed, comfort and weather protection (Bissel & Becker, 2024). Although CBS is used less frequently than private cargo bikes, it appeals to a wider audience – especially those who do not require frequent mass transport, who are put off by high purchase costs or a lack of parking space, or who want to try out cargo bikes before deciding on their own car (Bissel & Becker, 2024). In addition, although CBS does not significantly reduce the number of car journeys, it makes car-free living easier (Marincek et al., 2024). Acceptance could be further promoted through subsidies, improved bicycle design (e.g. better weather protection) and strategic communication (Bissel & Becker, 2024). Emphasizing cost savings compared to cars, rather than absolute prices or additional costs compared to conventional bicycles, could be particularly effective. In addition, changing societal perceptions and norms regarding cars and cargo bikes could promote CBS acceptance (Bissel & Becker, 2024).

2.2.2 Environmental sustainability

Like transit integration, the environmental impact of shared micromobility systems also varies significantly depending on several factors, including mode substitution, fleet management, lifecycle emissions, and energy sources. While these systems have the potential to reduce emissions, their actual environmental benefit depends on their operational characteristics and usage patterns.

One of the main factors determining the sustainability of shared micromobility systems is the extent to which they replace car trips rather than other low-carbon transport modes. For BS this relationship has been thoroughly examined in a number of studies, many coming to the conclusion that this system significantly reduces energy consumption and GHG emissions, but the magnitude of these benefits depends on which modes it replaces (Y. Chen et al., 2024; Saltykova et al., 2022). Y. Chen et al. (2022) analyzed 48 million SB BS trips over three years. By switching from several other modes of transport like bus riding, walking and driving a car, BS reduced carbon emissions by 30,070 tons, nitrogen oxides by 80 tons and saved 13,370 tons of oil equivalent (Y. Chen et al., 2022). Saltykova et al. (2022) further explored the impact of FF BS systems. When trips replace only cars and walking, 4,125.13 kg of CO_2 and 19,964.31l of fuel are saved. However, when FF BS replaces cars, buses, subways, and walking, the savings drop to 2,564.31 kg of CO_2 and 13,198.68l of fuel because buses and subways are already more environmentally friendly than cars (Saltykova et al., 2022). Comparative studies even suggest that BS systems are more sustainable than public bus transport in terms of carbon emissions (S. Zhang et al., 2021). E-scooters, on the other hand, can only have a net decrease in the environmental effect if they replace cars completely (Bozzi & Aguilera, 2021). Thus, as they mainly replace walking, cycling, or PT trips instead of car trips, they increase emissions rather than reducing them (Bozzi & Aguilera, 2021; Echeverría-Su et al., 2023). E-bikes, although often replacing PT and bike trips rather than car trips contribute to emission reductions on average by 108–120g per kilometers (Q. Li et al., 2023).

In addition to mode substitution, the overall environmental impact of shared micromobility systems largely depends on the production, use and disposal of vehicles. 28% to

90% of emissions are attributable to production and 10% to 70% to use (Arbeláez Vélez, 2024).

In the use phase, the factor that has the biggest negative impact on the environmental friendliness is fleet management, i.e. redistributing vehicles to specific locations and maintenance practices (Arbeláez Vélez, 2024). This is usually done by private companies, which often use conventional gasoline-powered vehicles (Bozzi & Aguilera, 2021). As FF systems usually have a higher demand for rebalancing than SB systems, the environmental impact of these two systems varies (Y. Chen et al., 2024). Therefore, a FF system leads to higher emissions of 115 g CO_2e[1]/km compared to the SB system with 65 g CO_2e/km (Y. Chen et al., 2024). This is in line with the findings of Arbeláez Vélez (2024), who conducted a systematic literature review on the environmental impacts of shared mobility and concluded that for a SB system emissions ranged from 57 to 68 g CO_2e/km and for a FF system from 118 to 129 g CO_2e/km. Despite these higher operational emissions of FF systems, they are gaining popularity because they eliminate the need for physical docking stations, reducing the resources required for infrastructure (Y. Chen et al., 2024). The percentage of emissions attributable to the manufacture of docks for SB BS systems varies between studies: around 70 % of emissions in the study of Y. Chen et al. (2024), 23% in the study of Arbeláez Vélez (2024). However, in both cases this is not an insignificant influence. Taking this into account, the “total normalized environmental impact” (TNEI) for FF systems is 1.49E-04 unit/bike-km compared to the TNEI of 2.30E-04 unit/bike-km for SB systems (Y. Chen et al., 2024).

For ESS Arbeláez Vélez (2024) found that emissions ranged from 61 to 109 g CO_2e/km, being higher than that of SB systems, but lower than FF systems. For this vehicle the materials and manufacturing process, mainly for the lithium-ion battery and the aluminum frame have the most environmental effect (Bozzi & Aguilera, 2021; Echeverría-Su et al., 2023). In the case of Lima, Peru the manufacturing process accounts for around 76% of their total environmental impact for global warming and even more for other environmental impacts like land acidification (Echeverría-Su et al., 2023). Because of this high impact of the manufacturing stage, all authors conclude that the lifespan becomes the critical factor for e-scooter’s environmental impact compared to

[1] CO_2e stands for carbon dioxide equivalent. It is a standard metric for comparing greenhouse gas emissions based on their global warming potential (Eurostat, 2025).

other modes of transportation (Bozzi & Aguilera, 2021; Echeverría-Su et al., 2023). According to Echeverría-Su et al. (2023), the lifetime must be more than 2,330km to be more environmentally friendly than buses, assuming a high percentage of renewable energy is used for charging. In addition, the energy mix used to charge the batteries is another important factor for the environmental sustainability of electric vehicles (Kontar et al., 2022) and is still responsible for a large amount of emissions (Bozzi & Aguilera, 2021). Although various studies have suggested ways to make this process more sustainable. Proposals include public photovoltaic charging stations (Bozzi & Aguilera, 2021), using battery swapping stations where users replace empty batteries with charged ones, or replacing only the battery instead of the entire vehicle (Finke et al., 2022). In addition, idle electricity wastage from charging infrastructure is a significant source of inefficiency in ESS systems and accounts for around 30% of the total electricity (Li et al., 2022). Meshulam et al. (2024) concluded that the majority of papers report negative results for the environmental sustainability of e-scooters due to their short lifespan and high emissions from production and use phase (Meshulam et al., 2024).

In addition, FF systems are more susceptible to vandalism, which may increase their environmental impact if more vehicles than anticipated are needed to replace damaged ones (Y. Chen et al., 2024). Poor treatment and vandalism, which shortens the lifespan of vehicles is also a reason why both shared e-scooters and bikes have a bigger negative impact over the course of their life cycle than privately owned ones (Arbeláez Vélez, 2024; Bozzi & Aguilera, 2021). Therefore, Arbeláez Vélez (2024) found that emissions for a privately owned bike sum up to 7.47 to 11.7 g CO_2e/km, being way lower than for any of the shared systems. End-of-life processes have a relatively low impact on the environmental sustainability (Arbeláez Vélez, 2024). According to Chen et al. (2024) with incineration after recycling a bike produces 34.56 kg of CO_2 annually, compared to 40.12 kg from natural decay (Y. Chen et al., 2024).

However, Sun and Ertz (2022) come to different conclusions. In their study, they compare the GHG emissions of shared micromobility models such as BS and ESS with the average GHG emissions of traditional means of transportation such as private cars and motorcycles. To do this, they use mode substitution rates derived from urban traffic data. They conclude that only SB BS leads to a reduction in CO_2e/km. All other forms of shared micromobility, such as FF ESS, FF EBS and FF BS, lead to an increase in this. This is mainly due to the low usage rate, which could be increased by actively encouraging the public to use these systems (Sun & Ertz, 2022).

This shows that the environmental impact of BS depends on several factors, including the type of system and lifecycle management practices. Although studies vary regarding the environmental impact of different practices in the use phase of micromobility sharing, they largely agree that the distance travelled to rebalance vehicles, the type of vehicle used for rebalancing and the energy used for recharging are the most important factors (Arbeláez Vélez, 2024). In addition, the efficiency of the shared micromobility system should be improved by building fleets of an appropriate size and increasing usage rates (Sun & Ertz, 2022).

2.2.3 Social sustainability

Shared mobility solutions not only provide environmental benefits but also address important social aspects. It enhances accessibility across time and space, reduces costs, and promotes equity (Chi et al., 2023; Storme et al., 2021). However, despite these benefits, shared mobility systems face challenges in terms of unequal access, digitalization, security and infrastructure constraints.

In this context, shared mobility systems emerge as a cost-effective alternative to owning private vehicles without the costs of ownership, offering a flexible solution for people with varying economic resources and possibilities (Chi et al., 2023; Storme et al., 2021). In addition, they have the benefit of reducing concerns over theft by allowing users to leave their vehicle at various locations (Kwiatkowski, 2021). This feature can encourage more people to use shared systems instead of private ones (Guo et al., 2023). Moreover, BS programs increase accessibility for those who are too young to operate motorized vehicles, which enables them to have a certain level of independence in mobility and an alternative to PT (Giuffrida et al., 2023). In addition, it played an important role in urban mobility during the COVID-19 pandemic, as this period highlighted the limits of relying solely on PT and the need for private vehicles in times of crisis (Cui & Zhang, 2024). In this regard, Azimi et al. (2024) found in their study in Houston, Texas that in 2020 trips on a shared bikes increased by 30.6%, with longer trips becoming more common and overall trip durations increasing by 73.52%. BS member trips stayed constant, but non-member trips significantly increased. Thus, the pandemic highlighted the versatility of shared micromobility and the significance of bicycle and pedestrian mobility in urban areas (Azimi et al., 2024). In addition to its practical benefits, shared micromobility can also contribute to social cohesion (An et al., 2024). An et al. (2024) state that an increased utilization of BS has been associated with elevated levels of social trust and cooperation. Conversely, the sharing of e-scooters has been demonstrated to foster network bonding. These systems can improve well-being and social inclusion by enhancing users' social capital and mitigating inequalities in accessibility (An et al., 2024).

Despite the apparent advantages of shared mobility, it does not inherently guarantee equity. There are several key challenges that need to be addressed. First, it is important to note that shared micromobility systems are not inherently cheaper. According to Roig-Costa et al. (2024) privately owned e-scooters have rapidly gained popularity among socioeconomically disadvantaged populations due to lower costs as well as fewer technological and informational barriers than shared ones. In particular, bans on FF ESS have led to a decline in purchase prices (Roig-Costa et al., 2024). Second, following Goralzik et al. (2022) accessibility remains a challenge, especially for people with multiple, physical or visual disabilities. With many shared mobility services, the user must take an active role, such as getting on the vehicle and maintaining balance. This requires perceptual ability and physical coordination, which is a barrier for people with reduced mobility (Goralzik et al., 2022). Second, access depends on the user’s knowledge of vehicle availability and the surrounding infrastructure, like cycle tracks (Giuffrida et al., 2023). This means that shared mobility requires users to possess a certain level of knowledge about the system to benefit fully from it (Guo et al., 2023). Additionally, shared mobility systems vary in their levels of user freedom, with FF models providing greater flexibility than SB systems (Guo et al., 2023). Studies show that users familiar with PT tend to navigate shared mobility services more effectively, as they are accustomed to understanding schedules, routes, and fares (Mock & Wankat, 2024). The digital divide further exacerbates accessibility issues. People who are not familiar with digital platforms, such as older adults, often struggle to use them effectively (Mubiru & Westerholt, 2024). On the other hand, host-based CBS services have encountered difficulties due to their low level of digitalization (Mock & Wankat, 2024). Users reported difficulties integrating these services into their daily routines because they had to schedule appointments, manage keys, and handle payments manually (Mock & Wankat, 2024). As a result, it must be ensured that all population groups have equal access to transport options (Giuffrida et al., 2023). This concept, referred to as vertical or social equity, emphasizes that the distribution of costs and benefits should favor disadvantaged groups (J. Gao & Li, 2024). In essence, transportation policies should give priority to individuals facing socioeconomic disadvantages, such as lower income, limited education, older age, gender disparities, or ethnic marginalization (J. Gao & Li, 2024).

Horizontal/spatial equity on the other hand, is about the distribution of systems across different spatial locations and ensuring that people in different urban regions have access to mobility services of the same quality (J. Gao & Li, 2024). In contrast to PT, shared micromobility is often run by private sector businesses, who usually concentrate their services in densely populated urban areas to maximize profits (J. Gao & Li, 2024). According to S. T. Jin and Sui (2024) it is therefore important to involve disadvantaged communities in the planning and management of micromobility sharing systems. To improve the service, more stations can be set up in disadvantaged communities. In the case of a privately organized systems, the municipal side can strengthen the expansion there through regulations and requirements (S. T. Jin & Sui, 2024).

Beyond equity, active mobility solutions improve both urban health and public well-being (Giuffrida et al., 2023; Kwiatkowski, 2021). E-scooter journeys, on the other hand, which are not a form of active mobility but often replace it, consume around nine times less energy than walking and four times less energy than cycling and therefore have a negative impact on public health (Bozzi & Aguilera, 2021). Additionally, concerns have been raised regarding the safety of ESS. Incorrectly parked vehicles can block streets and footpaths, creating obstacles for pedestrians, especially the elderly, who may trip over FF e-scooters left in inappropriate locations (Mubiru & Westerholt, 2024). Although studies on this topic are limited, it was shown that active mobility has benefits for one's mental health (Scrivano et al., 2024). According to Z. Chen et al. (2022) active travel modes like cycling and walking tend to offer greater fulfillment than cars or PT. FF BS tends to provide higher travel satisfaction compared to general cycling, especially when used as the principal mean of transportation. However, time pressure when changing or transferring on the FM/LM can reduce satisfaction, similar to PT. In addition, longer waiting times for access to FF bikes are associated with lower satisfaction (Z. Chen et al., 2022).

2.2.4 Urban identity and attractiveness

Micromobility sharing systems also impact urban identity and attractiveness by enhancing accessibility and contributing to the visual appeal of neighborhoods. These systems play a key role in shaping how cities are perceived by both residents and tourists as described in more detail in the following paragraphs.

Jaber and Csonka (2024) compiled a set of factors that determine a city's preparedness for adopting an EBS system. These factors were identified through a literature review and expert assessments. Their findings highlight the significance of demographic characteristics, such as the proportion of young residents, in shaping the feasibility of implementing such systems. Additionally, the extent to which cycling is established as a common mode of transportation, complemented by a local culture that encourages biking, serves as a supportive factor and can be reflected in the city's cycling modal share (Jaber & Csonka, 2024).

In addition, modelling results of Hurtubia et al. (2021) show that BS systems regardless of the type are generally viewed positively by respondents. This positive perception is not only due to their role in improving urban accessibility, but also because they contribute to a more modern and visually appealing neighborhood (Hurtubia et al., 2021).

Moreover, in urban areas BS also serves as a practical mobility option for tourists (Kwiatkowski, 2021; Yang et al., 2021). Therefore it should be considered in tourism planning, particularly to improve access to less-connected attractions (Yang et al., 2021). Yang et al. (2021) found that for tourists in urban destinations, BS and PT often complement each other, especially when traffic from private cars is a problem. Tru and Ngoc (2024) who examined tourists' preferences for BS in a Vietnamese city found that 24/7 availability is the most critical factor influencing usage. The results indicated that a SB system was the preferred choice among respondents. Additionally, the study identified pricing, as well as the time required to access and return the bikes, as key factors in their decision-making (Tru & Ngoc, 2024).

2.2.5 Management and organization

The successful implementation and sustainability of shared mobility services depends on efficient management and organization (Bach et al., 2023; L. Zhang et al., 2015). In addition, these systems require careful financial planning and operational efficiency to ensure their long-term viability (K. Gao et al., 2021; Papaix et al., 2023). However, various challenges like economic feasibility, the legal framework and operational logistics need to be overcome (Krauss et al., 2022).

According to Storme et al. (2021), shared mobility systems present service providers with significant business opportunities and the potential for enhanced operational efficiency. It has been demonstrated that such systems foster collaboration among various stakeholders, which can improve profitability and service delivery (Storme et al., 2021). Although, Zhu et al. (2022) argue that effective fleet management and strategic station placement are essential for maximizing usability and efficiency. BS providers need to identify high-demand locations, such as workplaces, recreational areas, government offices, and educational institutions, ensuring that enough space to park the vehicle is available at these destinations. Collaborating with local management to allow cyclists to park their bicycles inside of premises can further improve accessibility (Zhu et al., 2022). Moreover, micromobility services like BS and ESS are cost-effective solutions for underserved areas, as they can operate without human drivers, significantly reducing labor costs (J. Gao & Li, 2024). Thus, these services fill transit gaps where traditional transportation options may not be economically viable (J. Gao & Li, 2024). Krauss et al. (2022), who studied the utility of shared mobility services showed that even if the cost of using the system increases, a decline in users is rather unlikely. The cost structure of the business models therefore offers a certain degree of freedom, which can be very helpful for providers who have yet to demonstrate that these services can be offered with a viable business model (Krauss et al., 2022). Additionally, the information collected from these systems via GPS can provide valuable insights for cities and help them with infrastructure improvements, like planning and upkeep of bike paths or assessing the demand for parking spots (Brown et al., 2020). Access to this data would thereby support their decision-making processes (Brown et al., 2020).

However, service providers must also cope with the complexity of fleet management, which is particularly necessary in micromobility systems due to fluctuating demand in different urban areas (Krauss et al., 2022). In addition, the financial burden of setting up and maintaining shared mobility systems is one of the main problems, especially in the initial stages when demand may be low. Substantial investments in infrastructure, operations, and maintenance can strain the budget of governments and service providers (K. Gao et al., 2021; Papaix et al., 2023). Moreover, short lifecycle and higher maintenance costs can lead to high operational costs, particularly for ESS systems and pose additional challenges for long-term economic sustainability (Mubiru & Westerholt, 2024). ESS systems have also resulted in a significant increase in injuries, contributing to higher healthcare costs (Naaseh et al., 2024).

From a transportation planning perspective, a proactive and supportive local government is crucial for the success and long-term sustainability of shared mobility services (L. Zhang et al., 2015). L. Zhang et al. (2015) showed that the most effective business models involve government investment with high subsidy components. Systems run by the private sector and mainly funded by advertising were less effective. Thus, investments must be made in supporting infrastructure, such as cycle paths, and citizens must be involved through participatory processes. Together with other authorities like the police the government must enforce proper usage (L. Zhang et al., 2015). According to Bach et al. (2023) public private partnerships (PPP), where the public sector plays a significant role in management and regulation, are considered the most effective model for shared mobility systems. However, such models require considerable political will and financial resources and are therefore more feasible in cities that have already recognized the positive effects of shared mobility (Bach et al., 2023).

2.2.6 Space, order and traffic

The integration of shared micromobility into urban environments has raised critical questions regarding the allocation of public space, the organization of mobility flows and the overall impact on road safety and urban order. As cities adapt to these new mobility options, they face challenges in terms of infrastructure, parking, pedestrian safety and regulatory frameworks that balance accessibility and order.

One significant obstacle that communities encounter when implementing shared micromobility services is determining where to park and operate these vehicles. Public discourse often highlights issues related to cluttered sidewalks and accessibility concerns for pedestrians and wheelchair users (Brown et al., 2020). However, empirical studies suggest that the actual obstruction caused by parked bikes and scooters may be lower than perceived (Brown et al., 2020). Brown et al. (2020), who investigated parking practices and violations in five US cities, concluded that 99.2% of parked bikes and e-scooters did not block pedestrian walkways in the cases observed. So, although they might be considered visually annoying by some people, these vehicles rarely created accessibility problems (Brown et al., 2020). Nevertheless, inappropriate parking remains a key point of contention. Surveys and expert interviews suggest that most conflicts between pedestrians and e-scooter users are due to inappropriate parking practices (Hardinghaus et al., 2024). Additionally, these systems may struggle with poor maintenance and abandoned bikes cluttering sidewalks (Papaix et al., 2023).

To mitigate these issues, cities may need to enforce designated parking areas, especially near PT hubs, where shared micromobility can serve as a last-mile solution to strengthen multimodal transport networks (Hardinghaus et al., 2024; Krauss et al., 2022). Geofencing strategies could be one option to ensure that pick-up and parking only take place in specific zones, reducing the clutter associated with FF systems (Krauss et al., 2022).

Moreover, the introduction of e-scooters and shared bikes has influenced urban traffic dynamics, both in terms of safety and interaction with other road users. As noted by Naaseh et al. (2024) e-scooter use has also led to a sharp rise in accidents, many of which involve riders who do not wear protective gear or are under the influence of alcohol or drugs. Pedestrians and cyclists are also at risk, either from collisions with e-scooter riders or from tripping over e-scooters parked randomly (Naaseh et al., 2024). Hardinghaus et al. (2024) identified major danger hotspots in inner-city areas, particularly at important intersections where walkers, cyclists, PT passengers, automobiles, and e-scooter users often interact (Hardinghaus et al., 2024). E-scooter use on sidewalks increases this risk, endangering both riders and pedestrians (Naaseh et al., 2024). Despite these concerns, Bozzi and Aguilera (2021) found that riding a bicycle or e-scooter carries a lower risk of road death than riding a car or motorcycle. Although the risk of hospitalization may be higher with e-scooters, it is no more likely that a ride on an e-scooter will lead to a traffic fatality than a ride on a bicycle. In addition, as riders get better at navigating city traffic and drivers get used to the new modes of transportation, e-scooters will get safer overall. As the authors in general cite insecurity as a primary deterrent to e-scooter use, this is an important insight. In addition, they acknowledge that e-scooters might promote infrastructural change leading towards an environment of cycling and walking (Bozzi & Aguilera, 2021). In addition, to improve safety for vulnerable road users, investing in high-quality cycling infrastructure is essential (Hardinghaus et al., 2024).

In their systematic review Y. Zhang et al. (2023) found that shared micromobility creates new spatial challenges that require infrastructure adaptation. Micromobility users compete with other modes of transport for parking spaces, necessitating the installation of dedicated parking facilities. Because of differences in vehicle sizes and speeds, different types of micromobility interact differently with the built environment. E-bikes and e-scooters, for example, are faster than traditional bicycles and interact with both motorized and non-motorized traffic, creating new issues for traffic control. While shared micromobility poses immediate problems to urban order, some studies suggest that it might also serve as a catalyst for larger infrastructure changes. In the long run, these modes may induce changes in land use and urban architecture, such as extending transit-oriented developments and boosting the catchment areas of metro stations (Y. Zhang et al., 2023). Thus, following Y. Zhang et al. (2023), studies highlight both possible benefits and challenges. The majority of the 59 examined studies find negative consequences, underlining the need to alter public places to better support micromobility. However, other studies imply that the development of micromobility might help to improve the current urban infrastructure (Y. Zhang et al., 2023).

Considering the aforementioned problems, regulatory controls on shared micromobility, especially e-scooters, have gotten increasingly strict in recent years, with some cities even enforcing outright bans (An et al., 2024). While these attempts address concerns about public space use and safety, governments should also consider the possible advantages of micromobility sharing for urban inhabitants (An et al., 2024).

2.3 Q-studies in mobility research

The Q-method is an increasingly prevalent approach within the domain of environmental research (Sneegas et al., 2021), especially for conservation topics (Zabala et al., 2018). In mobility research, Q-methodology has so far seen limited application. A review of the literature for this thesis revealed only ten relevant studies, five of them published before 2020: Cools et al. (2009); Hickman et al. (2018); Rajé (2007); van Duin et al. (2018); van Exel et al. (2004). More recently, two were published in 2020 and three in the past year. Despite the lack of studies using the Q-method in this area of research, its use seems to have increased recently.

In 2020 Brůhová Foltýnová et al. examine differing stakeholder definitions of sustainable urban mobility, highlighting challenges in achieving consensus. Juschten et al. (2020) explore how cultural and institutional factors shape New Zealand's car-dependent travel habits, focusing on sustainable tourism perspectives. Eccarius and Liu (2024) analyze future sustainability leaders' views on transport in Taiwan, offering insights into emerging priorities. Nikitas et al. (2024) identify stakeholder groups advocating for Mobility-as-a-Service, emphasizing alignment for implementation success. Obersteiner et al. (2024) explore discourse complexities in transport infrastructure debates in Vienna, moving beyond polarized narratives.

The reviewed studies cover various mobility-related topics, but none focuses on shared micromobility. This highlights the need for further research by applying Q-methodology to new areas, helping to expand knowledge in this field.

3 Methodology

According to Webler et al. (2009) Q-studies can be divided into seven steps: (1) determining the objectives, (2) creating the concourse, (3) creating the Q-statements, (4) finding participants, (5) doing the Q-sorts, (6) finding social perspectives using factor analysis, (7) findings and recommendations.

The initial step was completed during the design and planning of the present research, as outlined in the introduction (Chapter 1). The following sections of the third chapter provide comprehensive explanations of the steps two to six, which entail the preparation and execution of the Q-sorts as well as the data analysis process. In the seventh and final step of the process, social perspectives are derived from the data. These perspectives are presented in detail in Chapter 4.

3.1 Media analysis

Since Q-methodology is a form of discourse analysis, a fundamental step in any Q-study is the identification and reconstruction of the discourse (Webler et al., 2009). Following Webler et al. (2009) this discourse typically includes perspectives from academic literature and media sources such as newspapers and interviews. It is crucial that the discourse encompasses a wide range of viewpoints, ensuring a comprehensive and thorough understanding of the subject matter. From this broad discussion, a carefully curated set of Q-statements, the Q-sample is derived (Webler et al., 2009). This final set should be as representative as possible of the full spectrum of perspectives (Watts & Stenner, 2005).

To establish the discourse surrounding micromobility sharing in Graz, various sources were analyzed. Since conducting interviews for this step is beyond the scope of this master's thesis, a media analysis was conducted to capture the perspectives of key decision-makers in Graz. Additionally, scientific literature was reviewed to examine how the discourse in Graz aligns with broader academic discussions. For this purpose, a thematic media analysis was carried out, focusing on Graz and selected media from Styria. Thematic analysis was selected as a methodological approach for the systematic identification, organization, and interpretation of patterns within qualitative data (Braun & Clarke, 2006). This approach is particularly effective for the analysis of complex and diverse datasets, such as news articles (Braun & Clarke, 2006). Thus, it is a valuable tool for comparing themes found in scientific literature with those specific to

Graz. However, it is important to acknowledge that the media analysis is not the primary focus of this research. Therefore, it was not conducted systematically. While a systematic approach is generally preferable in scientific research, the aim here is to gain sufficient understanding of the discourse in Graz to compare it with the broader academic discussion.

Thus, the question guiding this media analysis is: *"What is being discussed about the topic of micromobility sharing in Graz?"*. The following approach was taken to answer this question: Relevant newspapers were identified using the Styrian Media Directory. Daily newspapers were chosen for the analysis, as they provide timely coverage of current debates and continuously reflect public discourse on micromobility. Subsequently, the websites of the Styrian daily newspapers "Kleine Zeitung" and "Steirerkrone" as well as those of the national newspapers with Styrian editorial offices "Der Standard", "Die Presse", "Kurier" and "Salzburger Nachrichten", were searched for articles on the topic of micromobility sharing. The German search terms "Bikesharing", "Bike sharing", "Fahrradverleih", "Fahrradverleihsystem", "Radverleih", "E-scooter", "Leihscooter", "Leih-Lastenrad", "Lastenradverleih", "Lasten-Bike" and "Cargobike" were used[2]. In addition, the Ecosia search engine was used to search for further articles by entering "search term" + "title of newspaper" + "Graz". This was done without mentioning the newspaper title as well. Finally, "pressreader" was used to search for these terms in the same newspapers to not miss out on any publication or special editions. In an inductive process, the articles found were selected by reading the newspaper articles and seeing whether the topic of "micromobility sharing" was mentioned and whether there was a local reference to Graz and the surrounding area. In addition, duplicates were deleted. In the end, 37 articles from the following newspapers were included: "Der Standard" (3), "Der Grazer" (1), "MeinBezirk" (2) and "Kleine Zeitung Steiermark" (31). A detailed list can be found in appendix A.2. From these articles 76 quotes were taken and used to create the statements. The following six categories were built: (1) environmental sustainability, (2) social sustainability, (3) mobility and transit integration, (4) urban identity and attractiveness, (5) management and organization, (6) space, order and traffic. The media analysis findings suggest that the discourse in Graz closely mirrors that of academic literature, although some differences

[2] "Bikesharing", "Bike sharing", "bike rental", "bike rental system", "bike hire", "e-scooter", "rental scooter", "rental cargo bike", "cargo bike rental", "cargo bike" and "cargo bike"

were identified. The discourse on the environmental aspects of micromobility sharing was less pronounced and less differentiated in Graz than in academic literature. It was particularly striking that BS is generally seen as positive and e-scooter sharing as negative for the environment. Furthermore, no distinction is made between the systems. Social aspects are also not discussed to the same extent as in the academic environment. In contrast, the topic of urban identity was particularly prominent in Graz. With the extensive literature review and media analysis, the concourse surrounding micromobility sharing in Graz is now well-defined, allowing for the creation of a comprehensive and accurate set of Q-statements.

3.2 Q-sample

Following the guideline of Webler et al. (2009), the next step is to create the Q-statements. They were taken mainly from the media analysis and supplemented by the discourse in academic literature. As Q-statements should represent the entire concourse, strategic sampling is carried out (Webler et al., 2009). For this purpose, the statements were systematically edited to avoid similarities between the identified statements and carefully selected (Brůhová Foltýnová et al., 2020). To address precisely one topic at a time, statements that contained multiple opinions were broken up into separate statements, and lengthy statements were shortened without affecting the content (Brůhová Foltýnová et al., 2020). Although in contrast to purely qualitative studies the bias of the researcher is reduced (Zabala, 2014), this selection process might consist of some level of researcher bias and subjectivity (Nikitas et al., 2024). It is, however, limited by adherence to the discourse and complete consideration of its diversity (Robbins & Krueger, 2000). According to Webler et al. (2009) a good Q-statement does not need to be strictly defined but rather should be meaningful and comprehensible. It is okay if they have "excess meaning," so they can be interpreted slightly differently by different people (Webler et al., 2009). A Q-set typically has 20 to 60 statements (Webler et al., 2009). Therefore, the set used in this master thesis, which contains 34 Q-statements, is well in line with good research practice. Table 2 shows the English version of the Q-statements. However, since German is the national language of Austria and both the analyzed newspaper articles were in German and the participants are native German speakers, the Q-statements were originally written and used in German. The original German version is available in appendix A.3.

Table 2: List of Q-statements

Environmental sustainability	
1	A bike sharing system is positive from an environmental point of view.
2	A micromobility sharing system can influence the use of different modes of transportation so that more environmentally friendly alternatives are chosen (modal split shift).
3	Shared cargo bikes offer an environmentally friendly, stress-free alternative to the car by using them for everyday transportation such as shopping, crates of drinks or children.
4	Shared cargo bikes can replace many car journeys.
5	The ecological impact of shared e-scooters is questionable, as their short lifespan leads to increased electronic waste.
6	Shared e-scooters promote the goal of reducing exhaust emissions in the city.
7	With a shared bike, everyday journeys can be made efficiently, environmentally friendly and with exercise.
Social sustainability	
8	With a micromobility sharing system, transportation can be designed as a health-promoting activity.
9	A micromobility sharing system offers a cost-effective alternative to personal ownership and thus helps to reduce social inequality.
Mobility behavior and transport transition	
10	A bike sharing system is a key measure for the mobility transition.
11	A bike sharing system can help to encourage more people to cycle in the city.
12	Shared e-scooters and shared bikes promote the goal of using fewer cars in the city center.
13	Shared e-scooters and shared bikes can bridge the first and last mile to public transport quickly and in an environmentally friendly way, which is often the decisive factor for using public transport.
14	A station-based bike sharing system should offer a supplement to public transport, especially for commuters.
15	Especially at times when there is no public transport, shared e-scooters and shared bikes are a safe and cost-effective alternative to taxis.
16	Shared e-scooters help to reduce the volume of traffic in the city.
17	By using a micromobility sharing system, traffic jams within the city can be reduced.
18	Only pedestrians and public transport users use shared e-scooters, but hardly anyone leaves their car behind to use a shared e-scooter.
19	Shared e-scooters change mobility behavior in a counterproductive way, as trips that are made by foot are now made by e-scooter.
20	The use of shared e-scooters can have a negative impact on a pedestrian-friendly city.
Urban identity and attractiveness	
21	A bicycle-friendly city requires a practical and user-friendly bike sharing system.

22	As a city with a strong cycling culture, Graz should have a bike sharing system.	
23	The installation of a micromobility sharing system would be desirable in order to make Graz more attractive for tourists.	
24	The half of Graz residents who do not own a bike can benefit from a free-floating bike sharing system.	
25	It is in the city's interest to motivate more people to cycle, which includes setting up a bike sharing system.	
26	In Graz, shared bikes are not necessary, as bicycle penetration is very high and almost every household owns at least one bicycle.	
Management and organization		
27	It is unclear who should take over the financing of a micromobility sharing system.	
28	A comprehensive micromobility sharing system could only be financed through advertising revenue.	
29	Clear parking zones must be defined for free-floating shared e-scooters and shared bikes in highly frequented locations to avoid chaos and danger zones.	
30	Precautions such as penalties are necessary to avoid chaos caused by incorrectly parked shared e-scooters and shared bikes.	
Space, order and traffic		
31	Shared e-scooters lying around everywhere should not be allowed in Graz in order to avoid danger zones and conflicts.	
32	Carelessly parked shared e-scooters are an obstacle in public spaces, especially for older people and people with physical disabilities.	
33	Incorrectly parked shared e-scooters and shared bikes often obstruct traffic.	
34	There is no space for a micromobility sharing system in Graz.	

3.3 Q-participants

The participants in a Q-study are strategically sampled (Sneegas et al., 2021), meaning selected in such a way that they represent the diversity of opinion of the target population and because it is assumed that they "have something interesting to say" (Webler et al., 2009, p.9). Thus, to investigate the perspectives on micromobility sharing in Graz, decision-makers and experts that are related to the city will be used as participants. As is common in best practice procedures (Sneegas et al., 2021), the relevant stakeholder groups were identified prior to the study. Inspiration was also drawn from Macioszek et al. (2023), who conducted a stakeholder analysis for e-scooter sharing systems. In the end twelve Q-sorts were conducted with one person from each organization from different stakeholder groups as shown in Table 3.

Table 3: Q-participants

Stakeholder group	**Organization**
Political and regulatory actors of the city of Graz	• Department for Transport Planning • Department for Economic and Tourism Promotion • Department for the Environment
Operators and providers of public transport, mobility sharing and infrastructure	• Planning Management and Infrastructure of Graz Linien • TIM (Provider of the existing sharing system) • Verbundlinie (Styrian transport association)
Interest groups and organizations	• MoveIt (Association for Mobility and Transport in Transformation) • ARGUS Steiermark (bicycle lobby Styria) • Styrian commuter initiative
Consultants or scientists with special expertise	• Institute for urban planning - Graz University of Technology • Institute for roads and transport - Graz University of Technology • Civil engineering office

Participation was voluntary and partially anonymous. This means that while names and specific job titles were anonymized, it remains possible that organizational affiliations could allow for the identification of individual participants. To represent the interview content more clearly in chapter 4, participants were assigned numbers. However, for reasons of anonymity, these numbers do not correspond to the order shown in Table 3. Unfortunately, the gender distribution was skewed, with a higher proportion of men (n = 9; 72.73%) compared to women (n = 3; 27.27%). However, the lower representation of women highlights the male dominance in the transport industry, aligning with previous research (Nikitas et al., 2021). To determine the number of participants required, a ratio of 3:1 between statements and participants is generally used, resulting in a minimum number of 12 participants for 34 statements (Webler et al., 2009). Although this number is at the lower end of the range, it is still sufficient: Webler et al. (2009) argue that the number of Q-participants should be between eight and 30. Watts and Stenner (2005) also argue that a Q-study does not need a large number of participants because its aim is to identify the presence of perspectives, not to produce representative results. In addition, in their systematic review, Sneegas et al. (2021) found that the number of participants in Q-study range from seven to 386.

3.4 Q-sorting

After creating the statements and finding the participants the Q-sorting can be performed. For this the participants must sort the statements into a response chart according to how they match their own beliefs and ideas (Webler et al., 2009). The response chart (see figure 1) is shaped in a normal distribution with nine categories (from -4 to +4). This is favorable because it compels individuals to differentiate between their priorities (Webler et al., 2009).

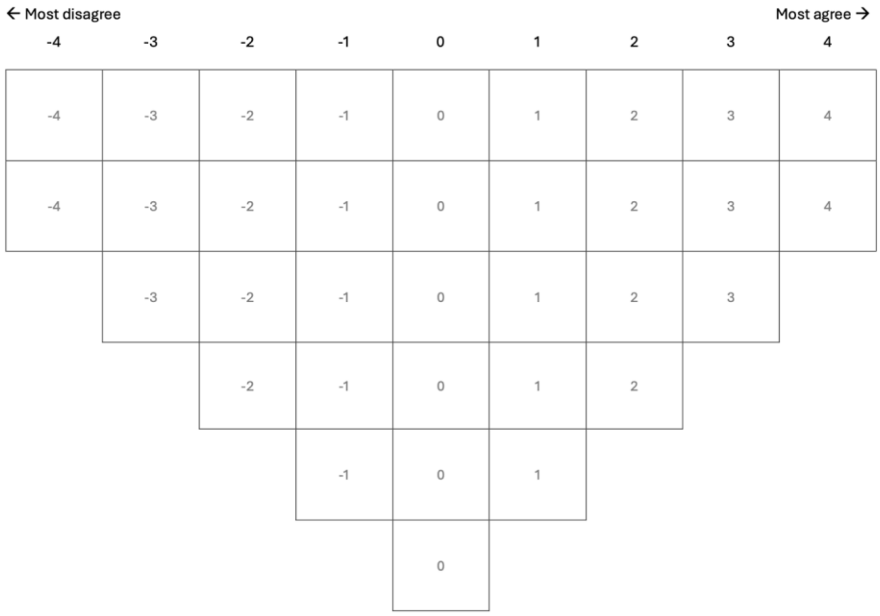


Figure 1: Response chart

The sorting process itself was based on the guideline by Weber et al. (2009) and proceeded as follows. Participants signed a declaration of consent before starting the Q-sorting procedure. Then the topic and the sorting process were explained. In addition, it was emphasized that the participants should not express their personal opinion, but the opinion they have due to their professional position or their position in an interest group. Starting the actual Q-sort process, the participants read through the Q-statements to familiarize themselves with the topic, organize their thoughts and ask any questions that may arise. For some participants, it was easier to pre-sort the statements according to general agreement, general disagreement and neutrality, while others sorted the statements directly into the grid. Normal distribution was enforced. This means that the participants were not allowed to deviate from the grid when sorting (Webler et al., 2009). Once they were satisfied with their sorting, they were asked to place a vertical marker to point out the indifference point between agreement and disagreement, meaning that all statements on the left are disagreed with and all on the right are agreed with (Webler et al., 2009). To improve accuracy and effectiveness and to fully understand the perspectives, participants were encouraged to think aloud, comment on their choices, and in some cases, asked to further explain their thoughts (van Duin et al., 2018; Webler et al., 2009). The process was audio recorded, and notes were taken, as well as a picture of the completed Q-sort. The sorting process took between 30 minutes and one hour and 11 minutes with an average of 42 minutes.

3.5 Data analysis

In the next step, the data was analyzed using KADE, a desktop application developed for the Q-method. The completed Q-sorts were uploaded to the program, which then carried out the calculations. It was chosen to use a principal component analysis (PCA) as this algorithm is the most used kind of factor analysis and considers both commonality among all Q-sorts and specificity of the individual sorts (Webler et al., 2009). A Varimax (i.e. automatic) rotation was carried out due to simplicity and transparency of the methodological approach (Webler et al., 2009). The software then calculated the factor loadings, which are the correlations between each Q-sort and the rotated factors (Eccarius & Liu, 2024). These factor loadings were then automatically flagged at $p<0.05$ to indicate which Q-sorts are most representative of which factor. To ensure reliability and validity of the factors, two general principles were applied to decide on which factors are used: an eigenvalue > 1 and at least two sorts must significantly load onto one factor (Webler et al., 2009). These criteria apply to four out of eight factors. The four factors explain 74% of the variance present in the data. Each factor can be interpreted as a common social perspective resulting from similar sorting of statements among the participants. Through the interpretation of factor differences and commonalities these perspectives are revealed (Watts & Stenner, 2005). The distinguishing features are statements that people from one factor rate significantly higher or lower in comparison to people from another factor, whereas consensus statements are similar between the factors (Watts & Stenner, 2005). Q-sort scores, Z-scores and standard deviations were used to further describe and interpret the factors. Z-scores represent the distance of the sorted statements from the distribution center (Webler et al., 2009). Statements with Z-scores above +1 or below -1 are the most relevant, although fruitful information can also be gained from statements sorted in the indifferent range around zero (Watts & Stenner, 2005). The notes taken during each Q-sort gave further insights and helped to understand the identified perspectives holistically and contextualize the more quantitative results.

4 Social perspectives on micromobility sharing in Graz

This section introduces the identified factors and an analysis of both areas of disagreement and consensus between factors.

4.1 Factors, loadings and correlations

As outlined before, a factor represents a group of individuals who share similar perspectives on a particular topic. Four distinct factors emerged from the analysis: The public transport complementors (Factor A), The e-scooter opponents (Factor B), The regulation advocates (Factor C), The context-conscious supporters (Factor D). The factors were named based on the most defining statements associated with each group. Table 4 shows the correlations between the factors.

Table 4: Correlations between factor scores

	Factor A	Factor B	Factor C	Factor D
Factor A	1	0.1145	0.3883	0.4742
Factor B	0.1145	1	0.0754	0.1961
Factor C	0.3883	0.0754	1	0.3306
Factor D	0.4742	0.1961	0.3306	1

Factor A and Factor D seem to be the most aligned, possibly representing perspectives that share a common overarching belief system. Factor B, however, appears to be the most distinct, meaning it represents a viewpoint that differs significantly from the others. Factor C holds a middle position, showing moderate alignment with both Factors A and D but remaining somewhat separate from Factor B. The defining characteristics of each factor are detailed in Table 5.

Table 5: Main characteristics of factors

	Factor A	Factor B	Factor C	Factor D
No. of Defining Variables	2	5	2	3
Avg. Rel. Coef.	0.8	0.8	0.8	0.8
Composite Reliability	0.889	0.952	0.889	0.923
S.E. of Factor Z-scores	0.333	0.219	0.333	0.277

Table 6 shows how strongly each participant applies to the individual factors. Except for participant 10, all load strongly on only one factor. Participant 10 could be a confounder, a person who loads on two factors, suggesting that this person has a hybrid view (Webler et al., 2009). Due to the slightly higher correlation for factor B, this participant was assigned to this factor.

Table 6: Loadings Table with Defining Participants

Participant number	Factor A	Factor B	Factor C	Factor D
Factor A: The public transport complementors				
P7	0.8644*	-0.1138	0.2092	0.2156
P6	0.7396*	0.2467	0.2414	0.3043
Factor B: The e-scooter opponents				
P2	-0.1223	0.8293*	0.258	0.2552
P9	-0.2066	0.8228*	-0.0824	-0.1683
P3	0.2694	0.7846*	0.0607	-0.0253
P4	0.192	0.7239*	0.0636	0.2032
P10	0.5076	0.5986*	-0.2998	0.1215
Factor C: The regulation advocates				
P11	0.1249	-0.063	0.9204*	0.1138
P12	0.2997	0.3268	0.6675*	0.2979
Factor D: The context-conscious supporters				
P5	0.1708	0.1897	0.1683	0.8321*
P1	0.1029	-0.1166	0.134	0.7705*
P8	0.1989	0.1236	0.0335	0.7064*

Note: The scores indicate the strength and direction of the correlation between the participants' responses and the factors. Asterisks indicate that the participant was marked and can therefore be attributed to the corresponding factor.

Table 7 shows which stakeholder group the participants in the various factors belong to. By comparing this with the factors, the study explores how respondents' backgrounds may influence their perspectives on micromobility sharing concepts.

Table 7: Characteristics of participants in each of the factors

Stakeholder group	Factor A	Factor B	Factor C	Factor D
Political and regulatory actors	0	2	0	1
Operators and providers of public transport, mobility sharing and infrastructure	0	2	0	1
Interest groups and organizations	1	1	0	1

Consultants or scientists with special expertise	1	0	2	0

Table 8 presents a summary of the factor descriptions to offer an overview of the results. The idealized Q-sorts for all four factors can be found in appendix A.4 to A.7. However, the following chapters provide a more detailed explanation of each factor. In the following, the letter “S” refers to a statement from the Q-study, followed by its assigned number (e.g., S14 refers to Statement 14).

Table 8: Summaries of factor descriptions

Factors	Summaries of factor descriptions
A: The public transport complementors	BS serves as a valuable complement to PT, particularly for commuters (S14). Implementing a BS system in Graz is essential (S22). While it encourages more people to cycle (S25), its impact on reducing car usage is likely to be minimal (S18). Micromobility is not at risk of failing due to space constraints (S34). Rather than penalties for e-scooter parking (S30), well-designed infrastructure is key.
B: The e-scooter opponents	E-scooters are an obstacle in public spaces (S32), harming pedestrian-friendly cities (S20). They should be banned in Graz due to their negative impact (S31) and environmental concerns (S5). Penalties are necessary to avoid chaos (S30). A micromobility sharing system is not a key measure for the mobility transition (S10), does not act as a supplement to PT (S14), neither does it reduce traffic (jams) (S16/17).
C: The regulation advocates	BS is suitable for everyday use (S7), motivates people to cycle more (S11), and should be implemented in Graz (S22). However, there is a need for clear parking zones (S29). In addition, it does not influence modal split shift (S2). ESS should be permitted in Graz despite potential conflicts (S31).
D: The context-conscious supporters	Micromobility can encourage sustainable travel choices (S12), influence the modal split shift (S2) and bridge FM/LM gaps (S13). BS is environmentally beneficial (S1) and practical for everyday use (S7). High bike penetration in Graz does not make BS unnecessary (S26), and a lack of space (S34) is not a decisive argument against implementing a micromobility system. However, Graz does not really need one (S22).

4.1.1 Factor A: The public transport complementors

This group sees BS as a useful supplement to PT, particularly for commuters (S14 at +4, distinguishing statement at $p<0.005$)[3]. Therefore, it can also bridge the gap between FM/LM and PT (S13 at +2). However, participant 6 stated that this would be

[3] Participants of Factor A placed statement 14 at +4 in the response chart, indicating strong agreement. For further clarification, refer to the idealized Q-sort of factor A in appendix 3.

more of an option to try out a multimodal trip chain without a private device than a long-term solution. Also, due to this test aspect, the fact that Graz has a high bicycle density (S26 at -3) is not an argument for the group against a rental system. Participant 6 further explains that sometimes the bike is broken, one has visitors or takes the tram in the morning but wants to take the bike after work because the sun is shining. In addition, for them such a system can be a safe and cost-effective alternative to taxis in times when there is no PT available (S15 at +2). During the night, especially as an alternative for women, who might feel unsafe by foot (Participant 6). Therefore, they strongly support having a BS system in Graz (S22 at +4). However, they don't see it as a transformative mobility solution as the impact it may have on mobility behavior is marginal (S2 at 0). Especially in Graz, since the modal split for bike users is already high, as explained by participant 6. They don't see that car use or traffic jams will be reduced (S18 at +3, distinguishing statement at $p<0.005$; S17 at -3). Instead, they argue that shared e-scooters and bikes primarily attract pedestrians and PT users (S18), leading to competition among active mobility modes rather than a shift away from cars. Therefore, e-scooters also have the possibility to change people's behavior in a counterproductive way (S19 at +1). Participant 7 stated that, "e-scooters are something between pedestrians and bicycles. As they do not have their own space, they tend to compete with pedestrians." However, for them this is no reason to totally ban e-scooters in Graz (S31 at -2, distinguishing statement at $p<0.05$).

Although they see that carelessly parked e-scooters can be an obstacle in public spaces (S32 at 1), they, unlike other groups, do not see the need for penalties or strict regulations on e-scooter parking (S30 at -3). They also don't see a lack of space in Graz as a problem (S34 at -4). The placement of these statements was explained as follows:

> From a professional point of view, I reject penalties, as it must be intuitive for road users how they should behave in traffic. And as the traffic image is still dominated by cars, many micromobility users feel unsafe on the road and ride on the pavement. Penalties can therefore help in the short term and act as a push measure. Fundamentally, however, it is about the perception of the traffic space, i.e. a pull measure (Participant 6)

Finally, this group acknowledges that financing is not their field of expertise. This may explain their uncertainty about who should fund a micromobility system (S27 at -1, with both sorts placing the indifference line left of -1). Nonetheless, they reject advertising revenue as a suitable solution (S28 at -4), suggesting they see other funding options as more appropriate.

4.1.2 Factor B: The e-scooter opponents

For those who share the opinions of Factor B named *the e-scooter opponents*, it is especially striking that they take a critical view of e-scooters. For them, e-scooters are an obstacle in public spaces, especially for older people and people with physical disabilities due to improper parking (S32 at +4, distinguishing statement at p<0.0005). They also argue that the use of rental e-scooters can have a negative impact on a pedestrian-friendly city (S20 at +3, distinguishing statement at p<0.0001). Consequently, they strongly support penalties and clear parking zones to avoid chaos (S30 at +3, distinguishing statement at p<0.01; S29 at +3). Unlike other groups, they perceive e-scooters as an environmentally unfriendly vehicle due to their short life span (S5 at 2, distinguishing statement at p<0.05). Moreover, they believe that rental e-scooters do not contribute to reducing traffic volume in the city (S16 at -4, distinguishing statement at p<0.05). In addition, participant 9 raised the issue of liability, which is particularly important for e-scooters, and argued that helmets should be compulsory due to the high risk of accidents. As a result, they see no positive aspects that could offset their critical view of e-scooters, unlike in other factors. Therefore, this group argues that ESS should not be allowed in Graz (S32 at +4, distinguishing statement at p<0.0001).

Overall, this group is skeptical that micromobility systems, regardless of the vehicle type, have a noticeable impact on the shift toward more environmentally friendly mobility. They do not replace many car journeys (S4 at -2), reduce traffic jams (S17 at -3) and significantly reduce exhaust emissions (S6 at -2). Micromobility sharing systems cannot be seen as a supplement to PT for commuters (S14 at -3, distinguishing statement at p<0.0001). Participant 2 notes that to be able to serve commuters, good cycle paths must first exist beyond the city limits. Participant 3 also argues that the expansion of PT should have priority to really support commuters, and that a sharing system can only be an additional offer. Thus, the group doesn't think that a BS system is a key measure for the mobility transition (S10 at -3).

This group remains largely indifferent on whether a bicycle-friendly city like Graz should have a BS system (S21 at -1, distinguishing factor at p<0.05). While they acknowledge

Graz's strong cycling culture, three out of five participants do not see the need for a BS system (S22 at -1, distinguishing statement at $p<0.05$). Of the two who agreed, their support was conditional, suggesting that only a small-scale system should be trialed in order to address critics. It could be argued that their agreement stems not from a strong belief in the necessity of such a system, but rather from a desire to appease opposing voices. Participant 2 expressed this sentiment, stating, "It is expected of the city because Graz is a student city and has repeatedly been Austria's cycling capital. But it doesn't have to be that a city with a cycling culture needs such a system." A unique aspect of this group's reasoning is their view that Graz's already high bicycle ownership reduces the need for a BS system (S26 at 0, distinguishing factor at $p<0.05$). Participant 9 explained the opinion on this as follows: “No, I don't agree that Graz should have a BS system, because the number of bicycles in Graz is very high. This means that if a BS system were conceivable, then, in my opinion, it would only be for tourists.”

For this group, as with members of Factor A, the question of who should finance the system remains somewhat unclear (S27 at 0). However, unlike Factor A, this group is primarily composed of individuals from government offices or mobility providers, actors who could potentially be involved in financing. They unanimously agreed that the government should at least partially fund the system while also setting the regulatory framework. Additional funding sources could include advertising revenue, contributions from companies hosting stations at their locations, and user fees, though these fees should remain affordable. The main uncertainty lies in the extent of government funding and whether there is political will to support such a system. As participant 2 noted, there is currently no budget allocated for this, as other priorities like infrastructure improvements take precedence.

Most of the factor members only see a SB system as practical, as an FF system counteracts PT and causes chaos, especially in the narrow city center area. However, participant 2 explained that the last plan drawn up, which was rejected by the local council, was a FF system in which the devices could only be parked in certain areas, i.e. a hybrid model.

4.1.3 Factor C: The regulation advocates

This group, called *the regulation advocates,* consists of two professionals from the road and transport sector. They hold a generally positive view of micromobility sharing, seeing BS as a way to enable efficient, environmentally friendly travel while promoting physical activity (S7 at +4). In their view, such a system can encourage more people to cycle (S11 at +3) and should be part of a city's strategy to promote cycling (S25 at +3). Consequently, they strongly support the implementation of a BS system in Graz (S22 at +3). However, for them, the key to success lies in clear regulations, particularly designated parking zones to prevent disorder (S29 at +4). They reject the argument that limited space is an issue (S34 at -3), suggesting that restructuring urban infrastructure could create room for micromobility. Participant 12 proposed this solution:

> In my opinion there should be large public underground parking facilities in Graz. Currently, everything is above ground. However, there are underground car parks in high-quality city center locations that are operated by investors but are poorly developed. If the city were to buy and develop these, there would be plenty of space for both private vehicles and rental stations.

While they acknowledge that e-scooters can become obstacles in public spaces when not parked in their defined zones (S32 at +0), they emphasize that proper regulation is necessary to prevent misuse (S30 at +1, distinguishing statement at $p<0.01$). Rather than strict penalties, they advocate for technological solutions such as geofencing and ride termination restrictions, requiring users to pay more for improper parking.

They see shared micromobility as a valuable complement to PT, helping to bridge FM/LM gaps and potentially reducing the number of cars in the city center (S12, S13, and S14 at +1). One participant observed this effect in his own company, where employees frequently switch to company e-bikes in warmer months, leaving their cars at home (Participant 12). However, they remain skeptical about its broader impact, believing that micromobility sharing does not significantly shift the modal split or serve as a key measure for the mobility transition (S2 at -3, distinguishing statement at $p<0.05$; S10 at -2). Unlike Factor B, they recognize e-scooters as beneficial, arguing that they can contribute, albeit modestly, to reducing the volume of motor vehicle traffic, congestion and exhaust emissions (S16 at +2, distinguishing statement at $p<0.0005$; S17 at +1, distinguishing statement at $p<0.05$; S6 at +2, distinguishing statement at $p<0.05$). They firmly reject a ban on e-scooters (S31 at -4, distinguishing statement at $p<0.05$), viewing regulation as a more effective approach.

A special and unique feature of this sub-group is their skepticism towards CBS. They do not perceive them as an environmentally friendly or stress-free alternative to cars and doubt their potential to replace a significant number of car trips (S3 at -1, distinguishing statement at $p<0.05$; S4 at -4, distinguishing statement at $p<0.005$). Participant 11 explained:

> I am not a fan of cargo bikes, and I feel that the public tends to think negatively about them. On the one hand, this is certainly culture-dependent, but on the other hand, it is also due to the lack of infrastructure, e.g. the insufficient width of cycle paths. Cargo bikes can be useful, but it takes time for people to recognize and accept them.

Finally, they are convinced that the question of who should finance the system is straightforward (S27 at -3). They both see various options, including funding from the government as well as private providers.

4.1.4 Factor D: The context-conscious supporters

This group in general is optimistic about micromobility systems. They see a real potential for mode shift, believing that such systems can encourage people to choose more sustainable travel options rather than just shifting between existing active modes of transport (S2 at +3, distinguishing statement at $p<0.01$). For them, micromobility is a valuable tool for bridging FM/LM gaps to PT (S13 at +4, distinguishing statement at $p<0.05$) and everyday journeys (S7 + 3). They also reject the notion that only pedestrians and PT users switch to shared e-scooters, while car users do not (S18 at -3, distinguishing statement at $p<0.01$). Additionally, they do not believe that e-scooters are used exclusively by pedestrians or that they negatively impact mobility behavior (S19 at -4, distinguishing statement at $p<0.0005$). They also see that shared bikes and e-scooters promote the goal of using fewer cars in the city center (S12 at +3). Despite this, they don’t see it as a key measure for the mobility transition (S10 at -3).

Overall, for them, a BS system is positive from an environmental point of view (S1 at +4, distinguishing statement at $p<0.01$). And they also don’t see e-scooters as environmentally unfriendly (S5 at -1). They think that with a micromobility sharing system, transportation can be designed as a health-promoting activity (S8 at +2, distinguishing statement at $p<0.05$). In addition, a BS system can encourage more people to cycle (S11 at +1).

For e-scooters in general, they see that they can obstruct traffic when parked incorrectly and therefore, that there is a need for clearly defined parking spaces (S33 and

S29 at +2). Like Factor A, they do not see penalties as necessary for managing shared mobility (S30 at -1). Participant 5 notes that users can be deprived of their authorization if they park their vehicle in the wrong place, but that fines are not necessary. Unlike Factor C, they are more open to CBS (S3 at +1 and S4 at 0). However, participant 8 identifies safety concerns with both vehicles and believes cargo bikes can be challenging to handle, particularly without prior experience or training, especially for women and depending on the model. Regarding e-scooters, this participant notes that although they are classified as bicycles, their higher speed creates a significant speed difference on cycle paths.

In the context of Graz, this group does not view the city's high bicycle penetration as a valid argument against implementing a BS system (S26 at -3), nor do they see a lack of space as a barrier (S34 at -4). Participant 5 explains that such a system is not only, or even primarily, intended for residents but also for commuters from outside the city and tourists. In addition, a BS system could also be useful for residents to avoid the risk of theft when parking expensive private bicycles in public parking spaces (Participant 5). Participant 8 supports this argument, noting that theft concerns make BS an attractive option, along with the convenience of not having to maintain a personal bike. Therefore, this group acknowledges that a micromobility sharing system can be a cost-effective alternative to personal ownership, though they do not strongly emphasize this point (S9 at 0, distinguishing statement at $p<0.05$).

Despite these arguments, enthusiasm for introducing a BS system in Graz remains moderate (S22 at +1, distinguishing statement at $p<0.05$). The same applies to shared e-scooters, as this group slightly agrees that they should be banned in Graz to prevent safety risks and conflicts (S31 at 0, distinguishing statement at $p<0.05$). However, based on what the participants said, this stance does not seem to stem from strong opposition but rather from a general sense that a sharing system is simply not necessary. Participant 5 argues that Graz’s well-developed PT system reduces the need for shared bikes in the city center. Likewise, participant 8 contends that, given the cost-benefit ratio, a BS system would be too expensive for the city, especially when more pressing issues, such as improving cycling infrastructure, require funding. This participant further emphasized that implementing a sharing system would necessitate infrastructure improvements. While Graz’s bicycle infrastructure is generally adequate, many paths are shared with pedestrians. An increase in traffic due to a sharing system would require wider paths and clearer separation between cyclists and pedestrians. Therefore, as this participant sees the government as responsible for the financing of such a system, it is argued that city funds would be better allocated to these improvements. On the other hand, participant 1 sees potential for a small, well-organized rental system targeted at tourists. Although this participant believes that the system must eventually be self-sustaining and not subsidized by the government.

4.2 Factor comparison

To better understand the different points of view represented in the Q-study, this section directly compares the factor groups. The analysis is divided into two parts: points of consensus and points of disagreement. Points of agreement highlight common perspectives among participants (Webler et al., 2009). In contrast, points of disagreement highlight differing priorities, values or assumptions within the debate on micromobility sharing in Graz (Webler et al., 2009). By examining both the commonalities and the controversies, this section sheds light on the broader narratives and underlying tensions shaping the discourse.

4.2.1 Points of consensus

Points of consensus amongst factor groups often indicate weaker opinions than points of conflict (Webler et al., 2009), as is the case with S23. All factors show at least some agreement that implementing a micromobility sharing system could make Graz more attractive for tourists (S23 at 0 for A, C, D and 1 for B). However, this is generally seen as a secondary benefit rather than a primary motivation.

There is also consensus that a BS system can encourage more people to cycle in the city (S11 at 0, +2, +3, +1 for A, B, C, D), as it provides an opportunity to try biking without the need for ownership. However, participants all pointed out that in Graz, purchasing a second-hand bike is both affordable and straightforward, raising doubts about whether a sharing system would truly offer a more cost-effective alternative. Therefore, most participants do not believe that a micromobility sharing system would help reduce social inequality (S9 at -1, -4, -2, 0 for A, B, C and D).

Participants generally agree that micromobility can make transportation a more health-promoting activity (S8 at 0,1, -1, +2 for A, B, C, D), though this argument was seldom applied to e-scooters. Regarding e-scooters, some participants noted a higher risk of accidents. Here, participants 4 and 12 pointed out that since recently, an accident involving an e-scooter during a commute is no longer classified as an occupational accident, as e-scooters are now considered toy-like devices rather than legitimate means of transport. Furthermore, participant 4 argues that e-bikes can also pose a higher risk of accidents because they are faster and often used by older people who generally have a higher risk of accidents. This also explains why Factor C rated S8 at -1. However, there is consensus that cycling, in general, promotes health. Consequently, participants also agree that a bicycle-friendly city should have a practical and user-friendly BS system (S21 at +2 for A and C, +1 for D), though Factor B does not share this view (S21 at -1).

There is broad agreement that micromobility sharing is not a key measure for driving the mobility transition (S10 at -1 for A, -2 for C and -3 for B and D). While participants acknowledge that it is one option cities can offer, they do not believe it has a significant enough impact to bring about meaningful change. However, the participants agree at least to some extent that a micromobility system can help to close the gap between FM/LM and PT (S13 at +2 for A, +1 for B and C, +4 for D).

All participants disagreed with the argument that there is no space for a micromobility sharing system in Graz (S34 at -4 for A and D, -3 for B, -2 for C). While some acknowledge that space is limited and that sidewalks and streets are relatively narrow, they consistently emphasized that solutions could be found if political will existed. The issue was seen less as a lack of space and more as a question of space distribution, which participants viewed as unfair. Some noted that Graz still prioritizes cars and car parking spaces too heavily, suggesting that reducing these could create more room for micromobility. While space itself is not an issue, there is a broad consensus that improperly parked e-scooters and shared bikes can create obstacles for traffic and public spaces in general. However, the level of concern varies (S33 at 0 for A and C, +2 for B and D). Consequently, there is also agreement on the need for designated parking zones to address this issue (S29 at +2, +3, +4, +2 for A, B, C, D). It is therefore not surprising that the majority of participants consider only a SB system to be practical, a topic that typically emerged during the sorting process or was raised at the end. Arguments against an FF system included concerns about chaos, competition with PT, and the risk of not finding a vehicle nearby when needed. Participant 6 noted the following:

> A SB system could incorporate additional features, such as repair tools for seat adjustments. Moreover, stations offering a variety of rental vehicles, such as

cars, cargo bikes, and bicycles , could increase user awareness of different options. Additionally, there could be service partners located near stations to assist users, for example, those with no experience handling a cargo bike.

However, some participants see a FF system as beneficial if designated parking spaces are available throughout the city or if geofencing functions effectively, essentially creating a hybrid system. This was also the model proposed by the municipal transport planning office in 2019 as explained in chapter 1.2. The management aspect was considered a critical factor for both systems.

Looking further into the e-scooter problem, most of the participants don't think that the ecological impact of ESS is questionable and that their short lifespan does not lead to increased electronic waste (S5 at -1 for A, C and D). Only Factor B members see this critic (at +2).

In terms of funding, opinions are mixed, and the statement is generally interpreted differently (S27 at -1, 0, -3, -2 for A, B, C and D). Participants generally recognized different funding options, with some expressing preferences, but overall, they saw it as a matter of negotiation between the relevant actors. Participant 6 stated that it seems as if "everyone is blaming the other so as not to burden themselves". This participant explained that such a system is either funded by the state or is a sub-system. This means that a private provider is responsible for maintenance and redistribution and the government subsidizes it, as is the case with the private company Nextbike that operates in other Austrian cities. Or it is offered by a separate mobility provider such as Holding Graz or tim. However, this participant conceded that these systems are generally not self-supporting and that it is difficult to introduce something "[…] if you already know that it is not worthwhile. But that's generally the problem with mobility, that hardly anyone knows where to get the funding from" (Participant 6). And this is precisely where the opinions of the participants diverge. Some see the main responsibility for funding as lying with the government, with or without a partnership. However, some others are more opposed to this and believe that it should be a private system where users have to pay for a service so that it is financially stable. Although, there was also unanimous agreement that such a system can be financed through multiple sources and that advertising revenue is not the sole option (S28). Participant 8 also noted that the advertising effect is questionable and that companies may therefore not use it as a platform.

4.2.2 Points of disagreement

The most polarizing discussions center around ESS and their impact on mobility behavior, as reflected in the placement of statements 16, 18, 19, and 20. Factor A perceives some competition between e-scooters and PT (S18 at +3, S19 at +1) whereas Factor D does not (S18 at -3, S19 at -4). However, neither considers this competition a major issue, nor do they believe e-scooters significantly harm pedestrian-friendly urban spaces (S20 at -2). Although both factor groups do not believe it can reduce the volume of motorized traffic (S16 at -2). Factor C remains largely indifferent to this topic but acknowledges that e-scooters might negatively impact pedestrian-friendly environments (S20 at -1). In contrast, Factor B sees e-scooters as a clear threat to pedestrian-friendly urban spaces (S20 at +3), firmly rejects the idea that they reduce motorized traffic (S16 at -4) and perceives them as obstacles in public areas (S32 at +4). Given these contrasting perspectives, it is unsurprising that opinions differ on whether ESS should be allowed in Graz (S31). Factors A and C do not oppose their presence (at -2 and -4), while Factor D remains neutral (at 0), which aligns with their view that e-scooters do not significantly impact pedestrian-friendly spaces. In stark contrast, Factor B, having strongly agreed with the negative statement, stands out with its firm rejection of e-scooters (S31 at +4).

Additionally, the regulation of micromobility systems, particularly e-scooters, is a point of significant disagreement. While there is consensus on the need for clear parking zones, the necessity of penalties to prevent parking chaos remains debated (S30). Factor B strongly supports such measures (+3), with Factor C showing mild agreement (+1), whereas Factors A and D oppose penalties (-3 and -1).

Another key area of debate is whether the city should actively promote cycling through a BS system (S25). Factor A strongly supports this idea (ranking it at +3), as does Factor C (+3), whereas Factor B is more skeptical (-1), and Factor D remains neutral (0). This disagreement extends to the question of whether Graz, as a city with an established cycling culture, should implement such a system (S22). While Factor A and C fully agree (+4 and +3), Factor B is hesitant (-1), and Factor D is only slightly supportive (+1). Similarly, there is also disagreement over whether a BS system should serve as a supplement to PT for commuters (S14). Factor A strongly endorses this role (at +4), while Factors C and D show only mild agreement or neutrality (at +1 and 0). Factor B, however, strongly opposes the idea (at -3). Participants held differing views on whether shared bikes enable efficient, environmentally friendly daily travel while also promoting physical activity (S7). While no one disagreed, the level of agreement varied (0 for A and B, +4 for C, +3 for D). Those who were less convinced often argued that for regular commuting needs, people would likely opt to own a bike rather than rely on shared ones.

Beyond cycling, opinions diverge on the potential of micromobility rental systems to influence travel behavior and encourage a shift toward more environmentally friendly alternatives (*modal split shift*) (S2). Factor D sees such a shift as plausible (ranking it at +3), whereas Factor C strongly disagrees (-3), indicating skepticism about whether these systems genuinely reduce car use. Factor A and B are neutral (0 for both). Likewise, there is no consensus on whether CBS can replace car trips (S4). Factor A views them as a viable alternative (1), while Factors B (-2) and C (-4) do not share this perspective. Although, for most factors, cargo bikes are an alternative to the car by using them for everyday transportation (S3 at 3 for A, 2 for B, 1 for D). Here a sharing system was mentioned as a good way to test the usage of a cargo bike due to high purchase costs. Although most participants also said that for daily use, people might want their own a cargo bike at some point.

5 Discussion

As detailed above, this study revealed that Graz-based mobility experts have different opinions about micromobility sharing systems. The research was able to elaborate the participants' views, concerns and ideas, and identify four distinct factor groups. Each of these groups represents a social perspective on micromobility sharing in Graz, and together they improve the understanding of the past and for future decision-making. The following section provides policy recommendations to support decision-makers in developing a sustainable micromobility sharing system. It also discusses the study's contributions to literature, outlines its limitations, and highlights implications for future research.

5.1 Policy implications

The results of this study provide relevant considerations for policymakers, mobility companies and interest groups regarding the introduction of a micromobility sharing system in Graz. They show the arguments for and against an introduction and which aspects should be considered in the efforts for such a system. These considerations are discussed in this section.

5.1.1 Securing long-term public support and financing

A key policy recommendation for the long-term success of micromobility sharing systems in cities like Graz is the development of a PPP model as well as active involvement of PT providers and transport authorities. This model would establish clear funding mechanisms, whereby public investment would support infrastructure development, while private operators would take on the responsibility for fleet management and maintenance.

The financing and management of micromobility systems represent a considerable challenge, as highlighted by both study participants of this study and research in this field, which underscores the complexities involved in sustaining such systems. High operational costs, particularly in the early stages, and the difficulty in maintaining fleet balance to meet fluctuating demand are recurrent issues in the literature (Krauss et al., 2022; Mubiru & Westerholt, 2024). These challenges make it difficult for privately funded schemes to achieve financial sustainability, as noted by one of the participants. A PPP model could provide a more balanced approach, drawing on the strengths of both sectors and creating a stable, efficient model in the long term (Bach et al., 2023;

Krauss et al., 2022; L. Zhang et al., 2015). It includes active government involvement in regulation, infrastructure development and operational support (König et al., 2022). In exchange, private operators can handle the operational aspects, including fleet management and maintenance (Bach et al., 2023). Most Austrian cities that have introduced a BS system have done so in cooperation with the company Nextbike (nextbikeAT GmbH, 2024). In Vienna, for example, the city government is subsidizing the system with 2.3 million euros per year until 2031, in addition to the 7.5 million euros in set-up costs (Wiener Linien, 2023).

However, as can be seen with this example, such partnerships require both significant financial commitment and political support, as well as confidence in the long-term benefits of micromobility (Bach et al., 2023; L. Zhang et al., 2015). Thus, if ongoing support as in Vienna is not possible, at least the introduction should be subsidized, as especially in the early phases of implementation, the high operating costs are recognized as a significant hurdle (Gao et al., 2021; Papaix et al., 2023). In Graz, where competing infrastructure priorities have so far overshadowed micromobility sharing initiatives, the development of a clear and dedicated budget for such a project would be crucial. Alternative revenue sources, such as advertising, contributions from operating companies, and user fees, should also be explored to diversify the funding base.

Ultimately, the success of micromobility systems depends on whether the goals and resources of the public and private sectors can be aligned. A well-structured PPP model could therefore provide the necessary financial stability and operational flexibility to ensure the long-term sustainability of micromobility in Graz and similar cities. Proactive government engagement, including the development of supportive infrastructure and regulatory frameworks, will be critical to the success of these initiatives (König et al., 2022).

5.1.2 Optimizing urban space and infrastructure for shared micromobility

Another recommendation is the reallocation of urban space to prioritize (shared) micromobility, particularly by reducing car parking spaces and repurposing underutilized spaces. Graz, like many cities, faces a shortage of available space, having relatively narrow streets and sidewalks. However, experts argue that this is more a matter of distribution than actual scarcity. As one potential solution, repurposing underutilized spaces, such as vacant commercial properties, into micromobility stations can help optimize urban space and support shared mobility services. Furthermore, the development of underground parking for e-scooters and bikes could free up valuable surface-level space for other uses. This approach could help Graz reduce the dominance of car-centric infrastructure and create a more balanced urban mobility ecosystem. Collaborating with local businesses to allow parking of bicycles and other micromobility vehicles inside premises could further improve accessibility (Zhu et al., 2022). Policy frameworks should encourage such innovative uses of space to foster a more integrated (shared) micromobility system.

Another critical policy recommendation to support micromobility sharing systems in Graz is the expansion of cycling infrastructure (Hardinghaus et al., 2024; Y. Zhang et al., 2023). The city's *Masterplan Radoffensive 2030* outlines significant improvements to cycling lanes, including wider and physically separated bike paths (Bendiks et al., 2021). Policy efforts should focus on further developing these infrastructures to ensure that they can accommodate both traditional cyclists and other micromobility users, including e-scooters and e-bikes. Jaber and Csonka (2024) emphasize that the presence and condition of existing infrastructure play a crucial role in determining a city's preparedness to implement a sharing system. Thus, if the city decides to introduce a micromobility sharing system, the infrastructure needs to accommodate more users. The measures set out in the master plan, such as coloring and widening cycle paths to at least 2.00 meters and expanding the infrastructure along main roads with speed limits of 50 km/h, are supported by the results of this study. This will allow safe overtaking, particularly given the growing use of faster e-bikes and e-scooters and improve safety for all users. This could also lead to a higher usage rate of cargo bikes when people feel safer using them on wider streets. Policymakers should prioritize building physically separated and dedicated lanes to minimize conflicts between different types of road users and ensure the safety of pedestrians, cyclists, and micromobility users alike.

Even though Brown et al. (2020) have shown that most parked bikes and e-scooters in their study did not block pedestrian walkways, concerns about disorderly parking remain a major concern (Hardinghaus et al., 2024). To counteract this, a policy framework should provide for the establishment of designated parking zones and the use of geofencing technology to prevent journeys from ending outside these zones. This hybrid approach would help mitigate the issue of clutter and disorder in public spaces. By enforcing these parking regulations through technology, the city could reduce the need for costly redistribution efforts and improve the overall sustainability of the system.

Policymakers should also promote the development of parking facilities at busy transport hubs to ensure that shared micromobility vehicles are easily accessible to users. These measures align with existing literature that advocate designated micromobility facilities to address space constraints, particularly in busy areas (Y. Zhang et al., 2023).

With regard to the enforcement of parking and traffic regulations, it is recommended that a graduated penalty system for repeat offenders be introduced rather than relying on strict fines. This system could gradually increase penalties for users who repeatedly violate parking regulations or traffic safety regulations. In serious cases, users could be temporarily banned from using the service, thereby promoting responsible behavior without resorting to overly strict penalties. This approach would align with current trends that emphasize the use of technology to enforce regulations and minimize the need for costly enforcement mechanisms (Krauss et al., 2022). A well-structured penalty system could deter irresponsible behavior while maintaining a fair and accessible service for users who comply with the rules.

To address the safety concerns raised by experts, a policy recommendation is to offer safety training programs or public training days for micromobility users to try out these vehicles and learn how to handle them (Tice, 2019), especially for e-scooters and cargo bikes. Since insecurity is a major deterrent to micromobility adoption (Bozzi & Aguilera, 2021), these programs would help improve rider confidence, reduce accidents, and promote responsible usage of shared micromobility services. In addition, helmets should be provided at sharing stations (Naseeh et al., 2024). Given the rising number of accidents involving e-scooters, particularly among inexperienced riders, these measures would provide users with the necessary skills, knowledge and equipment to operate these vehicles safely. In addition, safety training should be tailored to different user groups, including vulnerable riders such as older people. This measure would not only improve safety but also help to promote a culture of responsible use of micromobility. Nevertheless, a recent court ruling could potentially lead to a decline in the number of people using e-scooters for commuting. Now in Austria, accidents involving e-scooters on the way to work are not classified as work-related (Scheucher, 2025). This is because e-scooters are considered more of a leisure device than a legitimate means of transport (Scheucher, 2025). This could potentially diminish the benefits of e-scooters and restrict their utilization.

5.1.3 Increasing public adoption and system accessibility

The study results show that BS plays an important role in improving FM/LM connectivity. Several participants saw potential for BS to support PT, especially in areas with limited transport links, while others viewed micromobility as more of a competitor. These differing perceptions are also reflected in literature. Chi et al. (2023) found that BS improves transit access in suburban areas, while F. Jin et al. (2024) showed that FF systems can strengthen FM/LM links and increase subway ridership. Participants in this study also emphasized that micromobility is more beneficial on the urban fringe, whereas in well-connected city centers, its added value is limited.

At the same time, there was skepticism regarding its potential to reduce car usage. Many participants believed micromobility often replaces walking or PT rather than driving. This is consistent with Cui and Zhang (2024) and Munkácsy et al. (2024), who argue that micromobility primarily competes with existing active modes of mobility, especially in cities with well-developed local transport systems. Furthermore, Gao and Li (2024) emphasize that deployment in underserved areas is more cost-effective, and Soltani et al. (2022) identified strong interest in shared micromobility in suburban areas. Based on these findings from this study and from scientific research, shared bikes and e-scooters should be prioritized in suburbs and less-connected areas. This approach helps to close mobility gaps, provide alternatives where PT is limited, and improve transport equity.

However, to realize this potential, micromobility must be effectively integrated into the broader PT network. Such integration fosters seamless multimodal travel, boosts accessibility, and strengthens the long-term sustainability of urban mobility. Subsidies or discounts, such as those in Vienna, where holders of annual PT passes receive reduced rates for BS programs (Wiener Linien, 2023), can encourage use. Combined pricing offers for users of micromobility and PT can further promote multimodal travel and make the transition between modes of transport more seamless. This strengthens the overall connectivity of the transport system and expands the reach of PT. Cui and Zhang (2024) emphasize that such integration is essential for widespread implementation and goes beyond mere operational regulations. However, König et al. (2022) point out that a lack of uniform strategies and differing opinions often hinder progress in this area. It is therefore crucial that the authorities take the lead in this integration process and lay the foundations for a coherent, reliable and affordable transport system for all residents (Cui & Zhang, 2024).

In addition, public perception plays an important role in the adoption of micromobility sharing. The skepticism regarding their effectiveness in reducing car use suggests that awareness work is needed to change attitudes. Awareness campaigns should inform users about the advantages of micromobility, including its role in sustainable urban transport, its environmental benefits and proper usage etiquette. Roaf et al. (2024) also found that infrastructure changes should be combined with behavioral/social programs as they have the greatest impact on active travel. They also recommend that such programs be implemented initially with subgroups that are willing to change their behavior or are in a 'learning phase'. This can demonstrate the potential for increasing active travel without significant investment (Roaf et al., 2024). Research has indicated that the predominant users of shared micromobility are those with a high level of education (Guo et al., 2023; Soltani et al., 2022). Consequently, students may be an appropriate group from which to initiate such programs. Given Graz's status as a student city, this could be a particularly fruitful approach. In addition, Galdona (2024) identified different groups of cyclists in Graz with different mobility behaviors and priorities. Among others, a group of *wannabe cyclists* who have a high potential for behavioral change with simultaneous infrastructure adaptation. These could be targeted to increase cycling in Graz (Galdona, 2024).

5.1.4 Improving operational efficiency

To minimize the environmental impact and improve the operational efficiency of micromobility systems, a set of targeted policy interventions should be implemented. These recommendations focus on optimizing system design, reducing emissions, and promoting long-term sustainability.

To balance flexibility and order in public spaces, a hybrid micromobility model that combines FF BS with designated parking zones is recommended. Literature suggests that SB BS may become less dominant as technological advancements enable more flexible and user-friendly rental options (Guo et al., 2023). However, many participants favor SB BS due to concerns about disorder, competition with PT, and the unreliability of vehicle availability. A hybrid system, incorporating geofencing and designated parking areas, represents a promising compromise as also noted by S. T. Jin and Sui (2024). The city of Graz's transport planning office has already proposed such a system. The results of this study underscore this idea. Integrating e-bikes into this system, especially in suburban areas, would improve accessibility and convenience (Kwiatkowski, 2021).

Fleet redistribution significantly contributes to the environmental footprint of micromobility services. Therefore, policy measures should require micromobility operators to adopt electric or other low-emission vehicles for fleet management (Arbeláez Vélez, 2024; Bozzi & Aguilera, 2021). Additionally, predictive fleet balancing using data analytics can help minimize unnecessary vehicle relocations, further reducing fuel consumption and emissions (Saum et al., 2024).

As micromobility services increasingly incorporate e-scooters and e-bikes, ensuring sustainable energy use is critical. Thus, if a system in Graz is set up including electric vehicles, innovative charging solutions should be incorporated. Photovoltaic charging stations and modular, solar-powered docking stations should be promoted to reduce reliance on conventional electricity sources (Bozzi & Aguilera, 2021). Additionally, battery-swapping infrastructure can enhance efficiency and reduce electronic waste by enabling operators to replace depleted batteries rather than discarding entire vehicles (Finke et al., 2022). In addition, the recycling process of batteries should be supported through information sharing and government substitutions, thus strengthening formal recycling channels and promoting a transparent, efficient and environmentally sound battery recycling system (Xiao et al., 2024). This is particularly important given that battery-related issues often result in premature vehicle replacement, as highlighted by Lee et al. (2023).

Not only batteries, but in general the short lifespan of vehicles is problematic for the environmental sustainability of these shared vehicles, particularly e-scooters. Research indicates that frequent replacements due to vandalism and non-repairable components contribute to substantial environmental costs (Y. Chen et al., 2024; Arbeláez Vélez, 2024). To address this, policies should mandate the use of repairable and modular components in vehicle design, ensuring that e-scooters and e-bikes can be serviced rather than replaced. Moreover, partnerships with local businesses and second-life programs should be encouraged to facilitate the reuse and refurbishment of micromobility vehicles. These initiatives support a circular economy approach and help mitigate electronic waste.

While BS systems are generally perceived as environmentally beneficial, their actual impact depends on utilization rates. Sun and Ertz (2022) argue that underused shared mobility services contribute to inefficiency and increased per-kilometer emissions. Tim has reported usage rates of only 1% to 20% for their shared cargo bikes during the sorting process, which indicates the need for political measures to promote acceptance. To increase usage, it was shown that municipality support is crucial for CBS (Zimmermann & Palgan, 2024). It is therefore recommended to expand combined subscription options for shared micromobility and PT users, as discounts are currently limited to holders of the *Klimaticket* and student pass (Graz Holding, 2022). Furthermore, prioritizing deployment in high-demand areas such as university districts, business hubs, and transit interchanges can boost efficiency. Graz has already begun taking steps in this direction, recently expanding its cargo bike offering at key locations across the city ("Mobilitäts-Angebot erweitert: Es gibt neue Lastenräder bei tim in Graz", 2025). As already mentioned before, public awareness campaigns should educate users on the environmental benefits of shared micromobility and promote responsible usage behavior to ensure long-term adoption (Zimmermann & Palgan, 2024).

5.2 Contributions to literature

The present study makes a valuable contribution to the existing body of academic work in the field of micromobility sharing by offering a qualitative perspective that stands in contrast to the prevailing quantitative research in this field. Quantitative research has extensively examined the impacts of micromobility sharing on urban mobility (Cui & Zhang, 2024; Ye et al., 2024), environmental sustainability (Arbeláez Vélez, 2024; Y. Chen et al., 2024), and societal dynamics (An et al., 2024; F. Jin et al.,), as well as strategies for optimal implementation (König et al., 2022). However, the motives and arguments put forward by decision-makers or influential organizations for or against the introduction of such systems are often overlooked.

Using the Q-method, this study addresses this gap by analyzing diverse perspectives on micromobility sharing in Graz. The Q-method, a robust tool for studying subjective viewpoints, enables the identification and systematic analysis of shared attitudes and opinions (Webler et al., 2009). This methodological approach is particularly useful for capturing the nuanced trade-offs and empirical findings that quantitative methods may overlook.

Furthermore, this study expands the range of research methods in the field of micromobility sharing systems. Q-methodology offers a differentiated, experience-based perspective that enriches existing research. It also highlights the value of mixed-method approaches that combine qualitative depth with quantitative structure to enable a more comprehensive understanding of the complex trade-offs associated with micromobility sharing systems (Sale et al., 2002).

5.3 Limitations and directions for future research

While the results of this study provide valuable insights into the perspectives of various stakeholders on micromobility sharing systems in Graz, some limitations should be considered.

The media analysis in this study was not conducted in a completely systematic manner. A more rigorous approach would have been ideal but was not prioritized as media analysis was not the primary research method. Instead, a more flexible approach was chosen to allow sufficient time and resources for the central Q-method study. In general, the Q-approach assumes that all essential aspects are represented in the collection of Q-statements, but this may not always be the case (Eccarius & Liu, 2024). Although this limitation may reduce the depth of the media analysis results, it nevertheless provided valuable context and supported the overall research objectives by confirming that the discourse on micromobility systems in the scientific literature is largely consistent with that in Graz.

There are several relevant limitations regarding the participant pool. The sample size is limited, with only twelve participants. Although this is consistent with the 3:1 ratio for statements about participants, this criterion is only one possibility. Webler et al. (2009) also mention the rule that each resulting perspective has four to six people loading onto it. This criterion is only true for Factor B. Watts and Stenner (2005) also suggest two different rules. On the one hand, they speak of 40 to 60 participants being sufficient. On the other hand, they also state that effective studies can be conducted with “significantly fewer” (p. 79) participants and consider fewer participants than Q-statements to be important. Therefore, this study could have been improved by including more participants. However, according to some criteria, the size of the participant pool is sufficient for a solid analysis.

In general, the small number of participants typical of Q-research precludes generalizability of the conclusions to a population (Webler et al., 2009). By definition, the Qtechnique is not intended to yield findings that are representative of a wide population, as is often the goal of transportation policies (Eccarius & Liu, 2024). As a result, Q-outcomes are restricted in their direct relevance to policy planning (Eccarius & Liu, 2024). However, by using a person-centered factor analysis to discover shared mind-sets among participants, these views give useful in-depth insights for policy analysis and implementation. Such findings are frequently buried in bigger quantitative investigations (Watts & Stenner, 2012). It also sought to prioritize the choices of transport stakeholders themselves and to gain authentic insights from experts in academia, government and industry to develop a deeper understanding of the preferences of those who can influence decision-making.

Further research should therefore be carried out to confirm the existence of the identified groups and to find out how strongly the different groupings are represented in Graz. This could help the city and mobility providers to make an informed decision for or against the introduction of a micromobility sharing system in Graz. In addition, this study can serve as a basis for conducting more in-depth research into how the policy recommendations outlined above could affect the development of shared micromobility systems and future transport in general. Moreover, these initial findings provide a valuable foundation for future large-scale quantitative studies that could extend the current stakeholder-focused perspective by examining the views and preferences of potential users. For this, the perspectives identified can facilitate the development of a survey that assesses the degree of consensus among a representative sample of the population with regard to each perspective (Webler et al., 2009). While this study concentrated on influential actors involved in shaping mobility policy in Graz, further research could explore how different user groups perceive shared micromobility and what factors influence their willingness to adopt such services. Understanding user-side motivations, expectations, and concerns would complement the stakeholder perspective and support more balanced, evidence-based decision-making around the potential introduction of a shared micromobility system.

Lastly, this thesis focuses on Graz as a case study for analyzing narratives around micromobility concepts. While this allows for a detailed, context-specific analysis, it limits the generalizability of the findings. Graz's unique characteristics, such as its size, high bicycle ownership, and local policy context, differ from those of other cities, making direct transfer of results difficult. To overcome this limitation, future research should adopt a comparative approach, examining multiple cities with varying structures and mobility cultures. This would help distinguish locally specific narratives from those with broader relevance.

6 Conclusion

By applying the Q-method, the present study was able to identify four different social perspectives on micromobility sharing in Graz. *The public transport complementors* have a generally positive attitude toward shared micromobility and support its introduction in Graz as an additional mobility option. They view it as a valuable complement to existing transport services that can encourage more people to cycle. In their opinion, there are no significant obstacles to introducing such systems in the city. *The e-scooter opponents*, on the other hand, are critical of shared micromobility, especially e-scooters. They argue that these systems do not contribute to more sustainable mobility behavior but rather create new obstacles for other road users. As a result, they are against the introduction of shared micromobility in Graz. *The regulation advocates* see both ESS and BS positively. They believe such services are useful for daily mobility and help promote cycling. However, their support is conditional: they emphasize the need for strong regulation to prevent disorder and misuse. Finally, *the context-conscious supporters* generally view shared micromobility as a valuable tool to promote sustainable transport. In the specific context of Graz, however, they do not see the issue as a lack of space or an oversupply of private bicycles, but rather that there is simply no demand for such a system at present.

With a clearer understanding of the different perspectives and arguments of the key stakeholders in Graz, the issue of shared micromobility can now be addressed more effectively, especially as the debate has reignited this year. The policy recommendations developed in this work aim to support this renewed debate and provide guidance for potential future decisions.

An important aspect is clarifying the financing model for the system and ensuring strong support from the city. A long-term, sustainable implementation can only succeed through close collaboration between the municipality and the service providers. This cooperation should include not only financial and logistical planning but also a shared commitment to quality, accessibility, and environmental goals. At the same time, the city should continue working on improving infrastructure and the distribution of space in order to better accommodate all road users and support a shift toward more sustainable mobility. This includes expanding cycling lanes, improving safety, and ensuring that public space is allocated in a way that reflects changing mobility needs. Peripheral areas of Graz must not be overlooked, as they offer particularly high potential for the use of shared micromobility systems. In these districts, such services could fill existing mobility gaps and offer flexible alternatives to car use. Furthermore, when introducing a shared micromobility system, particular attention should be paid to its integration into the existing PT network. A well-connected system can significantly increase user acceptance by enabling smooth, multimodal travel chains. Finally, the type and scope of the system must be carefully planned. Factors such as operational efficiency, coverage and environmental sustainability should be weighed up. At the same time, new and innovative approaches, whether in vehicle technology, service models or data integration, should be considered as part of a forward-looking strategy. In addition, safety training should be offered and campaigns carried out to raise awareness of shared micromobility.

This study not only highlights the complex perspectives of key stakeholders in Graz but also opens up new areas of research that could influence future policy decisions. By combining methodological innovation and local relevance, it contributes to a more reflective and context-sensitive debate on shared micromobility. As cities continue to search for sustainable and inclusive transport solutions, such nuanced approaches to design mobility systems that are both effective and socially acceptable will be crucial. Future research could further investigate the extent to which the views and motivations of potential users align with those of experts to obtain a more complete picture that would support more comprehensive decision-making regarding the introduction of shared micromobility systems.

Transport remains a major source of GHG emissions. Given the growing demand for urban mobility, shared micromobility systems offer a promising solution to complement PT and reduce dependence on private vehicles. This study examined the perspectives of key stakeholders in Graz and provided valuable insights into the potential of such systems to improve sustainable mobility. By addressing the challenges and opportunities in the local context, this study contributes to ongoing efforts to develop cleaner and more efficient transport options and supports the overarching goal of reducing urban emissions.

7 References

"Graz-Bike" bietet Verleih über Buchungsplattform (2016, June 22). *Kleine Zeitung*. https://www.kleinezeitung.at/steiermark/graz/3978701/Fahradverleih_GrazBike-bietet-Verleih-ueber-Buchungsplattform

Agora Verkehrswende. (2020). *Städte in Bewegung. Zahlen, Daten, Fakten zur Mobilität in 35 deutschen Städten*. https://www.agora-verkehrswende.de/fileadmin/Projekte/2020/Staedteprofile/Agora-Verkehrswende_Bewegung_in_Staedten_1-2.pdf

An, Z., Mullen, C., Guan, X., Ettema, D., & Heinen, E. (2024). Shared micromobility, perceived accessibility, and social capital. *Transportation*, 1-36. https://doi.org/10.1007/s11116-024-10521-5

Arbeláez Vélez, A. M. (2024). Environmental impacts of shared mobility: A systematic literature review of life-cycle assessments focusing on car sharing, carpooling, bikesharing, scooters and moped sharing. *Transport Reviews*, 44(3), 634–658. https://doi.org/10.1080/01441647.2023.2259104

Azimi, M., Wali, M. M., & Qi, Y. (2024). Studying the Impact of the COVID-19 Pandemic on Bikeshares as a Mode of Shared Micromobility in Major Cities: A Case Study of Houston. *Future Transportation*, 4(1), 270–282. https://doi.org/10.3390/futuretransp4010014

Bach, X., Marquet, O., & Miralles-Guasch, C. (2023). Assessing social and spatial access equity in regulatory frameworks for moped-style scooter sharing services. *Transport Policy*, 132, 154–162. https://doi.org/10.1016/j.tranpol.2023.01.002

Bauer, F. (2018). Narratives of biorefinery innovation for the bioeconomy: Conflict, consensus or confusion? *Environmental Innovation and Societal Transitions*, 28, 96–107. https://doi.org/10.1016/j.eist.2018.01.005

Becker, S., & Rudolf, C. (2018). Exploring the Potential of Free Cargo-Bikesharing for Sustainable Mobility. *GAIA - Ecological Perspectives for Science and Society*, 27(1), 156–164. https://doi.org/10.14512/gaia.27.1.11

Bendiks, S., Degros, A., Monsberger, M., Freudenthaler, S., Orhan, M., Keuschnig, C., & Gay, C. (2021). *Masterplan Radoffensive 2030*. Artgineering, Office for Urbanism and Architecture, Brussels. https://rad.graz.at/masterplan/

Bissel, M., & Becker, S. (2024). Can cargo bikes compete with cars? Cargo bike sharing users rate cargo bikes superior on most motives – Especially if they reduced car ownership. *Transportation Research Part F: Traffic Psychology and Behaviour*, 101, 218–235. https://doi.org/10.1016/j.trf.2023.12.018

BMIMI INFOTHEK. (2023, August 30). *Sinkende Treibhausgas-Emissionen im heimischen Verkehr.* https://infothek.bmimi.gv.at/sinkende-treibhausgas-emissionen-im-heimischen-verkehr/

Bozzi, A. D., & Aguilera, A. (2021). Shared E-Scooters: A Review of Uses, Health and Environmental Impacts, and Policy Implications of a New Micro-Mobility Service. *Sustainability*, 13(16), 8676. https://doi.org/10.3390/su13168676

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Brown, A., Klein, N. J., Thigpen, C., & Williams, N. (2020). Impeding access: The frequency and characteristics of improper scooter, bike, and car parking. *Transportation Research Interdisciplinary Perspectives*, 4, 100099. https://doi.org/10.1016/j.trip.2020.100099

Brůhová Foltýnová, H., Vejchodská, E., Rybová, K., & Květoň, V. (2020). Sustainable urban mobility: One definition, different stakeholders' opinions. *Transportation Research Part D: Transport and Environment*, 87, 102465. https://doi.org/10.1016/j.trd.2020.102465

Carey, C. (2024, March 6). How the e-scooter ban has changed mobility in Paris. *Cities Today*. https://cities-today.com/how-the-e-scooter-ban-has-changed-mobility-in-paris/

Chen, Y., Zeng, D., Deveci, M., & Coffman, D. (2024). Life cycle analysis of bike sharing systems: A case study of Washington D.C. *Environmental Impact Assessment Review*, 106, 107455. https://doi.org/10.1016/j.eiar.2024.107455

Chen, Y., Zhang, Y., Coffman, D., & Mi, Z. (2022). An environmental benefit analysis of bike sharing in New York City. *Cities*, 121, 103475. https://doi.org/10.1016/j.cities.2021.103475

Chen, Z., van Lierop, D., & Ettema, D. (2022). Travel satisfaction with dockless bike-sharing: Trip stages, attitudes and the built environment. *Transportation Research Part D: Transport and Environment*, 106, 103280. https://doi.org/10.1016/j.trd.2022.103280

Cheng, L., Huang, J., Jin, T., Chen, W., Li, A., & Witlox, F. (2023). Comparison of station-based and free-floating bikeshare systems as feeder modes to the metro. *Journal of Transport Geography*, 107, 103545. https://doi.org/10.1016/j.jtrangeo.2023.103545

Chi, B., Han, H., & Lee, J. (2023). Travel behaviour of shared mobility users: a review of empirical evidence. *Australian Planner*, 59(3), 185–201. https://doi.org/10.1080/07293682.2024.2327283

Cools, M., Moons, E., Janssens, B., & Wets, G. (2009). Shifting towards environment-friendly modes: profiling travelers using Q-methodology. *Transportation*, 36(4), 437–453. https://doi.org/10.1007/s11116-009-9206-z

Cui, C., & Zhang, Y [Yu] (2024). Integration of Shared Micromobility into Public Transit: A Systematic Literature Review with Grey Literature. *Sustainability,* 16(9), 3557. https://doi.org/10.3390/su16093557

Dias, G., Ribeiro, P., & Arsenio, E. (2024). Determinants of shared e-scooter usage and their policy implications. findings from a survey in Braga, Portugal. *European Transport Research Review*, 16(1). https://doi.org/10.1186/s12544-024-00642-4

Dickinson, K. (2024, March 5). What Went Wrong with the Paris Referendum On E-Scooters? *CityChangers.Org*. https://citychangers.org/e-scooters-referendum-paris/

Drimlová, E., Šucha, M., Rečka, K., Haworth, N., Fyhri, A., Wallgren, P., Silverans, P., & Slootmans, F. (2024). Attitudes Towards E-scooter Safety - A Survey in Five Countries. *Transactions on Transport Sciences*, 15(3), 24–36. https://doi.org/10.5507/tots.2024.009

Eccarius, T., & Liu, S.-C. (2024). Views of emerging sustainability leaders on the future of Transport: A Q study in a Taiwan tertiary education program. *Transportation Research Part a: Policy and Practice*, 190, 104290. https://doi.org/10.1016/j.tra.2024.104290

Echeverría-Su, M., Huamanraime-Maquin, E., Cabrera, F. I., & Vázquez-Rowe, I. (2023). Transitioning to sustainable mobility in Lima, Peru. Are e-scooter sharing initiatives part of the problem or the solution? *The Science of the Total Environment*, 866, 161130. https://doi.org/10.1016/j.scitotenv.2022.161130

European Comission. (2021). *Sustainable & Smart Mobility Strategy*. https://transport.ec.europa.eu/document/download/be22d311-4a07-4c29-8b72-d6d255846069_en?filename=2021-mobility-strategy-and-action-plan.pdf

Eurostat. (2025, April 27). *Glossary: Carbon dioxide equivalent*. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Carbon_dioxide_equivalent

Filipe Teixeira, J., Diogo, V., Bernát, A., Lukasiewicz, A., Vaiciukynaite, E., & Stefania Sanna, V. (2023). Barriers to bike and e-scooter sharing usage: An analysis of non-users from five European capital cities. *Case Studies on Transport Policy*, 13, 101045. https://doi.org/10.1016/j.cstp.2023.101045

Finke, S., Schelte, N., Severengiz, S., Fortkort, M., & Kähler, F. (2022). Can battery swapping stations make micro-mobility more environmentally sustainable? *E3S Web of Conferences*, 349. https://doi.org/10.1051/e3sconf/202234902007

Fluctuo. (2024a). Shared mobility fleet in Europe in 2023, by mode [Graph]. https://www.statista.com/statistics/1395333/shared-mobility-vehicle-fleet-europe/

Fluctuo. (2024b). Shared mobility ridership growth in Europe in 2023 as compared to 2022, by mode [Graph]. https://www.statista.com/statistics/1399200/shared-mobility-ridership-growth-europe/

Galdona, B. (2024). Co-Benefits of Active Mobility: Social Perspectives in Graz, Austria [Masterthesis]. Universität Leipzig, Leipzig.

Gao, J., & Li, S. (2024). Synergizing shared micromobility and public transit towards an equitable multimodal transportation network. *Transportation Research Part a: Policy and Practice*, 189, 104225. https://doi.org/10.1016/j.tra.2024.104225

Gao, K., Yang, Y., Li, A., Li, J., & Yu, B. (2021). Quantifying economic benefits from free-floating bike-sharing systems: A trip-level inference approach and city-scale analysis. *Transportation Research Part a*, 144, 89–103. https://doi.org/10.1016/j.tra.2020.12.009

Giuffrida, N., Pilla, F., & Carroll, P. (2023). The social sustainability of cycling: Assessing equity in the accessibility of bike-sharing services. *Journal of Transport Geography*, 106, 103490. https://doi.org/10.1016/j.jtrangeo.2022.103490

Gkavra, R., Susilo, Y. O., Grigolon, A., Geurs, K., & Roider, O. (2025). Mobility chameleons: The current and potential users of shared micromobility. *Travel Behaviour and Society*, 39, 100967. https://doi.org/10.1016/j.tbs.2024.100967

Goralzik, A., König, A., Alčiauskaitė, L., & Hatzakis, T. (2022). Shared mobility services: An accessibility assessment from the perspective of people with disabilities. *European Transport Research Review*, 14(1), 34. https://doi.org/10.1186/s12544-022-00559-w

Graz. (2024, September 18). *Multimodale Mobilität*. https://www.graz.at/cms/beitrag/10265606/8038402/Multimodale_Mobilitaet.html

Graz Holding. (Juli 2022). *tim Tarife*. https://www.tim-oesterreich.at/graz/wp-content/uploads/sites/2/2022/06/tim-tarifinfo-juli-2022.pdf

Graz Holding. (2024, July 07). *Lastenrad-Offensive: Positive Bilanz, neue Pläne - Holding Graz*. https://www.holding-graz.at/de/lastenrad-offensive-positive-bilanz-neue-plaene/

Graz soll neues Leihradsystem bekommen. (2016, June 21). *Kleine Zeitung*. https://www.kleinezeitung.at/steiermark/graz/4071989/Graz-soll-neues-Leihradsystem-bekommen

Guo, D., Yao, E., Liu, S., Chen, R., Hong, J., & Zhang, J [Junyi] (2023). Exploring the role of passengers' attitude in the integration of dockless bike-sharing and public transit: A hybrid choice modeling approach. *Journal of Cleaner Production*, 384, 135627. https://doi.org/10.1016/j.jclepro.2022.135627

Hardinghaus, M., Nieland, S., Oostendorp, R., & Weschke, J. (2024). Developing a multi-method approach to identifying e-scooter hazard hotspots. *Journal of Traffic and Transportation Engineering (English Edition),* 11(4), 667–680. https://doi.org/10.1016/j.jtte.2023.03.002

Hecke, B. (2020, November 28). Stadt Graz startet Gratis-Verleih von Lastenrädern. *Kleine Zeitung*. https://www.kleinezeitung.at/steiermark/graz/5904094/In-allen-Bezirken_Stadt-Graz-startet-GratisVerleih-von-Lastenraedern

Heineke, K., Kloss, B., Ruden, A. M., Möller, T., & Wiemuth, C. (2023, January 05). Shared mobility: Sustainable cities, shared destinies. *McKinsey&Company.* https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/shared-mobility-sustainable-cities-shared-destinies#/

Heineke, K., Kloss, B., Rupalla, F., & Scurtu, D. (2021, December 02). Why micromobility is here to stay. *McKinsey&Company*. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/why-micromobility-is-here-to-stay

Hermwille, L. (2016). The role of narratives in socio-technical transitions—Fukushima and the energy regimes of Japan, Germany, and the United Kingdom. *Energy Research & Social Science*, 11, 237–246. https://doi.org/10.1016/j.erss.2015.11.001

Hickman, R., Lopez, N., Cao, M., Lira, B. M., & Biona, J. B. M. (2018). “I Drive outside of Peak Time to Avoid Traffic Jams—Public Transport Is Not Attractive Here.” Challenging Discourses on Travel to the University Campus in Manila. *Sustainability*, 10(5), 1462. https://doi.org/10.3390/su10051462

Homem de Gouveia, P., Boccioli, F., Wrzesińska, D., Kabbaj, L., & Manso García, J. (November 2023). Catch me if you can: How European Cities are regulating Shared Micromobility. *POLIS*. https://www.polisnetwork.eu/wp-content/uploads/2023/11/SHARED-MICROMOBILITY-REPORT.pdf

Hurtubia, R., Mora, R., & Moreno, F. (2021). The role of bike sharing stations in the perception of public spaces: A stated preferences analysis. *Landscape and Urban Planning*, 214, 104174. https://doi.org/10.1016/j.landurbplan.2021.104174

Institute for Transportation and Development Policy. (2024). *Promoting sustainable and equitable transportation worldwide - Defining Micromobility.* https://itdp.org/multimedia/defining-micromobility/

IPCC. (2023). Summary for Policymakers. In: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 1-34, doi: 10.59327/IPCC/AR6-9789291691647.001

Ist Graz reif für ein Radverleihsystem? (2019, December 6). *Kleine Zeitung*. https://www.kleinezeitung.at/steiermark/graz/5733901/Umfrage-der-Woche_Ist-Graz-reif-fuer-ein-Radverleihsystem

Jaber, A., & Csonka, B. (2024). Assessment of Hungarian large cities readiness in adopting electric bike sharing system. *Discover Sustainability*, 5(1). https://doi.org/10.1007/s43621-024-00413-0

Jin, F., Cheng, Y., Li, X., & Hu, Y. J. (2024). Connecting the Last Mile: The Impact of Dockless Bike-sharing on Public Transportation. *Production and Operations Management,* 10591478231224953. https://doi.org/10.1177/10591478231224953

Jin, S. T., & Sui, D. Z. (2024). Shared micromobility and equity: A comparison between station-based, hybrid, and dockless models. *Transportation Research Part D: Transport and Environment,* 129, 104113. https://doi.org/10.1016/j.trd.2024.104113

Juschten, M., Page, S., & Fitt, H. (2020). Mindsets Set in Concrete? Exploring the Perspectives of Domestic Travellers on New Zealand's (Auto-)Mobility Culture. *Sustainability*, 12(18), 7646. https://doi.org/10.3390/su12187646

König, A., Gebhardt, L., Stark, K., & Schuppan, J. (2022). A Multi-Perspective Assessment of the Introduction of E-Scooter Sharing in Germany. *Sustainability,* 14(5), 2639. https://doi.org/10.3390/su14052639

Kontar, W., Ahn, S., & Hicks, A. (2022). Electric bicycles sharing: opportunities and environmental impacts. *Environmental Research: Infrastructure and Sustainability,* 2(3), 35006. https://doi.org/10.1088/2634-4505/ac7c8b

Krauss, K., Krail, M., & Axhausen, K. W. (2022). What drives the utility of shared transport services for urban travellers? A stated preference survey in German cities. *Travel Behaviour and Society*, 26, 206–220. https://doi.org/10.1016/j.tbs.2021.09.010

Kwiatkowski, M. A. (2021). Metropolitan bicycle-sharing system in the Polish context of various needs of cities, towns, and villages. Bulletin of Geography. *Socio-Economic Series,* 54, 97–111. https://doi.org/10.2478/bog-2021-0036

Lee, U., Kang, N., & Lee, Y. K. (2023). Shared autonomous electric vehicle system design and optimization under dynamic battery degradation considering varying load conditions. *Journal of Cleaner Production*, 423, 138795. https://doi.org/10.1016/j.jclepro.2023.138795

Li, A., Zhao, P., Liu, X., Mansourian, A., Axhausen, K. W., & Qu, X. (2022). Comprehensive comparison of e-scooter sharing mobility: Evidence from 30 European cities. *Transportation Research Part D: Transport and Environment*, 105, 103229. https://doi.org/10.1016/j.trd.2022.103229

Li, Q., Fuerst, F., & Luca, D. (2023). Do shared E-bikes reduce urban carbon emissions? *Journal of Transport Geography*, 112, 103697. https://doi.org/10.1016/j.jtrangeo.2023.103697

Li, Q., Zhang, E., Luca, D., & Fuerst, F. (2024). The travel pattern difference in dockless micro-mobility: Shared e-bikes versus shared bikes. *Transportation Research Part D: Transport and Environment,* 130, 104179. https://doi.org/10.1016/j.trd.2024.104179

Li, Y., Wang, S., Tang, J. H. C. G., Peng, Z., & Zhuge, C. (2024). Public attention and attitudes towards bike-sharing in China: A text mining approach. *Transportation Research Part D,* 134, 104348. https://doi.org/10.1016/j.trd.2024.104348

Macioszek, E., Cieśla, M., & Granà, A. (2023). Future Development of an Energy-Efficient Electric Scooter Sharing System Based on a Stakeholder Analysis Method. *Energies*, 16(1), 554. https://doi.org/10.3390/en16010554

Marincek, D., Rérat, P., & Lurkin, V. (2024). Cargo bikes for personal transport: A user segmentation based on motivations for use. *International Journal of Sustainable Transportation,* 18(9), 751–764. https://doi.org/10.1080/15568318.2024.2402753

Meshulam, T., Goldberg, S., Ivanova, D., & Makov, T. (2024). The sharing economy is not always greener: a review and consolidation of empirical evidence. *Environmental Research Letters,* 19(1), 13004. https://doi.org/10.1088/1748-9326/ad0f00

Miedl-Rissner, M. (2025, March 7). Erneute Prüfung angeordnet - Kehrtwende bei Leihfahrrädern*. Kleine Zeitung*. https://www.kleinezeitung.at/steiermark/graz/19429250/kommt-nun-doch-ein-bike-sharing-system-fuer-die-grazer-innenstadt

Mobilitäts-Angebot erweitert: Es gibt neue Lastenräder bei tim in Graz. (2025, March 31). *Der Grazer.* https://grazer.at/story/de/mobilitaets-angebot-erweitert-es-gibt-neue-bei-tim-VISVQ404/

Mock, M., & Wankat, K. (2024). Why do sustainable shared mobility practices not proliferate more widely? Insights from digital mobility diaries. *Journal of Cleaner Production*, 475, 143582. https://doi.org/10.1016/j.jclepro.2024.143582

Mubiru, I., & Westerholt, R. (2024). A scoping review on the conceptualisation and impacts of new mobility services. *European Transport Research Review,* 16(12), 1–18. https://doi.org/10.1186/s12544-024-00633-5

Munkácsy, A., Földes, D., Miskolczi, M., & Jászberényi, M. (2024). Urban mobility in the future: text analysis of mobility plans. *European Transport Research Review,* 16(29). https://doi.org/10.1186/s12544-024-00649-x

Naaseh, A., Tohmasi, S., Kranker, L. M., & Schuerer, D. J. (2024). Road Traffic Injury Prevention: Standing Electric Scooters. *Current Trauma Reports*, 1-6. https://doi.org/10.1007/s40719-024-00270-2

nextbikeAT GmbH. (2024, October 24). https://www.nextbike.at/de.

Nikitas, A., Cotet, C., Vitel, A.-E., Nikitas, N., & Prato, C. (2024). Transport stakeholders' perceptions of Mobility-as-a-Service: A Q-study of cultural shift proponents, policy advocates and technology supporters. *Transportation Research Part a: Policy and Practice*, 181, 103964. https://doi.org/10.1016/j.tra.2024.103964

Nikitas, A., Vitel, A.-E., & Cotet, C. (2021). Autonomous vehicles and employment: An urban futures revolution or catastrophe? *Cities*, 114, 103203. https://doi.org/10.1016/j.cities.2021.103203

Obersteiner, P., Trimmel, K., Brudermann, T., & Kriechbaum, M. (2024). Beyond polarisation and simplified storylines: Exploring discursive struggles over a transport infrastructure project in Vienna, Austria. *Case Studies on Transport Policy*, 18, 101293. https://doi.org/10.1016/j.cstp.2024.101293

Oeschger, G., Caulfield, B., & Carroll, P. (2025). User characteristics and preferences for micromobility use in first- and last-mile journeys in Dublin, Ireland. *Travel Behaviour and Society*, 38, 100926. https://doi.org/10.1016/j.tbs.2024.100926

Papaix, C., Eranova, M., & Zhou, L. (2023). Shared mobility research: Looking through a paradox lens. *Transport Policy*, 133, 156–167. https://doi.org/10.1016/j.tranpol.2023.01.009

Radoffensive. (2024, November 12). *Radoffensive - Die Radoffensive aus Graz*. https://rad.graz.at/

Rajé, F. (2007). Using Q methodology to develop more perceptive insights on transport and social inclusion. *Transport Policy*, 14(6), 467–477. https://doi.org/10.1016/j.tranpol.2007.04.006

Roaf, E., Larrington-Spencer, H., & Lawlor, E. R. (2024). Interventions to increase active travel: A systematic review. *Journal of Transport & Health*, 38, 101860. https://doi.org/10.1016/j.jth.2024.101860

Robbins, P., & Krueger, R. (2000). Beyond Bias? The Promise and Limits of Q Method in Human Geography. *The Professional Geographer*, 52(4), 636–648. https://doi.org/10.1111/0033-0124.00252

Roig-Costa, O., Marquet, O., Arranz-López, A., Miralles-Guasch, C., & van Acker, V. (2024). Understanding multimodal mobility patterns of micromobility users in urban environments: insights from Barcelona. *Transportation*, 1-29. https://doi.org/10.1007/s11116-024-10531-3

Roig-Costa, O., Miralles-Guasch, C., & Marquet, O. (2024). Shared bikes vs. private e-scooters. Understanding patterns of use and demand in a policy-constrained micromobility environment. *Transport Policy*, 146, 116–125. https://doi.org/10.1016/j.tranpol.2023.11.010

Sale, J. E. M., Lohfeld, L. H., & Brazil, K. (2002). Revisiting the Quantitative-Qualitative Debate: Implications for Mixed-Methods Research. *Quality & Quantity*, 36(1), 43–53. https://doi.org/10.1023/A:1014301607592

Saltykova, K., Ma, X., Yao, L., & Kong, H. (2022). Environmental impact assessment of bike-sharing considering the modal shift from public transit. *Transportation Research Part D,* 105, 103238. https://doi.org/10.1016/j.trd.2022.103238

Saum, N., Sugiura, S., & Piantanakulchai, M. (2024). Optimizing Shared E-Scooter Operations Under Demand Uncertainty: A Framework Integrating Machine Learning and Optimization Techniques. *IEEE Access*, 12, 26957–26977. https://doi.org/10.1109/ACCESS.2024.3365947

Scheucher, J. (2025, January 27). Mit dem E-Scooter zur Arbeit: Bei Unfall Pech gehabt. *ORF.At*. https://help.orf.at/stories/3228623/

Scrivano, L., Tessari, A., Marcora, S. M., & Manners, D. N. (2024). Active mobility and mental health: A scoping review towards a healthier world. *Cambridge Prisms: Global Mental Health*, 11, e1. https://doi.org/10.1017/gmh.2023.74

Sneegas, G., Beckner, S., Brannstrom, C., Jepson, W., Lee, K., & Seghezzo, L. (2021). Using Q-methodology in environmental sustainability research: A bibliometric analysis and systematic review. Ecological Economics, 180, 106864. https://doi.org/10.1016/j.ecolecon.2020.106864

Soltani, A., Allan, A., Pojani, D., Khalaj, F., & Mehdizadeh, M. (2022). Users and non-users of bikesharing: how do they differ? *Transportation Planning and Technology*, 45(1), 39–58. https://doi.org/10.1080/03081060.2021.2017215

Stadt Graz Abteilung für Verkehrsplanung. (2025). *Die Inhalte des Mobilitätsplan Graz 2040*. https://www.graz.at/cms/beitrag/10403377/12799279/Die_Inhalte_des_Mobilitaetsplan_Graz.html

Stadtportal der Landeshauptstadt Graz. (2025). *Radfahren in Graz*. https://www.graz.at/cms/beitrag/10122448/12063979/Radfahren_in_Graz.html

Stadtportal der Landeshauptstadt Graz. (2023, June 10). *Studentenhochburg Graz*. https://www.graz.at/cms/beitrag/10411950/8106444/

Stadtportal der Landeshauptstadt Graz. (2025, January 1). *Zahlen + Fakten: Bevölkerung, Bezirke, Wirtschaft, Geografie*. https://www.graz.at/cms/beitrag/10034466/7772565/zahlen_fakten_bevoelkerung_bezirke_wirtschaft.html

Storme, T., Casier, C., Azadi, H., & Witlox, F. (2021). Impact Assessments of New Mobility Services: A Critical Review. *Sustainability*, 13, 3074. https://doi.org/10.3390/su13063074

Sun, S., & Ertz, M. (2022). Can shared micromobility programs reduce greenhouse gas emissions: Evidence from urban transportation big data. *Sustainable Cities and Society*, 85, 104045. https://doi.org/10.1016/j.scs.2022.104045

Tice, P. C. (2019). Micromobility and the Built Environment. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 63(1), 929-932. https://doi.org/10.1177/1071181319631430

Tru, V. N., & Ngoc, A. M. (2024). Exploring Tourists' Preferences for Bike-Sharing Services in the Context of Tourism. *Sustainability*, 16(8), 3375. https://doi.org/10.3390/su16083375

Umweltbundesamt. (2024, October 30). *Treibhausgase*. https://www.umweltbundesamt.at/klima/treibhausgase

van Duin, R., Slabbekoorn, M., Tavasszy, L., & Quak, H. (2018). Identifying dominant stakeholder perspectives on urban freight policies: A Q-analysis on urban consolidation centres in the netherlands. *Transport,* 33(4), 867–880. https://doi.org/10.3846/16484142.2017.1350996

van Exel, N., Graaf, G. de, & Rietveld, P. (2004). View of Getting from A to B: Operant Approaches to Travel Decision Making. *Operant Subjectivity*, 27(4). https://doi.org/10.22488/okstate.04.100524

Verleihsystem "Graz Bike" startet (2012, August 29). *Der Standard*. https://www.derstandard.at/story/1345165537867/verleihsystem-graz-bike-startet

Watts, S., & Stenner, P. (2005). Doing Q methodology: theory, method and interpretation. *Qualitative Research in Psychology*, 2(1), 67–91. https://doi.org/10.1191/1478088705qp022oa

Webler, T., Danielson, S., & Tuler, S. (2009). Using Q method to reveal social perspectives in environmental research. *Greenfield MA: Social and Environmental Research Institute*, 54(1), 45. www.serius.org/pubs/Qprimer.pdf

Wiener Linien. (2023, March 21). *WienMobil Rad startet in ganz Wien*. https://www.wienerlinien.at/wienmobil-rad-startet-in-ganz-wien?utm_source=chatgpt.com

Winter-Pölsler, G. (2017a, July 22). Radverleih-Riese aus Asien nimmt Kurs auf Graz. *Kleine Zeitung.*

https://www.kleinezeitung.at/steiermark/graz/5256235/Per-App-zum-Rad_RadverleihRiese-aus-Asien-nimmt-Kurs-auf-Graz

Winter-Pölsler, G. (2017b, August 31). Das Grazer Ringen mit dem Radverleih-Riesen aus Asien. *Kleine Zeitung.* https://www.kleinezeitung.at/steiermark/graz/5277430/Nach-oBikeStart-in-Wien_Das-Grazer-Ringen-mit-dem-RadverleihRiesen

Winter-Pölsler, G. (2017c, November 16). Kommt nach tim-Carsharing auch Leihradsystem für Graz? *Kleine Zeitung.* https://www.kleinezeitung.at/steiermark/graz/5321672/Greenpeace-Mobilitaetsranking_Kommt-nach-timCarsharing-auch

Winter-Pölsler, G. (2021, February 13). Neuer Anlauf für ein Rad-Verleihsystem in Graz. *Kleine Zeitung.* https://www.kleinezeitung.at/steiermark/graz/5934808/Beim-SmartCityStandort_Neuer-Anlauf-fuer-ein-RadVerleihsystem-in-Graz

Winter-Pölsler, G. (2024, May 16). SPÖ startet neuen Anlauf für Radverleih-System in Graz. *Kleine Zeitung*. https://www.kleinezeitung.at/steiermark/graz/18468937/spoe-startet-neuen-anlauf-fuer-radverleih-system-in-graz

Xiao, M., Xu, C., & Xie, F. (2024). Research on the impact of information sharing and government subsidy on competitive power battery recycling. *Journal of Cleaner Production*, 467, 142989. https://doi.org/10.1016/j.jclepro.2024.142989

Yang, Y [Yang], Jiang, L., & Zhang, Z. (2021). Tourists on shared bikes: Can bikesharing boost attraction demand? *Tourism Management*, 86, 104328. https://doi.org/10.1016/j.tourman.2021.104328

Ye, J., Bai, J., & Hao, W. (2024). A Systematic Review of the Coopetition Relationship between Bike-Sharing and Public Transit. *Journal of Advanced Transportation,* 2024(1), 6681895. https://doi.org/10.1155/2024/6681895

Yin, Z., Rybarczyk, G., Zheng, A., Su, L., Sun, B., & Yan, X. (2024). Shared micromobility as a first- and last-mile transit solution? Spatiotemporal insights from a novel dataset. *Journal of Transport Geography*, 114, Article 103778, 1–11. https://doi.org/10.1016/j.jtrangeo.2023.103778

Yu, S., Han, X., Liu, L., Liu, G., Cheng, M., Ke, Y., & Li, L. (2024). Exploring usage pattern variation of free-floating bike-sharing from a night travel perspective. *Scientific Reports*, 14(1), 16017. https://doi.org/10.1038/s41598-024-66564-2

Zabala, A. (2014). qmethod: A Package to Explore Human Perspectives Using Q Methodology. *The R Journal*, 6(163).

Zabala, A., Sandbrook, C., & Mukherjee, N. (2018). When and how to use Q methodology to understand perspectives in conservation research. *Conservation Biology: The Journal of the Society for Conservation Biology*, 32(5), 1185–1194.

Zhang, L., Zhang, J., Duan, Z., & Bryde, D. (2015). Sustainable bike-sharing systems: characteristics and commonalities across cases in urban China. *Journal of Cleaner Production*, 97, 124–133. https://doi.org/10.1016/j.jclepro.2014.04.006

Zhang, S., Chen, L., & Li, Y. (2021). Shared Bicycle Distribution Connected to Subway Line Considering Citizens' Morning Peak Social Characteristics for Urban Low-Carbon Development. *Sustainability*, 13, 9263. https://doi.org/10.3390/su13169263

Zhang, Y., Kasraian, D., & van Wesemael, P. (2023). Built environment and micromobility: A systematic review of international literature. *Journal of Transport and Land Use,* 16(1). https://doi.org/10.5198/jtlu.2023.2266

Zhao, C., Wang, L., Li, M., Chen, X., & Liu, N. (2024). Unlocking Sustainable Urban Mobility: Understanding the Impact of Motivational Factors on Dockless Bike-Sharing Adoption Within the Knowledge-Based Economy. *Journal of the Knowledge Economy*, 1–39. https://doi.org/10.1007/s13132-024-01737-y

Zhu, L., Ali, M., Macioszek, E., Aghaabbasi, M., & Jan, A. (2022). Approaching Sustainable Bike-Sharing Development: A Systematic Review of the Influence of Built Environment Features on Bike-Sharing Ridership. *Sustainability*, 14(10), 5795. https://doi.org/10.3390/su14105795

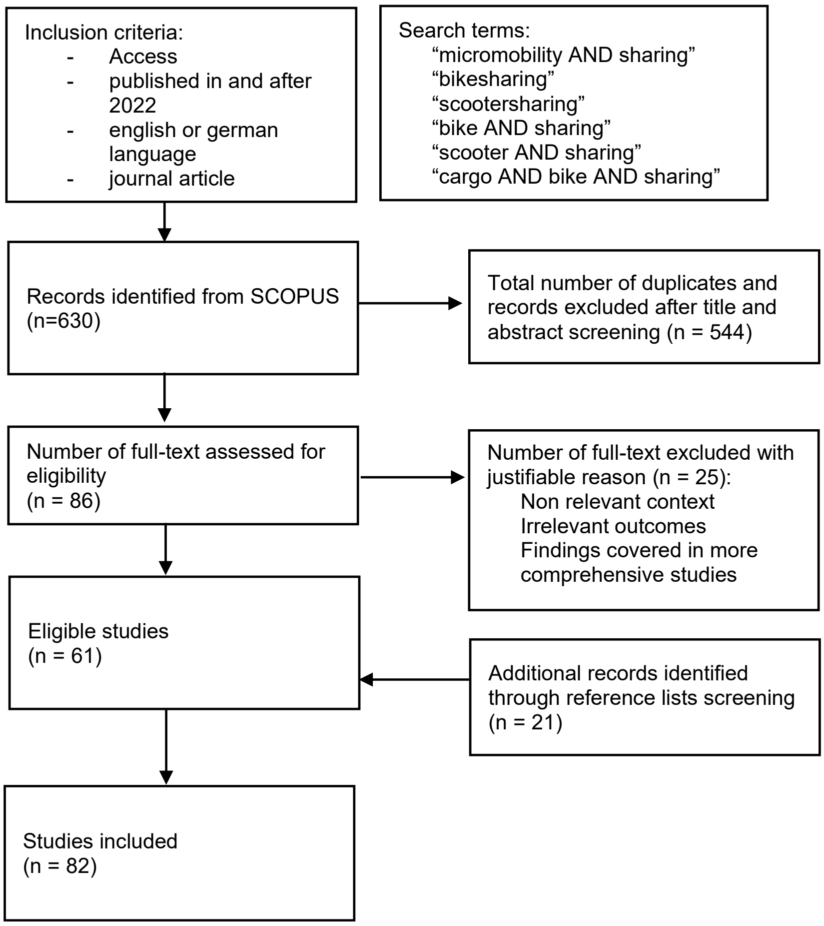
Zimmermann, K., & Palgan, Y. V. (2024). Upscaling cargo bike sharing in cities: A comparative case study. *Journal of Cleaner Production*, 477, 143774. https://doi.org/10.1016/j.jclepro.2024.143774

Zukunft Fahrrad e.V. (2024, September 17). *Ranking: Dresden und Karlsruhe beste deutsche Städte mit Bikesharing.* https://zukunft-fahrrad.org/bikesharing-europa-2024-report/?utm_source=chatgpt.com

Appendix

A.1 Prisma flow chart

The keyword search was conducted in December 2024.



A.2 List of newspaper articles

Newspaper	Title of the article	Date	Author	Link
Der Standard	Der "Radlerhauptstadt" Graz ist die Luft ausgegangen	01.04.2017		https://www.derstandard.at/story/2000055213593/der-radlerhauptstadt-graz-ist-die-luft-ausgegangen
Der Standard	Mobilität: Wien in Führung, Graz das Schlusslicht	30.05.2017	Müller, Walter	https://www.pressreader.com/austria/der-standard/20170530/page/12
Der Standard	Verleihsystem "Graz Bike" startet	29.08.2012		https://www.derstandard.at/story/1345165537867/verleihsystem-graz-bike-startet
MeinBezirk	Ein Gratis-Lastenrad für alle Jakomini-Bewohner - Graz	31.05.2016	Daublebsky, Max	https://www.meinbezirk.at/graz/c-lokales/ein-gratis-lastenrad-fuer-alle-jakomini-bewohner_a1754309
MeinBezirk	Lastenradverleich: Radverkehr wird neu gedacht - Graz-Umgebung	20.02.2020	Schemmerl, Nina	https://www.meinbezirk.at/graz-umgebung/c-lokales/lastenradverleich-radverkehr-wird-neu-gedacht_a3922200
Der Grazer	Die Stadt Graz bekommt bald 300 E-Scooter zum Ausleihen	01.12.2019	Radkovic, Vojo	https://grazer.at/story/de/die-stadt-graz-bekommt-bald-300-e-scooter-zum-36tVav3l/
Kleine Zeitung	Ab 10. Juli Radverleih in Weiz	29.06.2016		https://www.kleinezeitung.at/steiermark/weiz/4768902/Weiz-Bike_Ab-10-Juli-Radverleih-in-Weiz
Kleine Zeitung	Die Stadt Weiz setzt auf Elektro-Lastenräder	26.04.2019	Breitler, Robert	https://www.kleinezeitung.at/steiermark/weiz/5618570/EUProjekt_Die-Stadt-Weiz-setzt-auf-ElektroLastenraeder
Kleine Zeitung	E-Scooter per App leihen: Anbieter drängt nach Graz	24.08.2019		https://www.kleinezeitung.at/steiermark/graz/5678801/Mobilitaet_EScooter-per-App-leihen_Anbieter-draengt-nach-Graz
Kleine Zeitung	"Graz-Bike" bietet Verleih über Buchungsplattform	22.06.2016		https://www.kleinezeitung.at/steiermark/graz/3978701/Fahradverleih_GrazBike-bietet-

				Verleih-ueber-Buchung-splattform
Kleine Zeitung	Graz investiert 100 Millionen Euro in Radnetz	04.03.2020	Gruber, Jakob; Birchbauer, Ilian; Nussbaumer, Aurora; Kahr, Fiona	https://www.kleinezeitung.at/service/schule/5779296/Schueler-machen-Zeitung-im-Klusemann-Extern_Graz-investiert-100
Kleine Zeitung	E-Scooter erfreuen sich in Leoben großer Beliebtheit	08.07.2024	Gruber, Vanessa	https://www.kleinezeitung.at/steiermark/leoben/18637842/e-scooter-erfreuen-sich-in-leoben-grosser-beliebtheit
Kleine Zeitung	Stadt Graz startet Gratis-Verleih von Lastenrädern	28.11.2020	Hecke, Bernd	https://www.kleinezeitung.at/steiermark/graz/5904094/In-allen-Bezirken_Stadt-Graz-startet-GratisVerleih-von-Lastenraedern
Kleine Zeitung	Graz soll neues Leihradsystem bekommen	21.06.2016		https://www.kleinezeitung.at/steiermark/graz/4071989/Graz-soll-neues-Leihradsystem-bekommen
Kleine Zeitung	Ist Graz reif für ein Radverleihsystem?	06.12.2019		https://www.kleinezeitung.at/steiermark/graz/5733901/Umfrage-der-Woche_Ist-Graz-reif-fuer-ein-Radverleihsystem
Kleine Zeitung	Zwei neue Stationen: Fahrtwind für E-Scooter in Feldkirchen	07.08.2024	Miedl-Rissner, Marie	https://www.kleinezeitung.at/steiermark/graz/18740792/zwei-neue-stationen-fahrtwind-fuer-e-scooter-in-feldkirchen
Kleine Zeitung	Mit diesen Grazer Initiativen können Sie nachhaltig sparen	11.07.2022	Müller, Nina; Müller, Annalena; Rieger, Andrea	https://www.kleinezeitung.at/steiermark/graz/6162693/Fairteiler-bis-LastenradVerleih_Mit-diesen-Grazer-Initiativen
Kleine Zeitung	Radverleihsystem "WeizBike" funktioniert jetzt über das Handy	30.04.2021	Pregartner, Jonas	https://www.kleinezeitung.at/steiermark/weiz/5973587/Statt-mit-der-WeizCard_Radverleihsystem-WeizBike-funktioniert
Kleine Zeitung	Rad ausleihen wird deutlich einfacher	15.12.2020		https://www.kleinezeitung.at/steiermark/weiz/5911810/WeizBike_Rad-ausleihen-wird-deutlich-einfacher

Kleine Zeitung	Schwarz-Blau erteilt E-Scooter-Verleih in Graz eine Absage	05.12.2019		https://www.kleinezeitung.at/steier-mark/graz/5733297/Mobili-taet_SchwarzBlau-erteilt-EScooterVerleih-in-Graz-eine-Absage
Kleine Zeitung	Was tun Sie persönlich gegen den Feinstaub, Herr Bürgermeister?	22.02.2017		https://www.kleinezeitung.at/steier-mark/graz/5173382/Feinstaub_Was-tun-Sie-per-soenlich-gegen-den-Feinstaub-Herr-Nagl
Kleine Zeitung	Weizer fahren auf Leih-räder ab	29.06.2016		https://www.kleinezeitung.at/steier-mark/weiz/4849799/Rad-verleih_Weizer-fahren-auf-Leihraeder-ab
Kleine Zeitung	Ein Rad für Bierkisten, Waschmaschinen und Co	20.06.2016	Winter-Pöl-sler, Gerald	https://www.kleinezeitung.at/steier-mark/graz/4168847/Graz_Ein-Rad-fuer-Bierkisten-Waschmaschinen-und-Co
Kleine Zeitung	Radverleih-Riese aus Asien nimmt Kurs auf Graz	22.07.2017	Winter-Pöl-sler, Gerald	https://www.kleinezeitung.at/steier-mark/graz/5256235/Per-App-zum-Rad_Radver-leihRiese-aus-Asien-nimmt-Kurs-auf-Graz
Kleine Zeitung	Das Grazer Ringen mit dem Radverleih-Riesen aus Asien	31.08.2017	Winter-Pöl-sler, Gerald	https://www.kleinezeitung.at/steier-mark/graz/5277430/Nach-oBikeStart-in-Wien_Das-Grazer-Ringen-mit-dem-RadverleihRiesen
Kleine Zeitung	Kommt nach tim-Car-sharing auch Leihrad-system für Graz?	16.11.2017	Winter-Pöl-sler, Gerald	https://www.kleinezeitung.at/steier-mark/graz/5321672/Green-peace-Mobilitaetsrank-ing_Kommt-nach-timCar-sharing-auch
Kleine Zeitung	Das Ende des Leihrad-Booms: Warum Graz unbeschadet davon-kommt	11.07.2018	Winter-Pöl-sler, Gerald	https://www.kleinezeitung.at/steier-mark/graz/5462402/Ofo-Obike-Co_Das-Ende-des-LeihradBooms_Warum-Graz-unbeschadet
Kleine Zeitung	Graz zieht eine Ober-grenze für E-scooter ein	15.03.2019	Winter-Pöl-sler, Gerald	https://www.pressreader.com/austria/kleine-zeitung-steier-mark/20190315/page/28
Kleine Zeitung	Graz will ein Monopol bei E-Scootern schaffen.	13.11.2019	Winter-Pöl-sler, Gerald	https://www.kleinezeitung.at/steier-mark/graz/5721117/Mobili-taet_Graz-will-ein-Monopol-bei-EScootern-schaffen

Kleine Zeitung	Kann Graz auf einen globalen und gehypten Trend verzichten? Ja, Graz kann	05.12.2019	Winter-Pölsler, Gerald	https://www.kleinezeitung.at/steiermark/graz/5733494/EScooter_Kann-Graz-auf-einen-globalen-und-gehypten-Trend
Kleine Zeitung	E-Scooter-Verleih: Graz erteilt keine Lizenzen	09.12.2019	Winter-Pölsler, Gerald	https://www.pressreader.com/austria/kleine-zeitung-steiermark/20191205/page/20
Kleine Zeitung	Neuer Anlauf für ein Rad-Verleihsystem in Graz.	13.02.2021	Winter-Pölsler, Gerald	https://www.kleinezeitung.at/steiermark/graz/5934808/Beim-SmartCityStandort_Neuer-Anlauf-fuer-ein-RadVerleih-system-in-Graz, zuletzt geprüft am 18.09.2024.
Kleine Zeitung	Bestärkt durch Paris: Graz bleibt beim Nein zu Leih-Scootern	03.04.2023	Winter-Pölsler, Gerald	https://www.kleinezeitung.at/steiermark/graz/6271353/Tier-vor-Gericht-abgeblitzt_Bestaerkt-durch-Paris_Graz-bleibt
Kleine Zeitung	Feldkirchen hat jetzt 55 E-Scooter zum Ausleihen	22.03.2024	Winter-Pölsler, Gerald	https://www.kleinezeitung.at/steiermark/graz/18300266/feldkirchen-hat-jetzt-55-e-scooter-zum-ausleihen
Kleine Zeitung	Feldkirchen setzt voll auf Leih-Scooter	23.03.2024	Winter-Pölsler, Gerald	https://www.pressreader.com/austria/kleine-zeitung-steiermark/20240323/page/28
Kleine Zeitung	SPÖ startet neuen Anlauf für Radverleih-System in Graz	16.05.2024	Winter-Pölsler, Gerald	https://www.kleinezeitung.at/steiermark/graz/18468937/spoe-startet-neuen-anlauf-fuer-radverleih-system-in-graz
Kleine Zeitung	"Ich nehme Kritik ernst – das ist der große Unterschied"	30.09.2022	Winter-Pölsler, Gerald; Rieger, Andrea	https://www.kleinezeitung.at/steiermark/graz/stadtpolitik/6184844/Schwentner-im-Interview_Ich-nehme-Kritik-ernst-das-ist-der-grosse

A.3 Q-statements – German version

Ökologische Nachhaltigkeit	
1	Ein Fahrradverleihsystem ist aus Umweltsicht positiv.
2	Ein Mikromobilitätsverleihsystem kann die Nutzung verschiedener Verkehrsmittel so beeinflussen, dass mehr umweltfreundliche Alternativen gewählt werden (Modal Split Verschiebung).
3	Leih-Lastenräder bieten eine umweltschonende, stressfreie Alternative zum Auto, indem sie für alltägliche Transporte wie Einkäufe, Getränkekisten oder Kinder genutzt werden.
4	Durch Leih-Lastenräder können viele Autofahrten ersetzt werden.
5	Die ökologischen Auswirkungen von Leih-E-Scootern sind bedenklich, da ihre kurze Haltbarkeit zu erhöhtem Elektroschrott führt.
6	Leih-E-Scooter fördern das Ziel, die Abgasemissionen in der Stadt zu reduzieren.
7	Mit einem Leih-Fahrrad lassen sich alltägliche Wege effizient, umweltfreundlich und mit Bewegung bewältigen.
Soziale Nachhaltigkeit	
8	Mit einem Mikromobilitätsverleihsystem kann Fortbewegung als gesundheitsfördernde Aktivität gestaltet werden.
9	Ein Mikromobilitätsverleihsystem bietet eine kostengünstige Alternative zum persönlichen Besitz und hilft damit soziale Ungleichheit zu reduzieren.
Mobilitätsverhalten und Verkehrswende	
10	Ein Fahrradverleihsystem ist eine zentrale Maßnahme für die Mobilitätswende.
11	Ein Fahrradverleihsystem kann dazu beitragen, dass sich mehr Menschen in der Stadt für das Radfahren entscheiden.
12	Leih-E-Scooter und Leih-Fahrräder fördern das Ziel, innerstädtisch weniger Autos zu nutzen.
13	Leih-E-Scooter und Leih-Fahrräder können die erste und letzte Strecke zum öffentlichen Verkehr schnell und umweltfreundlich überbrücken, was oft der entscheidende Faktor für die Nutzung des öffentlichen Verkehrs ist.
14	Ein stationäres Fahrradverleihsystem soll vor allem für Pendler:innen eine Ergänzung zum öffentlichen Verkehr bieten.
15	Besonders zu Zeiten, in denen kein öffentlicher Verkehr fährt, sind Leih-E-Scooter und Leih-Fahrräder eine sichere und kostengünstige Alternative zum Taxi.
16	Leih-E-Scooter tragen zur Verringerung des Verkehrsaufkommens in der Stadt bei.
17	Durch Nutzung eines Mikromobilitätsverleihsystems können Staus innerhalb der Stadt reduziert werden.
18	Lediglich Fußgänger:innen und ÖV-Nutzer:innen nutzen Leih-E-Scooter, aber kaum jemand lässt das Auto stehen, um einen Leih-E-Scooter zu verwenden.
19	Leih-E-Scooter verändern das Mobilitätsverhalten kontraproduktiv, indem nun Wege, die man zu Fuß geht, mit dem E-Scooter erledigt werden.
20	Der Einsatz von Leih-E-Scootern kann sich negativ auf eine fußgänger:innenfreundliche Stadt auswirken.

Städtische Identität und Attraktivität	
21	Zu einer fahrradfreundlichen Stadt gehört ein praktikables und nutzer:innenfreundliches Fahrradverleihsystem.
22	Als Stadt mit starker Fahrradkultur sollte Graz über ein Fahrradverleihsystem verfügen.
23	Die Installation eines Mikromobilitätsverleihsystems wäre wünschenswert, um Graz für Tourist:innen attraktiver zu gestalten.
24	Jene Hälfte der Grazer:innen, die kein eigenes Fahrrad besitzen, kann von einem stationslosen Fahrradverleihsystem profitieren.
25	Es liegt im Interesse der Stadt, mehr Menschen zum Radfahren zu motivieren, wozu auch der Aufbau eines Fahrradverleihsystems gehört.
26	In Graz sind Leih-Fahrräder nicht notwendig, da die Raddurchdringung sehr groß ist und fast jeder Haushalt mindestens ein Fahrrad besitzt.
Management und Organisation	
27	Es ist unklar, wer die Finanzierung eines Mikromobilitätsverleihsystems übernehmen soll.
28	Ein flächendeckendes Mikromobilitätsverleihsystem wäre nur durch Werbeeinnahmen finanzierbar.
29	Für stationslose Leih-E-Scooter und Leih-Fahrräder müssen klare Abstellzonen an stark frequentierten Orten definiert werden, um Chaos und Gefahrenzonen zu vermeiden.
30	Es sind Vorkehrungen wie Strafen notwendig, um Chaos durch falsch abgestellte Leih-E-Scooter und Leih-Fahrräder zu vermeiden.
Platz, Ordnung und Verkehr	
31	Leih-E-Scooter, die überall herumliegen, dürfen in Graz nicht zugelassen werden, um Gefahrenzonen und Konflikte zu vermeiden.
32	Achtlos abgestellte Leih-E-Scooter stellen eine Hürde im öffentlichen Raum dar, insbesondere für ältere Menschen und Personen mit körperlichen Einschränkungen.
33	Falsch abgestellte Leih-E-Scooter und Leih-Fahrräder behindern oft den Verkehr.
34	In Graz gibt es keinen Platz für ein Mikromobilitätsverleihsystem.

A.4 Idealized Q-sort for Factor A

Factor A: The public transport complementors

-4	-3	-2	-1	0	1	2	3	4
28. A comprehensive micromobility sharing system could only be financed through advertising	26. In Graz, shared bikes are not necessary, as bicycle penetration is very high and almost every	20. The use of shared e-scooters can have a negative impact on a pedestrian-friendly city.	10. A bike sharing system is a key measure for the mobility transition.	11. A bike sharing system can help to encourage more people to cycle in the city.	19. Shared e-scooters change mobility behavior in a counterproductive way, as trips that	13. Shared e-scooters and shared bikes can bridge the first and last mile to public transport	25. It is in the city's interest to motivate more people to cycle, which includes setting up a bike	** ► 14. A stationbased bike sharing system should offer a supplement to public transport, especially for
34. There is no space for a micromobility sharing system in Graz.	17. By using a micromobility sharing system, traffic jams within the city can be reduced.	12. Shared e-scooters and shared bikes promote the goal of using fewer cars in the city center.	5. The ecological impact of shared e-scooters is questionable, as their short lifespan leads to	8. With a micromobility sharing system, transportation can be designed as a health-promoting	32. Carelessly parked shared e-scooters are an obstacle in public spaces, especially for older people	15. Especially at times when there is no public transport, shared e-scooters and shared bikes are a	** ► 18. Only pedestrians and public transport users use shared e-scooters, but hardly anyone	22. As a city with a strong cycling culture, Graz should have a bike sharing system.
	30. Precautions such as penalties are necessary to avoid chaos caused by incorrectly parked shared	16. Shared e-scooters help to reduce the volume of traffic in the city.	27. It is unclear who should take over the financing of a micromobility sharing system.	23. The installation of a micromobility sharing system would be desirable in order to make	1. A bike sharing system is positive from an environmental point of view.	29. Clear parking zones must be defined for stationless shared e-scooters and shared bikes in	3. Shared cargo bikes offer an environmentally friendly, stress-free alternative to the	
		* 31. Shared e-scooters lying around everywhere should not be allowed in Graz in order to avoid	6. Shared e-scooters promote the goal of reducing exhaust emissions in the city.	2. A micromobility sharing system can influence the use of different modes of transportation so that more	4. Shared cargo bikes can replace many car journeys.	21. A bicycle-friendly city requires a practical and user-friendly bike sharing system.		
			9. A micromobility sharing system offers a cost-effective alternative to personal ownership	7. With a shared bike, everyday journeys can be made efficiently, environmentally friendly and with	24. The half of Graz residents who do not own a bike can benefit from a stationless bike sharing system.			
				33. Incorrectly parked shared e-scooters and shared bikes often obstruct traffic.				

Legend

- * Distinguishing statement at P< 0.05
- ** Distinguishing statement at P< 0.01
- ► z-Score for the statement is higher than in all other factors
- ◄ z-Score for the statement is lower than in all other factors

A.5 Idealized Q-sort for Factor B

Factor B: The e-scooter opponents

-4	-3	-2	-1	0	1	2	3	4
* ◄ 16. Shared e-scooters help to reduce the volume of traffic in the city.	** ◄ 14. A stationbased bike sharing system should offer a supplement to public transport, especially for	6. Shared e-scooters promote the goal of reducing exhaust emissions in the city.	* ◄ 21. A bicycle-friendly city requires a practical and user-friendly bike sharing system.	18. Only pedestrians and public transport users use shared e-scooters, but hardly anyone	19. Shared e-scooters change mobility behavior in a counterproductive way, as trips that	3. Shared cargo bikes offer an environmentally friendly, stress-free alternative to the	29. Clear parking zones must be defined for stationless shared e-scooters and shared bikes in	** ► 32. Carelessly parked shared e-scooters are an obstacle in public spaces, especially for older people
9. A micromobility sharing system offers a cost-effective alternative to personal ownership	17. By using a micromobility sharing system, traffic jams within the city can be reduced.	4. Shared cargo bikes can replace many car journeys.	25. It is in the city's interest to motivate more people to cycle, which includes setting up a bike	* ► 26. In Graz, shared bikes are not necessary, as bicycle penetration is very high and almost every	23. The installation of a micromobility sharing system would be desirable in order to make	33. Incorrectly parked shared e-scooters and shared bikes often obstruct traffic.	** ► 30. Precautions such as penalties are necessary to avoid chaos caused by incorrectly parked shared	** ► 31. Shared e-scooters lying around everywhere should not be allowed in Graz in order to avoid
	10. A bike sharing system is a key measure for the mobility transition.	28. A comprehensive micromobility sharing system could only be financed through advertising	12. Shared e-scooters and shared bikes promote the goal of using fewer cars in the city center.	1. A bike sharing system is positive from an environmental point of view.	24. The half of Graz residents who do not own a bike can benefit from a stationless bike sharing system.	11. A bike sharing system can help to encourage more people to cycle in the city.	** ► 20. The use of shared e-scooters can have a negative impact on a pedestrian-friendly city.	
		34. There is no space for a micromobility sharing system in Graz.	* ◄ 22. As a city with a strong cycling culture, Graz should have a bike sharing system.	27. It is unclear who should take over the financing of a micromobility sharing system.	13. Shared e-scooters and shared bikes can bridge the first and last mile to public transport	* ► 5. The ecological impact of shared e-scooters is questionable, as their short lifespan leads to		
			15. Especially at times when there is no public transport, shared e-scooters and shared bikes are a	7. With a shared bike, everyday journeys can be made efficiently, environmentally friendly and with	8. With a micromobility sharing system, transportation can be designed as a health-promoting			
				2. A micromobility sharing system can influence the use of different modes of transportation so that more				

Legend

- * Distinguishing statement at P< 0.05
- ** Distinguishing statement at P< 0.01
- ► z-Score for the statement is higher than in all other factors
- ◄ z-Score for the statement is lower than in all other factors

A.6 Idealized Q-sort for Factor C

Factor C: The regulation advocates

-4	-3	-2	-1	0	1	2	3	4
** ◄ 4. Shared cargo bikes can replace many car journeys.	* ◄ 2. A micromobility sharing system can influence the use of different modes of transportation so that more	15. Especially at times when there is no public transport, shared e-scooters and shared bikes are a	8. With a micromobility sharing system, transportation can be designed as a health-promoting	1. A bike sharing system is positive from an environmental point of view.	** 30. Precautions such as penalties are necessary to avoid chaos caused by incorrectly parked shared	21. A bicycle-friendly city requires a practical and user-friendly bike sharing system.	22. As a city with a strong cycling culture, Graz should have a bike sharing system.	29. Clear parking zones must be defined for stationless shared e-scooters and shared bikes in
* ◄ 31. Shared e-scooters lying around everywhere should not be allowed in Graz in order to avoid	27. It is unclear who should take over the financing of a micromobility sharing system.	26. In Graz, shared bikes are not necessary, as bicycle penetration is very high and almost every	28. A comprehensive micromobility sharing system could only be financed through advertising	18. Only pedestrians and public transport users use shared e-scooters, but hardly anyone	12. Shared e-scooters and shared bikes promote the goal of using fewer cars in the city center.	24. The half of Graz residents who do not own a bike can benefit from a stationless bike sharing system.	25. It is in the city's interest to motivate more people to cycle, which includes setting up a bike	7. With a shared bike, everyday journeys can be made efficiently, environmentally friendly and with
	34. There is no space for a micromobility sharing system in Graz.	10. A bike sharing system is a key measure for the mobility transition.	5. The ecological impact of shared e-scooters is questionable, as their short lifespan leads to	32. Carelessly parked shared e-scooters are an obstacle in public spaces, especially for older people	14. A stationbased bike sharing system should offer a supplement to public transport, especially for	** ► 16. Shared e-scooters help to reduce the volume of traffic in the city.	11. A bike sharing system can help to encourage more people to cycle in the city.	
		9. A micromobility sharing system offers a cost-effective alternative to personal ownership	* ◄ 3. Shared cargo bikes offer an environmentally friendly, stress-free alternative to the	33. Incorrectly parked shared e-scooters and shared bikes often obstruct traffic.	13. Shared e-scooters and shared bikes can bridge the first and last mile to public transport	* ► 6. Shared e-scooters promote the goal of reducing exhaust emissions in the city.		
			20. The use of shared e-scooters can have a negative impact on a pedestrian-friendly city.	19. Shared e-scooters change mobility behavior in a counterproductive way, as trips that	* ► 17. By using a micromobility sharing system, traffic jams within the city can be reduced.			
				23. The installation of a micromobility sharing system would be desirable in order to make				

Legend

* Distinguishing statement at P< 0.05

** Distinguishing statement at P< 0.01

► z-Score for the statement is higher than in all other factors

◄ z-Score for the statement is lower than in all other factors

A.7 Idealized Q-sort for Factor D

Factor D: The context-conscious supporters

-4	-3	-2	-1	0	1	2	3	4
** ◀ 19. Shared e-scooters change mobility behavior in a counterproductive way, as trips that	10. A bike sharing system is a key measure for the mobility transition.	16. Shared e-scooters help to reduce the volume of traffic in the city.	6. Shared e-scooters promote the goal of reducing exhaust emissions in the city.	14. A stationbased bike sharing system should offer a supplement to public transport, especially for	11. A bike sharing system can help to encourage more people to cycle in the city.	* ▶ 8. With a micromobility sharing system, transportation can be designed as a health-promoting	7. With a shared bike, everyday journeys can be made efficiently, environmentally friendly and with	* ▶ 13. Shared e-scooters and shared bikes can bridge the first and last mile to public transport
34. There is no space for a micromobility sharing system in Graz.	** ◀ 18. Only pedestrians and public transport users use shared e-scooters, but hardly anyone	28. A comprehensive micromobility sharing system could only be financed through advertising	5. The ecological impact of shared e-scooters is questionable, as their short lifespan leads to	25. It is in the city's interest to motivate more people to cycle, which includes setting up a bike	21. A bicycle-friendly city requires a practical and user-friendly bike sharing system.	15. Especially at times when there is no public transport, shared e-scooters and shared bikes are a	12. Shared e-scooters and shared bikes promote the goal of using fewer cars in the city center.	** ▶ 1. A bike sharing system is positive from an environmental point of view.
	26. In Graz, shared bikes are not necessary, as bicycle penetration is very high and almost every	20. The use of shared e-scooters can have a negative impact on a pedestrian-friendly city.	24. The half of Graz residents who do not own a bike can benefit from a stationless bike sharing system.	* 31. Shared e-scooters lying around everywhere should not be allowed in Graz in order to avoid	3. Shared cargo bikes offer an environmentally friendly, stress-free alternative to the	33. Incorrectly parked shared e-scooters and shared bikes often obstruct traffic.	** ▶ 2. A micromobility sharing system can influence the use of different modes of transportation so that more	
		27. It is unclear who should take over the financing of a micromobility sharing system.	30. Precautions such as penalties are necessary to avoid chaos caused by incorrectly parked shared	23. The installation of a micromobility sharing system would be desirable in order to make	32. Carelessly parked shared e-scooters are an obstacle in public spaces, especially for older people	29. Clear parking zones must be defined for stationless shared e-scooters and shared bikes in		
			17. By using a micromobility sharing system, traffic jams within the city can be reduced.	* ▶ 9. A micromobility sharing system offers a cost-effective alternative to personal ownership	* 22. As a city with a strong cycling culture, Graz should have a bike sharing system.			
				4. Shared cargo bikes can replace many car journeys.				

Legend

- * Distinguishing statement at P< 0.05
- ** Distinguishing statement at P< 0.01
- ▶ z-Score for the statement is higher than in all other factors
- ◀ z-Score for the statement is lower than in all other factors