The Electric Scooter: a sustainable form of urban micro-mobility transport?

A Geographical Overview

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ABSTRACT:

Urbanisation has been overgrown in recent years, and the ever-increasing demand for efficient transportation options has pointed to significant challenges for cities around the globe. It became a pressing concern for eco-friendly, sustainable and convenient modes of transportation. To overcome these challenges, electric scooters have emerged with a unique blend of mobility as a promising solution with the interface of convenience, and environmental friendliness. The introduction of electric scooters (e-scooters) in transportation has provoked debate about the pros & cons of the service within the cities. It is relatively a new mode of transportation that has grown in popularity in recent years. People have seen them as a potential solution to problems such as traffic congestion and air pollution. While others raised concerns regarding the safety of e-scooters and their impact on pedestrian walkways, alongside debates regarding their true environmental impact.

However, there are trade-offs and their impact on city dwellers is controversial which is the starting point for this thesis. To justify the contribution of e-scooters to both transportation and society, the main research question outlined below will be the main focus area.

To what extent can e-scooters be considered a sustainable mode of transport?

To seek the answer to the above question, two additional sub-questions were considered. They are, Q1. What modes of transport do e-scooters replace? And Q2. What socio-demographic factors affect an individual's preference to replace other transport?

A structured questionnaire survey was conducted, incorporating opportunities for respondents to express their opinions alongside structured inquiries. The survey focused on e-scooter users in Bergen as participants. This thesis will also adopt a geographical perspective to analyze the various factors that influence the adoption and implementation of electric scooters as a sustainable transport option. However, individuals who do not use e-scooters were excluded from consideration.

This thesis aims to provide a comprehensive understanding of electric scooters as an urban micro-mobility sustainable transport option. It will explore the geographical context within which electric scooters operate, focusing on their implications for urban landscapes, transportation networks, and overall sustainability. By examining the opportunities and challenges associated with the integration of electric scooters into urban environments, this study intends to contribute to the ongoing discourse surrounding sustainable transportation solutions.

The concept of micro-mobility has gained significant attention in recent years. For a short-distance trip, the use of compact and lightweight vehicles such as Electric scooters, powered by electric motors and rechargeable batteries, has quickly emerged as a popular choice among people since it is offering an efficient and flexible solution for short trips within urban areas. With their ability to manoeuvre through congested city streets and their potential to reduce traffic congestion, electric scooters have gained interest as a viable solution for last-mile connectivity and urban micro-mobility transportation challenges. Another benefit of e-scooters is their adaptability in size which allows users to easily board on public transport. This feature facilitates the realization of multimodal trips, where e-scooters can be combined with any mode of public transportation subsystem.

The literature review reveals numerous studies exploring various aspects of e-scooters, from their impact on urban mobility to safety and regulatory challenges. However, a notable gap exists in comprehensively understanding the long-term societal implications of e-scooter adoption, especially regarding their integration into broader urban transportation systems and consequent shifts in travel behaviour. Current studies have focused on specific areas such as consumer acceptance, safety measures, and regulatory practices. However, there is a critical need for a comprehensive investigation into the overall effects of e-scooters on urban mobility patterns, environmental sustainability, and social equity.

In conclusion, E-scooters have emerged with prospects of sustainable and transformative force in Bergen's transportation system that has appealed to a diverse demographic and significantly influenced travel behavior. They reduced the reliance on polluting transport modes slightly, such as cars and taxis, but dangerously replaced other recognised sustainable modes of transport like walking and public transport which is limiting their overall sustainability impact.

This study used the Avoid-Shift-Improve (ASI) model to justify its sustainability. E-scooters have the potential to be a sustainable form of transport, but their current impact is mixed. They are not significantly avoiding a substantial amount of unsustainable transport but being a part of the multimodal trip, they are contributing to reducing the connectivity gap. Following the ASI principle, “avoid” and “shift” are challenging due to their huge popularity. However, the “improve” perspective may play a significant role here. Enhancing existing transportation systems, addressing challenges like user behavior and implementing strategic policies are essential for promoting responsible use and enhancing safety. Technological advancements in battery efficiency, stringent regulations, and better integration with public transport are crucial for maximizing the benefits of e-scooters and ensuring their role in a comprehensive, sustainable urban mobility network.

Keywords:

Electric scooters (e-scooters), Urban micro-mobility, Avoid-Shift-Improve (ASI) model, Sustainable transport, Last-mile connectivity, Travel behavior, Regulatory challenges

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1. Introduction:

In the fast-paced life of the city, people are looking for smart ways to stick to their schedules, and e-scooters have emerged as a unique type of vehicle with special technical features to address this need. Currently, these scooters are primarily used for covering the last mile or short distances within the transportation system. The widespread adoption of e-scooters in many cities worldwide has generated significant interest in the concept of micro-mobility, which refers to the movement over short distances—a notable challenge in urban areas today. This involves various scenarios, such as commuting from home to bus or train stops, travelling short distances within the vicinity of universities or workplaces to reach transit stops, and sometimes just enjoying a ride for leisure. E-scooters are becoming increasingly recognized for their ability to address the challenges associated with short-distance movement in cities, bridging the gap between different points within urban areas. The widespread adoption of e-scooters is anticipated to correspondingly decrease car usage, particularly for short distances. This shift from cars to e-scooters is expected to enhance the overall environmental and urban sustainability of cities. E-scooters offer significant advantages over cars, such as environmental friendliness (lower noise and emissions), space efficiency, and notably, congestion reduction. Consequently, there is a growing imperative and preference to embrace this new, sustainable mode of transportation and integrate it into urban landscapes (Glavić et al., 2021). Another benefit of e-scooters is their adaptability in size, allowing users to easily board public transport vehicles. This feature facilitates the realization of multimodal trips, where e-scooters can be seamlessly combined with any mode of public transportation subsystem.

In a few cities like Oslo, suddenly the operators distributed a large number of e-scooters without the knowledge of authority and many local authorities were not prepared to efficiently handle the situation to integrate this new transport with the existing regulatory system (Johnson, 2020). Even though the current traffic system and its traffic rules are unclear, day by day e-scooters are going to be popular. We may consider its popularity involved in the socio-demographic characteristics, psychological factors, and individual values.

Photo 1 (own source), Numbers of E-scooters at the centre of the Bergen city

Like other cities in the world, e-scooters in Bergen also became popular within a short time. On the one hand, its usage increasing as urban micro-mobility transport, on the other hand, issues are associated with them like dockless e-scooters left by the riders all over the city, and obstruction created in the sidewalk and public paths which create hazards to pedestrians (Choron and Sakran, 2019).

In my research, I will consider Bergen as my geographical study location. Despite valuable research on its pros and cons, this research aims to assess the sustainability of e-scooters in Bergen by examining their impact on existing transportation modes and the socio-demographic factors influencing their adoption. While e-scooters offer a flexible, low-carbon alternative for short trips and last-mile connectivity, they often replace more sustainable modes like walking, cycling, and public transport rather than car trips. This substitution, coupled with high accident rates and improper usage, challenges their sustainability credentials. The study seeks to clarify e-scooters' role in urban mobility, providing insights for policymakers to enhance their benefits and address their drawbacks. Key questions include identifying which transport modes e-scooters replace and the socio-demographic factors influencing their use.

Refer to the EU Commission's recommendations about the distance of the most significant urban activity destinations below and an e-scooter can cover all fields (Zagorskas and Burinskienė, 2020).

Scale	Objects:	Distance, m	Dominating mode
Neighborhood	Public transport stops	300	Walking
	Child playground, kindergarten, pre-schoool	400	Walking, bicycle, car, public transport
	Local shops, stores	400	Walking, bicycle, car, public transport
District	Sports club, park	600	Walking, bicycle
	Health care centers	800	Bicycle, car, public transport, walking
	Secondary school	1000	Bicycle, car, public transport, walking
	Leasure centers	1500	Bicycle, car, public transport
	Supermarkets, hospitals	5000	Bicycle, car, public transport

Figure 1 Distance of the most significant urban activity.

E-scooters have emerged as a novel addition to the suite of shared transportation alternatives available in urban environments. What distinguishes them is not just their functional utility but also their emotional resonance with users. One notable aspect contributing to their popularity is the sense of playfulness they evoke. Unlike traditional modes of transportation, riding an e-scooter often elicits feelings of joy, freedom, and excitement. This emotional experience enhances the overall appeal of e-scooters, making them not only a practical means of getting around but also a source of enjoyment for users. As a result, the infusion of playfulness into the e-scooter experience has played a significant role in shaping their widespread adoption and acceptance in urban settings (Hardt and Bogenberger, 2019).

"The rapid rise of shared mobility—through ride-hailing, car sharing, and shared public bicycle systems—paved the way for e-scooters, responding to the public's appetite for cheap, convenient, and flexible ways to quickly get around increasingly congested cities. But even beyond the practicality of e-scooters is the element of fun that they offer: anyone—whether an executive in a suit or a student in jeans—can enjoy feeling like a little kid again", stated a study (Schellong et al., 2019).

Initiated by the American operator Bird in Los Angeles in 2017, electronic scooters (e-scooters) have proliferated across numerous urban centres. This rapid proliferation is underpinned by substantial venture capital investments, driven by the financial sector's recognition of micro-mobility as a burgeoning industry. According to The Boston Consulting Group (BCG), a preeminent consultancy, the foremost 12 e-scooter start-ups globally have secured over US$1.5

billion in funding, and BCG posits that the worldwide market valuation of e-scooters may attain US$40–50 billion by 2025 (Schellong et al., 2019). Anticipated significant markets shortly encompass Europe and the USA, each estimated at US$12–15 billion, and China, expected to reach US$6–8 billion (Schellong et al., 2019). The prevailing business outlook is centred on the expectation that e-scooters will evolve into a pivotal mode of urban transportation.

Companies assert that integrating e-scooters into sharing services is sustainable, as it can reduce private car use and mitigate its negative environmental consequences (Bird Rides, 2019, Savage, 2023). The industry also contends that these schemes hold promise in establishing a more equitable transportation network accessible to all individuals (Clewlow et al., 2018, Stowell, 2020), although academic research has not yet corroborated this assertion. Researchers argue that e-scooter trips primarily replaced trips that would otherwise have been conducted by more sustainable modes of transportation such as walking, cycling, or public transport (Civity, 2019). While this is the scenario, the resources needed for producing, charging, collecting, and distributing shared e-scooters, generate emissions that may constitute an additional burden with negative effects on people and the environment (Hollingsworth et al., 2019).

E-scooters are particularly well-suited for short-distance travel, analysed data from a German e-scooter provider, approximately 5% of trips cover distances up to 1 km, 25% span between 1 and 3 km, and 33% fall within the range of 4 to 6 km (Degele et al., 2018). Notably, a third of journeys extend beyond the 6 km mark, challenging the notion that e-scooters exclusively serve as 'last mile' transport modes, as suggested by some scholars (Herrman, 2019). However, the extent to which e-scooters generate additional transport demand and potentially substitute car traffic remains uncertain. Sceptical views say that e-scooters may compete with cycling and walking (Civity, 2019). In contrast, bike rentals have reduced motor vehicle use (Fishman et al., 2014), and e-scooters have a unique role that doesn't compete directly with cycling (McKenzie, 2019). Despite these uncertainties, both observers and urban planners generally concur that e-scooters contribute positively to urban mobility (Civity, 2019). Overall, this suggests that although electric scooters may replace environmentally friendly modes of transportation such as walking, public transport, and cycling, they likely contribute to a multimodal transportation system that collectively provides an alternative to car use and car ownership.

However, numerous ancillary issues hinder and diminish the positive impacts of electric scooters, including unclear regulations, insufficient infrastructure, and inappropriate user behaviour (Gössling, 2020, Yang et al., 2020). Several countries, such as Germany, France, Singapore, New Zealand, Australia, and California, have implemented comprehensive regulations governing e-scooter usage. Also, many countries, like the UK, are in transitional phases, while others have yet to enact any regulatory measures (Glavić et al., 2021). Following incidents of battery explosions on the subway, several rail companies in Britain (Yanatma, 2023) and public transport systems in a few cities in Spain (Burbano, 2023) imposed a ban on e-scooters due to safety concerns related to Li-ion batteries.

I also witnessed a battery issue with an e-scooter (not rental) in Dec 2021, Fantoft student housing. In the middle of the night, the total building residents were evacuated due to a fire alarm. Later we got to know that a personal usage e-scooter was being charged and that battery was burning while the person was outside of the room. Downstairs, we found two fire Bridget fighters who took the e-scooter into the ice to make it cool.

Photo 2 (own source) Battery issue, E-scooter at Fantoft student housing, Bergen

A fundamental question arises when considering the introduction of e-scooters: could these vehicles become a groundbreaking niche innovation? This question delves into the potential transformative impact of e-scooters within the transportation landscape. It prompts exploration into whether e-scooters possess the capacity to revolutionize urban mobility patterns, challenging existing norms and paradigms.

1.1. Statement of the problem:

Day by day micro-mobility is increasingly getting attention in urban transport, particularly because it has the potential to reduce private transport use in short-distance movement. Among the current micro-mobility modes, e-scooters are powered by electricity, smaller than traditional transportation modes, and suitable for personal use at a relatively short distance (Hardt and Bogenberger, 2019). Nevertheless, they are convenient to carry and can easily be moveable in a micro-space (Lee et al., 2021). Considering shared-based micro-mobility transport, an e-scooter is a low-weight small space space-consuming vehicle and a low-carbon emitter. Nowadays micro-mobility is a unique urban transport solution considering the last and first-kilometre trips, it's an on-demand vehicle alternative (Shaheen et al., 2020). Therefore, its popularity is gaining day by day around the globe. E-scooters offer another type of micro-mobility transport system and play an important role in the city's residents. It offers a smart solution to urban life and is chosen especially by the young population aged below forty years because it is a faster, more flexible, and more fun vehicle (Zagorskas and Burinskienė, 2020). Both categories of e-scooters, public and ride-sharing companies are seen on the road, companies dockless ride-sharing app allows people to use them and leave them at their destination for the next user's usage which makes them popular.

Worldwide its popularity increased and got public attention in 2017 when many private companies established large-scale 'free-floating or 'dockless' rental policies in urban areas worldwide (Choron and Sakran, 2019). Their e-scooters became easy to get on the road, people can unlock them by using the mobile app and can lock them again after using them in public places within their allowed areas (Tuncer et al., 2020). The factors contributing to the substitution of cars with e-scooters include competition with transport network companies or taxi services, trip purposes, lower cost, and social or entertainment motives. Additionally, households with multiple vehicles opt to replace one or more of their private vehicles (Guo and Zhang, 2021). It is beneficial for those who cannot afford to buy a private vehicle, a shared micro-mobility service gives them access to a smart travel experience. It seems a smart transport solution with an environment-friendly interface, lower carbon emissions, and fewer space-taking features have made it unique from other motorized conventional vehicles.

Though the e-scooter is a promising vehicle in the micro-mobility sector, there are debates about its sustainability too. In a survey study, it was found that among the people who are using sharing e-scooter systems, 50-80% of trips they previously were done by walking, cycling, or public transport (Eccarius and Lu, 2018). The short-distance travelling behaviour of people is going to be changed and they are looking for a smart solution, and another two key challenges also involved in it are high accident risk and littering of e-scooters. Preliminary data from Oslo, Denmark, and the USA indicate that the accident frequency for e-scooters is approximately ten times higher than that for bicycles. In 2019, two separate studies in Oslo revealed that 1 in 10 electric scooter riders had experienced an accident while using an e-scooter (Johnson, 2020). Another survey data showed that e-scooters in Oslo replace more walking and cycling trips than car and taxi trips, around four times higher (Johnson, 2020). Nevertheless, the substitution of car and taxi trips is substantial enough to balance out this effect. Additionally, it's noteworthy that some of the walking and cycling trips replaced by e-scooters were originally part of a travel sequence for which a car or taxi was an alternative. Approximately 20% of e-scooter trips were taken in combination with public transport (Aarhaug, 2022).

Photo 3 (Own source) A group of E-Scooters on a sidewalk

The rapid integration of e-scooters into urban transportation systems has introduced both opportunities and challenges for sustainable urban mobility. On one hand, e-scooters offer a promising solution for short-distance travel, potentially reducing reliance on private cars and alleviating urban congestion. On the other hand, their impact on existing modes of transport, user safety, and regulatory frameworks remains inadequately understood.

E-scooters are primarily used for last-mile connectivity, short trips within city limits, and leisure rides. However, their widespread adoption has sparked a debate about their actual contribution to sustainability. While they are environmentally friendly compared to cars, there is concern that they may replace more sustainable modes of transport like walking, cycling, and public transportation.

A significant problem is the lack of comprehensive study on how e-scooters affect travel behaviour and urban mobility patterns. It is unclear to what extent e-scooters are reducing car usage versus displacing more sustainable transportation modes in Bergen. Furthermore, the socio-demographic factors influencing individuals' preference for e-scooters over other transport options are not well-documented.

This research aims to address these gaps by examining the extent to which e-scooters can be considered a sustainable mode of transport in Bergen municipality. It will investigate the modes of transport e-scooters replace, the socio-demographic factors affecting e-scooter adoption, and the broader implications for urban mobility and sustainability. By doing so, the study seeks to provide valuable insights for policymakers and urban planners to harness the potential benefits of e-scooters while mitigating their challenges.

1.2. The Evolution and Challenges of E-Scooters in Norway:

Personal transportation behaviour has changed significantly in the last decade due to technological progress. The usage of micro-mobility transport has also been modified a lot, resulting in e-scooters and other small, motorized vehicles. Technologies such as micro-mobility are assumed to present an advanced possible transport like e-scooter which could be sustainable too since e-scooters give users flexible movement advantages, are readily available

and are low space consuming. It allows people to use less physical effort to move over a short distance and takes less time compared to walking or cycling. It has been welcomed by the market as well as by people. New technology-driven e-scooters, on the one hand, allowed people to move flexibly but on the other hand created problems with road space sharing, safety, and traffic regulations (Zagorskas and Burinskienė, 2020). Also, the walking space sharing issue is involved as there are no recognized regulations for e-scooters. So, often it is seen that the e-scooter is moving around on the footpath and conflict happens with the pedestrians. Lack of safety gear and insufficient controlling system tend to accidental hazards. Also, it has controversial issues involved in the environmental interface, less lifetime and lack of reusable functionality for the major components resulting in e-garbage and may cause environmental issues in the future.

There are different types of debates on e-scooters which are sometimes complex and vary with points of view, we can only assume it here but during the initial stage of the arrival of e-scooters is reported positively (Lee, 2018). In France, after introducing the e-scooter in 2017, accident rates increased significantly, especially among older people and while various complaints started coming from non-users as well as from the locality, authorities urged to take initiatives to regulate (Bremner, 2018). From the visual point of view, there are two issues related to e-scooters: unused rental vehicles are leaving here and there and blocking public spaces as well as hampering public movement; and other groups are involved in reckless driving, yet pay attention to traffic rules, and danger to pedestrians (Tuncer et al., 2020).

We can argue that the usual micro movement was conducted by walking or cycling, those are covered by the e-scooter which would put a strain on human health. Older adults are reluctant to use it rather they feel comfortable walking, but adolescents and ages below forty are enjoying fast and flexible transport. Few reports were published on the accident history of the lack of a proper braking system as well as inadequate safety gear used during the ride (Iroz-Elardo and Currans, 2021). We can see there are no carbon emissions from the e-scooter but from manufacturing to the end of this life cycle it pollutes the environment which is lower than the other conventional gasoline-driven vehicles (Hollingsworth et al., 2019).

Finally, recycling e-garbage is important since rare and potentially polluting material is used to make e-scooters. Especially need to take care of the battery and electrical equipment attached to it that make it pollutant substances at least manufacturing industries can make it efficiently

recyclable. Charging dock stations should be available like electric cars that can allow the scooter more time on the road. The uses of e-scooters should be studied and controlled through government policy such that their utilization should not be harmful to humans as well as the environment.

If we look back from the introduction of e-scooters to the current situation in Norway, few challenges and efforts are seen here with the authority and rental company. In the year 2020, Norway witnessed a surge in the popularity of electric scooters, drastically altering the urban landscape of its cities. However, alongside this transformation came a host of safety concerns and mounting accidents, prompting the Minister of Transport and Communications, Knut Arild Hareide, to advocate for stricter regulations on electric scooter rentals in Norwegian cities.

According to statistics from the emergency care centre in Oslo, a significant number of individuals, totalling 1,309, sustained injuries while riding electric scooters, with 8% of cases classified as serious. Complaints from the blind and partially sighted community regarding obstacles posed by poorly parked scooters underscored the urgency for regulatory intervention. Minister Hareide emphasized the need for better legislation and enhanced oversight to ensure the safety of both scooter riders and pedestrians, acknowledging that electric scooters play a role in urban mobility but deeming the current situation unsustainable (Nikel, 2020).

Responding to Hareide's (Minister Of Transport, Norway) call for action, several rental scooter companies proposed initiatives such as street patrols and lower speed limits to mitigate safety risks. Collaborative efforts between rental companies, including Voi, Tier, Bolt, Bird, Lime, and Wind, resulted in proposals for defined non-parking zones and limits on scooter numbers in specific areas. Additionally, the companies committed to deploying patrols to address improperly parked scooters. Despite these proactive measures, challenges remain, with some cities like Bergen facing legal disputes with rental companies.

In response to the unauthorized deployment of electric scooters by a company without a formal agreement with the municipality, legal action was taken by the municipality. Despite the municipality's efforts, the Bergen District Court ruled against their request for a temporary injunction, as reported by Bergens Tidende (Ørnhaug and Fenre, 2020). The court's decision hinged on the municipality's burden to demonstrate that the company's activities would result in challenges and harm to the city. However, the court found that the municipality failed to

substantiate these claims. In addition to dismissing the injunction request, the court ordered Bergen municipality to cover Ryde's legal expenses, amounting to 198,900 nok.

Existing regulations treat electric scooters as small electric-powered vehicles, subjecting them to the same rules as ordinary bicycles. While riders are permitted to use pavements/sidewalks, cycle lanes, and roads, they must yield to cars at pedestrian crossings. Parking on pavements/sidewalks is allowed provided it does not obstruct pedestrian pathways excessively. Although helmet use is not mandatory, safety advocates encourage its adoption and riding while drunk is strictly prohibited.

In 2021, the City of Oslo implemented significant regulatory changes aimed at controlling the proliferation of electric scooter rentals and addressing associated concerns. These measures included the imposition of a city-wide cap on scooter rentals, limiting the number of permits issued to rental providers to 8,000 from around 20,000, evenly distributed among all operating companies (Ghaderi et al., 2022). Additionally, Oslo introduced zoning regulations specifying the allocation of scooters across four zones, with restrictions on the proportion available in downtown areas versus peripheral locations. However, these measures faced criticism from experts like Nils Fearnley of TØI (Drægni, 2021), who argued that a tender system with fewer market players would better serve customers.

Moreover, Oslo enforced a ban on nighttime rentals from 11 pm to 5 am, aiming to reduce disturbances and enhance public safety. This decision was preceded by rental companies voluntarily halting nighttime rentals on weekends to preempt stricter regulation. Additionally, some companies, such as Voi, opted to reduce scooter speeds from 20 kph to 15 kph during nighttime hours.

Furthermore, rental companies were mandated to share data on scooter movements to facilitate regulatory oversight and development. Despite the intended benefits of regulation, this requirement elicited negative reactions from some industry players, especially Tier, citing concerns over data security and privacy. Overall, Oslo's crackdown on electric scooter rentals reflects efforts to balance the promotion of micro-mobility with urban governance considerations (Nikel, 2021).

Since the implementation of new regulations for electric scooters in Oslo in 2021, in the same time, Bergen has emerged as the European city with the highest density of electric scooters per 10,000 inhabitants. According to Lars Ove Kvalbein from Bergen Municipality, there are approximately 8,500 electric scooters in Bergen, resulting in a density of around 309 electric scooters per 10,000 inhabitants. In comparison, cities such as Paris, Berlin, and Rome reported fewer than 50 e-scooters per 10,000 inhabitants during a recent count. Oslo, which previously had 340 electric scooters per 100,000 inhabitants, now has around 125 (Today, 2021). Despite this, currently, there are no plans for changes in Bergen but they intend to regulate at the beginning of 2022.

Photo 4 (Own source), Bergen Kommune dedicated a few parking places

Bergen Kommune has implemented a distinct regulation concerning the rental of small electric vehicles. Electric scooters, classified as small electric motor vehicles, are permitted on pavements, footpaths, and pedestrian streets, with pedestrians given precedence. In congested areas, riders must be careful not to be obstacles or dangers to pedestrians. Additionally, riders should maintain a safe distance and maximum speed of 6 km/h when passing pedestrians. The municipality has designated zones with reduced speed limits to enhance pedestrian safety,

where electric scooters automatically adhere to the prescribed speed limit. Moreover, certain areas are off-limits for electric scooter use, with the E-scooter's engine gradually deactivating upon entry into these zones.

Only one individual is permitted per electric scooter, with violators subject to a fine of NOK 3,000 for multi-person riding. The minimum age for electric scooter operation is 12, with mandatory helmet use for individuals under 15. While this requirement is specific to those under 15, helmet use is recommended for all to bolster safety. Rental companies enforce an age limit of 15 or 16 for scooter usage.

Operating electric scooters under the influence of drugs is strictly prohibited, with the general blood alcohol limit of 0.2 applicable to scooter riders. In addition, E-scooter rentals are also suspended between 23:00 and 05:00 on Saturday and Sunday nights for safety reasons.

Under these regulations, the Bergen municipality has permitted operators Voi and Ryde to conduct rentals from April 1, 2024, to March 31, 2026, inclusive of (Kommune, 2024). Nevertheless, the authority has created a poster (See Annexe) outlining the regulations for using electric scooters, applicable to both private and shared vehicles. This poster is available for printing and display in locations such as high schools, university buildings, and other relevant areas to encourage e-scooter users to follow the regulations.

Photo 5 (Own source), Bad parking – an obstacle for short-sighted or blind people

Debates surrounding e-scooters are complex and varied. While initially welcomed for their convenience and potential environmental benefits, the practical implications of their widespread use have led to regulatory and safety concerns. In Norway, the popularity of e-scooters surged in 2020, accompanied by a rise in accidents and complaints from the public, especially the blind and partially sighted community. These issues prompted calls for stricter regulations to ensure the safety of both riders and pedestrians.

In Oslo, significant regulatory changes were implemented in 2021, including caps on scooter rentals, zoning regulations, and a ban on nighttime rentals to address safety concerns. These measures aimed to balance the promotion of micro-mobility with urban governance considerations. Despite the intended benefits, the regulations faced criticism and highlighted the ongoing need for effective policy frameworks.

Bergen, on the other hand, has emerged as the European city with the highest density of electric scooters, indicating a growing need for effective management and regulation. The municipality has implemented specific regulations to enhance safety and reduce pedestrian conflicts. These include speed limits, designated no-go zones, and restrictions on the number of riders per scooter. Additionally, measures such as mandatory helmet use for younger riders and alcohol restrictions aim to improve overall safety.

Given this context, it is crucial to evaluate the sustainability of e-scooters in Bergen. The primary concern is whether e-scooters replace less sustainable transport modes like private cars or if they displace more sustainable options like walking, cycling, and public transport. Furthermore, understanding the socio-demographic factors influencing e-scooter adoption can provide insights into their role in urban mobility.

1.3. Research questions:

Micro-mobility solutions, including e-scooters and other small motorized vehicles, have become prevalent, offering a modern alternative to traditional modes of transport. E-scooters present a paradox in their sustainability profile. On the surface, they offer a flexible, low-space-consuming, and physically undemanding transportation option with no direct carbon emissions during use. However, several issues undermine their sustainability credentials.

The introduction of e-scooters has brought about several challenges in Bergen. Although they promote flexible movement, they have also led to issues with road space sharing, safety, and traffic regulations. The problems discussed connect directly to the thesis through the research questions by providing a framework to evaluate the sustainability of e-scooters comprehensively. The primary research question, therefore, aims to balance these advantages and disadvantages to determine the overall sustainability of e-scooters. By addressing the extent to which e-scooters replace various transport modes and examining the socio-demographic factors influencing their use, the research will shed light on their actual impact on urban mobility and sustainability.

Main question-

- To what extent can e-scooters be considered a sustainable mode of transport?

Sub-questions-

- What modes of transport do e-scooters replace?
- What socio-demographic factors affect an individual's preference to replace other transport?

1.4. Geographical study area:

In this study, Bergen has been considered the study area, the second-largest populated city in Norway, and it is situated on the country's west coast with a population of about 300,000 that can be considered as any other medium-sized city in Europe. Having mountains and rainy weather conditions made micro-mobility difficult here (Engebretsen et al., 2017). It is considered a historic city with places of tourist attractions, it is also well known for the energy industry, shipping, and marine research. Bergen, the second-largest city in Norway, pioneered an urban investment package in 1986, partially funded by congestion road tolls. Presently, Norway's five largest urban regions have entered into multilateral agreements aligned with a goal of achieving zero growth in private vehicles, namely cars (Haarstad, 2020).

Norway has a predominantly renewable-powered electric grid, making the shift to electric vehicles (EVs) an attractive option for reducing emissions. Norwegian cities also demonstrate relatively low levels of inequality and socio-economic spatial segregation, supported by a historically robust social contract and welfare state (Rusten et al., 2013). In 2021, EVs constituted nearly two-thirds of new car sales, reaching 80% in 2022, indicating progress towards the national target of ceasing fossil fuel car sales by 2025 (Klesty, 2022). EVs are a key element in Norway's mobility strategy, backed by governmental incentives like subsidies, toll exemptions, bus lane access, and waived parking fees (Bjerkan et al., 2016).

Bergen, a city in Norway, is already ahead of the sustainable mobility transition and the transportation system mostly shifted from fossil fuel systems to electric vehicles (EVs) to cut out carbon emissions. The government’s incentive scheme for EVs and installation of available charging points also made it a popular transport (Wanvik and Haarstad, 2021). The city has committed to ambitious targets to decrease car usage while promoting walking, cycling, and public transportation. Through national subsidies, Norway has achieved a higher number of electric vehicles per capita than any other country (Remme et al., 2022). Now, let’s have a look at the introduction of e-scooters in Bergen.

Bergen initially capped e-scooters at 900 in the inner city and 1,500 in the close vicinity, with each operator sharing an equal portion. These caps are adjustable, and operators aim to demonstrate increased demand. The report from ZAG Daily (Hubbard, 2022), highlighted the

outcome of a tender for shared e-scooter operations in Bergen, Norway's second-largest city, for the next two years. Voi, Ryde, and Bolt emerged as the winning operators, while TIER secured permits for Oslo and Trondheim but did not win in Bergen. Voi achieved success in all three tender processes, indicating strong demand for its micro-mobility solutions. Considering safety as a key focus, Voi (VOI, 2022) launched a safety campaign emphasizing geofencing and training for safer traffic due to the challenging riding conditions in Bergen, such as cobblestones and rain, underscoring the importance of safety measures.

Norway presents a significant market for European electric scooter companies due to high demand and profitable margins. Ryde, based in Oslo, achieved a turnover of NOK 50 million in Bergen year, 2021. Bolt, based in Estonia, sees its third-place achievement in Bergen as a significant success, demonstrating a serious and compliant operation in the city (Hubbard, 2022).

However, Bergen municipality has permitted two micro-mobility companies, Voi and Ryde who would be able to operate rental or shared e-scooters in the period from 1 April 2024 to 31 March 2026 inclusive (Kommune, 2024). Bergen, Norway, actually just introduced e-scooters in June of 2022 with the above-mentioned tender. There wasn't a complete ban before then, but there also weren't any regulations for their use. While there aren't likely to be many in-depth research articles yet due to the relatively recent introduction of e-scooters in Bergen, I choose Bergen to study the controversial micro-mobility vehicle namely the e-scooter to justify its sustainability.

2. Background / Context:

While the transportation system fulfils the travel needs of users, a significant portion of trips are made using private cars, which are not environmentally, socially, or economically sustainable. The transportation system plays a crucial role in meeting the mobility needs of individuals and businesses. However, it also has the potential to create an unsafe and unhealthy environment. Overreliance on motorized and private vehicles can lead to reduced physical activity and ensuing health issues. Several nations have initiated efforts to transition towards a carbon-neutral environment. In the current technological era, where information systems and technologies are intertwined, there is a concerted effort to develop environmentally friendly, low-carbon emission vehicles that are also affordable, with the aim of fostering sustainable transportation systems (Aarhaug, 2022).

Transport planning is at a crisis point now as more than 50% of the world's total population lives in the cities and will increase to 66% by 2050 (Swilling et al., 2018). City planners are confronted with the urgent task of devising, advocating for, and executing strategies that fulfil the mobility requirements of urban residents and businesses, thereby enhancing overall quality of life. One effective approach to mitigate car dependency and foster environmentally friendly transportation modes is the promotion of public transport. This entails positioning public transit as the focal point of sustainable urban mobility, achieved through integrating services into a multimodal network and encouraging intermodal transportation interchange (Redman et al., 2013, Altieri et al., 2020, Musolino et al., 2022). Cities are considered the sustainable urban constitution that must provide the highest levels of quality services and suitable transport provisions to the citizens so that residents need not think about private transport (Oeschger et al., 2023). The first- and last-mile issue is a major problem in urban transportation systems. It often leads to other problems like limited access to public transport and people feeling the need to own a car, especially in certain urban areas (Kåresdotter et al., 2022). To tackle this problem, some cities in recent years have welcomed and encouraged the use of new light electric vehicles, like e-scooters and e-bikes, known as micro-mobility.

In recent years, micro-mobility has gained increased popularity, particularly due to advancements in mobile computing. Micro-mobility is a new and smart way to get around cities for short distances, covering the first and last parts of your journey. The charm of micro-

mobility is that it offers flexible, eco-friendly, affordable, and on-the-spot transportation choices (Shaheen et al., 2020). The goal is to improve how well people can connect with and access existing public transport networks. Micro-mobility solutions encompass a variety of lightweight devices or compact vehicles that typically operate at speeds not surpassing 45 kph. These devices, such as bicycles, scooters, skateboards, segways, and hoverboards, may be propelled by human effort or electric power and can be either privately owned or shared (Dia, 2019). Micro-mobility is gaining recognition as a viable urban transport solution, as it advocates for eco-friendly and sustainable modes of transportation. Published research on multimodality indicates that micro-mobility has the potential to either replace or complement public transport, contingent upon specific contexts and the chosen mode (Kong et al., 2020). Micromobility represents a promising avenue for steering users toward sustainable transportation modes characterized by low or negligible environmental emissions (Abduljabbar et al., 2021). Notably, micro-mobility solutions are frequently used to substitute public transport journeys with a connectivity gap or as a first or last-mile mode choice (Oeschger et al., 2023).

The concept of sustainable mobility is examined concerning micro-mobility, with an emphasis on advancing the understanding of micro-mobility as a pivotal facilitator of sustainability and the creation of sustainable value. Various cities have explored how the presence of micro-mobility influences users' decisions regarding transportation modes. However, findings tend to be specific to each city, likely influenced by urban context and user behaviours. For instance, a survey conducted in Paris (Christoforou et al., 2021) revealed that micro-mobility is predominantly utilized for trips under 15 minutes and within a distance of 2.5 miles. Specifically, 21% of micro-mobility trips replaced motorized transportation, while 35% replaced walking. In Oslo, micro-mobility enticed 60% of users away from walking, 23% from public transit, 3% from private cars, and the remainder from other modes of transportation (Fearnley et al., 2020). Therefore, the integration of micro-mobility and public transport offers a potential solution to reduce reliance on motorized transportation within urban areas. Creating integrated and multimodal transportation systems is essential for sustainable mobility. They play a constructive role in decreasing dependence on private vehicles, particularly for short-distance journeys. The rising popularity of these solutions signifies a growing acknowledgement of the adverse impacts linked to private vehicle usage, especially in terms of health and overall well-being, especially when factors like congestion, emissions, and air

quality are considered (Sperling, 2018). This shared mode of transportation is accessible through popular apps on smartphones and other connected devices.

The use of a sharing economy model, where users pay to use shared items like cars or bicycles, has led people to rethink owning private vehicles, making them less likely to want to own cars (Liyanage et al., 2019, Machado et al., 2018, Shaheen and Chan, 2016). It also encourages a multi-modal transport system to minimize trip length and efficiency in transportation. This involves developing seamless connections and interoperability between different modes of transportation, such as integrating public transit with cycling infrastructure and shared mobility services. Integrated systems provide convenient and efficient options for travellers, reducing the need for private vehicle use (Chakraborty et al., 2021). Trips using different modes of transport combinations make the trips shorter and more prominent. Multimodal trips involve reliable, affordable, and well-connected public transit networks, including buses, light rail, metro systems and other micro-mobility transportation (Berg Wincent et al., 2023).

The promotion of on-demand shared mobility is on the rise as a significant strategy for tackling urban transport challenges in expansive and rapidly growing cities. The attractiveness of this mode of transportation is predominantly ascribed to its convenience, user-friendly nature, and cost-effectiveness facilitated by digital platforms and innovative solutions (Liyanage et al., 2019). Emerging micro-mobility alternatives, notably the rise of dockless shared e-scooters, are experiencing widespread adoption globally. The introduction of these options raises complex inquiries for cities and transportation planners concerning their utilization, their impact on the transportation infrastructure, and their associated externalities (Caspi et al., 2020). CNN Travel (Buckley, 2019) released an article addressing the proliferation of electric scooters in urban environments, highlighting their benefits and challenges. While praised for their convenience and entertainment value, electric scooters have caused frustration among pedestrians who have to avoid them on sidewalks or deal with abandoned scooters blocking public areas. Safety concerns and scepticism regarding their environmental claims have also arisen. Concerns have been raised about their environmental claims, emphasising the importance of considering the entire lifecycle of scooters (Hollingsworth et al., 2019). It notes that despite being marketed as environmentally friendly, the materials used in their construction, such as aluminium frames, lithium batteries, and rubber wheels, contribute to their environmental burden since they last only a few months. In an interview with CNN (Buckley, 2019), Bird company claims that their “Bird One” model now has a lifetime of

around 18 months while its latest model “Bird Two” can last two years. Another company Lime says that their third-generation model is “demonstrating a lifespan of more than 12 months.”

What about the reactions around the globe? E-scooters are permitted to ride on pavements in Norway, Sweden, and Belgium, as long as they maintain an approximate walking speed, with variations in local regulations. Researchers from the Norwegian Centre for Transport Research (TØI) (Karlsen and Fyhri., 2020) conducted a study to compare non-users’ experiences when interacting with e-scooters while walking on the streets. Among the five countries surveyed, only the Czech Republic prohibits e-scooter use on sidewalks but allows them in pedestrian streets and squares. The findings indicate that the Czech Republic is the only country where people generally find the interaction with e-scooters pleasant, while in the other four countries, people find them annoying. Considering this, a ban on the use of e-scooters may be a welcomed regulatory measure for pedestrians.

News from The New York Times (Nouvian, 2023), Copenhagen and Montreal banned electric scooters in 2020, with Copenhagen later allowing their return under strict conditions in the next year. Another report was published that Paris banned rented electric scooters starting September 1, 2023, following a rise in injuries and fatalities, prompting a public vote in April where 90% of participants supported the ban (Nouvian, 2023, Yanatma, 2023). Additionally, Malta is poised to become the first EU country to prohibit all rental e-scooters, effective March 2024 (Council, 2023). Several rail companies in Britain implemented a ban on e-scooters on trains and platforms starting June 1, 2023, citing safety concerns due to Li-ion batteries (Yanatma, 2023). Similarly, both Barcelona and Madrid have prohibited the use of electric scooters on public transport due to incidents involving battery explosions on the subway (Burbano, 2023).

Despite the urban challenges, mobility experts still view e-scooters as a valuable micro-mobility solution for promoting green and sustainable mobility in cities since they can enhance first and last-mile connectivity to public transit, making it more accessible and encouraging multi-modal travel. However, their successful deployment requires integration into local planning strategies, regulations, and enforcement procedures.

3. Literature review and theoretical approach:

3.1. Literature Review:

With industrial progress and improved life quality, product functionality, as well as usability, have become the prime demands. With technological advancements, people are increasingly pleasure-oriented, seeking unique experiences and products that enable them to connect emotionally with their memories (Cheng et al., 2017). The popularity of personal and shared e-scooters has significantly increased, and the emergency departments of hospitals received many patients involved in e-scooter-related trauma (Smit et al., 2021). This research represents the inaugural investigation into e-scooter-associated maxillofacial (face or jaw) injuries in New Zealand and the first international inquiry to conduct a cost analysis regarding patient management. The study aimed to analyze the incidence of oral and maxillofacial trauma linked directly to e-scooter usage and to evaluate the associated treatment costs. Findings revealed that the majority of patients (70%) fell within the 20-39 age bracket, with 63.3% being male. Furthermore, two-thirds of the patients reported alcohol consumption prior to the e-scooter accident. The study underscores that e-scooter-related maxillofacial trauma presents a burgeoning injury mechanism associated with considerable facial trauma, imposing a substantial financial burden on the healthcare system.

While worldwide there are debates about the legalization and policies, they (Tuncer et al., 2020) studied the e-scooter users' current practices, behaviour, and interactions with pedestrians in the city. The situation entails two primary issues: first, unused rental e-scooters are reportedly cluttering public spaces and impeding pedestrian mobility; second, rental e-scooter users are criticized for reckless driving, disregarding traffic regulations, and posing dangers to pedestrians. The researchers investigated whether the introduction of e-scooters could lead to increased visitation activities (Bai et al., 2021). To address this question, they conducted a spatiotemporal similarity analysis between e-scooter usage and patterns of visits to leisure facilities. Their findings revealed a significant correlation between e-scooter use and daily activities such as dining, shopping, and recreational outings, with downtown and university campus areas showing higher correlations between scooter use and visits. Additionally, they applied the Difference-in-Differences approach to assess whether e-scooter

use contributed to an increase in visitation activities. Surprisingly, the results indicated that e-scooter use had no significant effect on the overall increase in visits.

A study conducted in Munich investigated the shift from car-sharing to e-scooter sharing, revealing that 23% of users transitioned to e-scooters due to the flexibility they offer for travel (Abouelela et al., 2021). This indicates a significant preference for e-scooters over car-sharing services among a notable portion of the population, highlighting the appeal of more adaptable and convenient urban mobility solutions. Micro-mobility technologies like e-scooters are often seen as potential catalysts for advancing urban transportation sustainability. This assumption stems from the fact that e-scooters provide users with an electric and convenient mode of transportation that can replace more carbon-intensive options but it's controversial too (Sareen et al., 2021). They studied e-scooter regulation and market-making micropolitics concerning micro-mobility. The introduction of e-scooters illuminated the intricate and often conflicting interplay among innovation, sustainability, and regulatory frameworks, exemplified by micro-political dynamics. They analyzed how e-scooter introduction intersects with sustainability and regulation, revealing complex dynamics shaped by micro-politics. While some operators disregarded rules, others complied during early regulation stages. They discussed these dynamics within innovation and micro-political studies, highlighting the formation of micro-mobility markets and their impact on urban transport sustainability. They found that while micro-mobility can promote low-carbon mobility and equitable access, market forces often prioritize profit over the public interest. However, they suggest that dynamic regulation can foster low-carbon micro-mobility markets and advance more inclusive mobility transitions.

Another investigation was administrated on the prospects and challenges of micro-mobility, focusing on e-scooters, and pointing to road safety, and environmental issues like mass e-garbage (Zagorskas and Burinskienė, 2020). The study gives an overview that the electric motors of e-scooters possess greater power than human propulsion and can pose significant risks if these vehicles share the same street space with pedestrians or cyclists. Also, a study was conducted based in Chicago on a dockless e-scooter and studied the comparison of travel time and cost-analysis within micro-mobility transport including bike-sharing, walking, bicycling, and local transport (Smith and Schwieterman, 2018). Their analysis focused solely on evaluating the potential citywide mobility advantages of e-scooters if they were integrated into an open public mobility system. The findings describe that numerous urban planning challenges associated with e-scooters are widely recognized. E-scooter systems often utilize

sidewalks and other public spaces for parking, posing safety concerns in crowded areas. Additionally, their impact on transit varies, with some routes experiencing increased competition from e-scooters while others benefit from complementarity, especially for bus line-oriented short-distance trips.

A study examining consumer acceptance of e-scooters found that the primary factors driving adoption were the fun factor and individual convenience were the key factors in adopting this vehicle (Kopplin et al., 2021). Due to frequent accidents with pedestrians on the footpath, Singapore lowered the speed limit from 15 km/h to 10 km/h on shared footpaths (Che et al., 2020). The study indicates that besides speed, inappropriate behavior also contributes to safety concerns on shared footpaths. Clearer codes of conduct and stricter enforcement could enhance safety in such areas. Safety remains crucial on shared footpaths, and while reducing riding speed can mitigate injury risks, other safety measures should also be considered. Despite these challenges, safety remains a top priority in sustainable mobility systems, emphasizing the need for education and enforcement measures for the continued advancement of active transportation. Based on social media data analysis namely Twitter, (Feng et al., 2021) a study was carried out and they found that most discussed topics on Twitter about the shared e-scooter were related to regulations in cities, parking issues, and injuries done by it.

Cities worldwide are trying to solve problems like traffic jams, pollution, noise, and accidents caused by transportation. Planners in charge of city transport are interested in using e-scooters as an alternative to cars. People have different opinions about e-scooters—some are excited about them, while others are unsure. Cities are dealing with unexpected issues like people riding e-scooters carelessly, leaving them in inconvenient places, or causing damage (Gössling, 2020). This study examines the obstacles linked to the implementation of e-scooters in ten prominent cities, utilizing a content analysis of local media coverage. Findings indicate that several cities have progressed through experimental phases in establishing suitable regulations. The research suggests that urban planners should implement measures concerning speed limits, obligatory use of bike lanes, designated parking areas, and restrictions on licensed operators. By addressing public concerns proactively, e-scooters could emerge as a transformative niche innovation capable of reshaping urban transportation systems.

The literature review reveals numerous studies exploring various aspects of e-scooters, from their impact on urban mobility to safety and regulatory challenges. However, a notable gap

exists in comprehensively understanding the long-term societal implications of e-scooter adoption, especially regarding their integration into broader urban transportation systems and consequent shifts in travel behaviour. While existing research has delved into specific facets such as consumer acceptance, safety protocols, and regulatory frameworks, there is a pressing need for a holistic investigation into the overall effects of e-scooters on urban mobility patterns, environmental sustainability, and social equity.

Moreover, further inquiry is warranted to evaluate the scalability and replicability of successful e-scooter deployment models across diverse urban contexts. This entails considering factors like infrastructure compatibility, public acceptance, and policy alignment. Additionally, there is a dearth of in-depth analysis of the transformative potential of e-scooters within the broader framework of urban transportation planning and policy-making.

Considering the sustainability aspects, the literature on e-scooters reveals significant insights into their potential for enhancing urban transportation sustainability but also highlights considerable challenges. E-scooters are often viewed as a greener alternative to cars, capable of reducing carbon emissions and urban congestion. However, their environmental benefits are offset by issues such as the short lifespan of e-scooters, which leads to significant electronic waste, and the carbon footprint associated with their production and maintenance.

Studies show mixed results regarding the integration of e-scooters into urban transport systems. While they can complement public transport for short-distance travel, their impact on overall mobility patterns is not significant. Furthermore, it is assumed that they are replacing more sustainable micro-mobility options like walking, cycling or public transport. Additionally, regulatory challenges and safety concerns persist, with e-scooter-related injuries placing a financial burden on healthcare systems. The improper parking and reckless use of e-scooters also contribute to urban clutter and pedestrian hazards.

However, my study aims to address these gaps by focusing on the sustainability prospects of e-scooters within the existing transportation system, particularly in terms of their potential to replace other modes of transport. It seeks to investigate changes in travel behaviour induced by e-scooter use, including alterations in trip length, frequency, and travel mode choice. Additionally, the study aims to assess whether e-scooters incentivize sustainable travel behaviour or contribute to increased overall travel demand.

Furthermore, the research will analyze how the introduction of e-scooters impacts communities and urban environments. This involves considering factors such as shifts in transportation patterns, accessibility to different areas, effects on local businesses, and the overall transformation of urban landscapes. By addressing these aspects comprehensively, the study aims to provide valuable insights into the implications of e-scooter adoption for urban sustainability and transportation planning.

While a literature review consolidates existing knowledge and identifies research gaps, a theoretical approach provides the conceptual tools and frameworks necessary for analyzing and understanding the research problem. Both components are crucial: the literature review grounds the research in existing scholarship, and the theoretical approach offers a structured way to interpret the findings and contribute to the theoretical advancement of the field.

3.2. Theoretical approach

The distinction between a literature review and a theoretical approach can be clarified by understanding their specific roles and purposes within academic research. A literature review synthesizes existing studies and findings related to a particular topic, providing a comprehensive overview of what is known, identifying gaps, and setting the context for new research. For instance, in the provided literature review on e-scooters, various studies are summarized to highlight their impact on urban mobility, safety concerns, and regulatory challenges. The literature review functions as a foundation, grounding the research in established knowledge and highlighting the need for further investigation into specific areas such as the long-term societal implications of e-scooter adoption and their potential for enhancing urban transportation sustainability.

On the other hand, a theoretical approach involves the application of specific theories or frameworks to analyze and interpret the research topic. It goes beyond summarizing existing studies by offering a conceptual lens through which the research question can be explored and understood. For example, the theoretical approach in the discussion emphasizes sustainable mobility, presenting theories related to land use, urban planning, and socio-technical transitions. It delves into the underlying mechanisms and patterns of transitioning to sustainable

transportation systems, emphasizing the need for a shift from private car use to more sustainable modes like public transit, cycling, and shared mobility options. This theoretical lens helps to frame the research within broader conceptual paradigms, guiding the analysis and interpretation of findings.

Sustainable Mobility Concepts

The notion of sustainable mobility emerged approximately 30 years ago, and although some advancements have occurred during this period, the transportation sector continues to fall short in its contribution to the globally established targets for carbon emissions reduction (Holden et al., 2020). The concept of sustainable mobility is not a new idea - it was initially introduced in the 1992 EC Green Paper on the Impact of Transport on the Environment (Holden et al., 2019). This document followed the influential report "Our Common Future," which delved into the global challenge of sustainable development (Brundtland, 1987). Sustainable mobility recognizes the interconnectedness of transportation with various aspects of sustainability and seeks to address the challenges associated with conventional transportation systems. The approach also recognizes the need to balance environmental, social, and economic considerations in transportation planning and decision-making (Høyer, 1999). Nevertheless, it aims to design a versatile urban format that may lead the transportation system to green modes and also, involves promoting modes of transportation that minimize negative impacts on the environment, enhance social equity, and support economic development (Holden et al., 2019). The sustainable mobility approach proposes an alternative framework that investigates the complex dimensions of the cities concerning land use and transport (Banister, 2008).

Sustainability and Mobility in Urban Planning

The concepts of "sustainability" and "mobility" have evolved considerably over the past three decades. Nonetheless, the conventional comprehension and interpretation of the sustainable mobility concept have undergone transformations since the early 1990s (Holden et al., 2019). As of the early 2000s, broader economic implications, including aspects such as accessibility and distribution, were incorporated into transportation assessments. Consequently, contemporary studies on sustainable mobility emphasize a comprehensive examination of environmental, societal, and economic impacts. Thus, the evolution of the concept of sustainable mobility has transitioned from initially addressing individual environmental

concerns to encompassing a broader spectrum of issues related to sustainable development (Guinee et al., 2011). Nowadays, discussions about sustainable transport have become more interesting and complex. People are not just talking about how it affects the environment but also how it impacts our health. The focus is on promoting healthier ways of getting around, like walking and cycling, while also worrying about how pollution from cars can harm our air and health, especially for vulnerable groups like the young and elderly (Brand and Hunt, 2018).

Most people agree that sustainability is a complex concept with ongoing uncertainties and debates. Surprisingly, the literature on sustainability transitions has only touched on the tough questions about what sustainability really means, for whom, and in which situations (Raven et al., 2017). Sustainable mobility is closely linked to land use and urban planning. Designing compact, mixed-use communities that prioritize walkability and access to public transportation helps reduce the need for long-distance travel and supports sustainable mobility options. Planning cities and neighbourhoods with transportation systems in mind can foster more sustainable travel behaviour. It is crucial to emphasize that uncertainties about the future should not hinder us from undertaking actions that we currently recognize as necessary for both the short and long-term establishment of a sustainable transport system (Johansson et al., 2016).

Challenges and Future Directions in Sustainable Mobility

Sustainable mobility aims to change how people travel by encouraging more group travel. Public transport like buses and trains, owned by governments, has been the common solution. This doesn't change—we still need public transport. However, we should significantly increase the use of public transport, even though it may not completely replace individual car travel. This means we need to consider new ways of travelling together, shifting from the 'ownership' to the 'usership' (Machado et al., 2018). The strategy focuses on transitioning from private car use to more sustainable transportation modes, including public transit, cycling, walking, and shared mobility options. This transition lowers greenhouse gas emissions, enhances air quality, and reduces traffic congestion (Udeagha and Ngepah, 2023). Achieving a sustainable transport system involves more than just developing and implementing technological innovations. It requires a comprehensive structural and societal transition encompassing technology, the economy, culture, behavioural patterns, and institutions (Nunen et al., 2011).

In the past, the main discussions about transport were about how it helps the economy grow by making it easier for people and goods to move around efficiently. Now, the talks have broadened to consider sustainability in a bigger picture, including its environmental effects (both worldwide and local) and its broader social impacts on health and inequality (Banister, 2018). Several research studies exhibit considerable variation; nevertheless, shared mobility schemes have the potential to substantially decrease the frequency of trips, travel distances, and emission levels (Santos, 2018). In addition, the alteration strategy aims to change the current transportation patterns by encouraging a shift in the way people choose to travel. The beneficial impacts of autonomous advancements in the transportation sector on various aspects of the sustainable transport concept are evident.

Technological Innovations and Their Impact

Technology is playing an increasingly significant role, as substantial funds from private investors are dedicated to research and improvement in autonomous vehicles, electric vehicles, mobility apps, information and guidance systems, and initiatives aimed at reducing the length of travel or travel behaviour (Rovňák et al., 2022). In recent years, cities globally have experienced the advent of novel mobility services facilitated by digital technologies. These services encompass vehicles like e-scooters, free-floating carpools, and bike-sharing programs. Commonly classified under the realm of smart mobility, these services are deemed essential components of prospective sustainable transport systems. For example, the European Environment Agency emphasizes in its report "Towards Clean and Smart Mobility" that "smart mobility can integrate diverse modes and options to meet mobility needs by leveraging IT, apps, and intelligent invoicing" (SIGNALS, 2016).

Technological progress, income growth, and heightened competition among providers have collectively contributed to substantial improvements in the quality and efficiency of transportation systems (Nunen et al., 2011). In the past few years, there has been growing pressure to seek alternative solutions (Hrelja and Rye, 2023). Mobility services and accessibility services have been put forward as potential solutions with the capacity to enhance the sustainability of transportation systems. Mobility services can be defined as services that facilitate transportation without the necessity of vehicle ownership, such as using one's own car. (Ringenson et al., 2018). Mobility services, a concept in transport distribution primarily based on passenger transport, amalgamate various transport modes and services to deliver a

user-oriented transport solution through a unified interface (Jittrapirom et al., 2018). There are indications that this transition is already occurring to a certain extent, as seen in the case of electric scooters replacing to some extent, private cars or utilizing taxi services and often public transport (Fearnley et al., 2020).

Policy Implications and Strategic Models

The first idea about transitions focused on them as processes of innovation. As time passed, this idea expanded to include a more detailed understanding of the patterns and mechanisms involved, viewing transitions as combined processes of building up and breaking down (Markard et al., 2012). This has introduced a fresh perspective to the conceptualization and implementation of sustainable development. From a transition standpoint, policies and programs for sustainable development have overly concentrated on mitigating unsustainability through optimization, inadvertently contributing to the entrenchment of societal systems (Frantzeskaki and Loorbach, 2010). The imperative for sustainable transport has given rise to the research field of 'sustainable mobility transitions.' Three pathways can lead to a sustainable transport future (Nykvist and Whitmarsh, 2008). The primary and extensively studied route is technological change, particularly focusing on automobility and the potential use of alternative fuels to decarbonize this sector (Nykvist and Whitmarsh, 2008, Mäkinen et al., 2015). The other two, albeit less explored, involve modal shift and the reduction of travel demand. The reduction in travel demand is typically achieved through mobility management strategies (Nykvist and Whitmarsh, 2008).

Transitions, in a literal sense, entail the progression from one state to another. In the context of transitions research, this term refers to the process of shifting from one system state to another, characterized by a phase of nonlinear and disruptive change (Loorbach et al., 2017). The modal shift entails efforts to decrease the reliance on motorized vehicles. The more specific aim of a transport transition, focusing on sustainability, is also regarded as a sustainable transition. This transition topic has gained traction in recent years (Markard et al., 2012). Sustainable transitions, similar to socio-technical transitions, revolve around achieving a more sustainable form of production and consumption (van Waes et al., 2018). What makes sustainable transitions distinctive is the unique nature of the guidance and governance (Smith et al., 2005), along with the need for coalitions of actors to collaborate in a coordinated manner to bring about the sustainability transition (Markard et al., 2012). In this case, the transition could be

the shift from traditional modes of transportation (e.g., cars, bicycles) to e-scooters as a new form of personal or shared mobility that may encourage behavioural shifts and demand management strategies, which are vital aspects of sustainable mobility. This includes promoting carpooling, ridesharing, flexible work arrangements, and travel demand management programs to reduce the number of single-occupancy vehicles on the road and promote more efficient use of transportation resources (Aarhaug et al., 2023).

Avoid-Shift-Improve (ASI) Model in Sustainable Transport

For an extended period, planners and transportation engineers have tackled traffic issues by forecasting future growth and expanding road capacity. This approach assumes that congested traffic, slow travel speeds, and poorly maintained roads are linked to increased delays, higher fuel consumption, and elevated greenhouse gas emissions. This traditional, predict-and-provide method falls short, particularly in growing urban areas, as it overlooks induced traffic effects. Experience has shown that building new highways or expanding existing ones, when implemented in isolation, often worsens long-term congestion and air pollution instead of alleviating them. In response to this, the "Avoid-Shift-Improve" (ASI) model has emerged as an alternative to traditional traffic planning. The shift towards sustainable mobility systems is commonly perceived to necessitate the adoption of three fundamental strategies: avoidance, mode shifting, and enhancement (Remme et al., 2022). It aims to achieve key performance goals for the transport system by effectively managing both supply and demand.

The model is grounded in three core principles: avoiding unnecessary travel, shifting travel to more efficient modes, and improving overall traffic efficiency. The model was initially developed especially looking for the alternative of dependency on using a car (Mattioli, 2014). Notably the "Avoid-Shift-Improve" (ASI) model is a different way of planning that helps reduce traffic and emissions. It suggests using strategies to decrease the number of cars on the road, improve traffic speeds, update vehicle fleets, and promote eco-friendly transportation options (Ringenson and Kramers, 2022).

Avoid-Shift-Improve" (ASI) framework

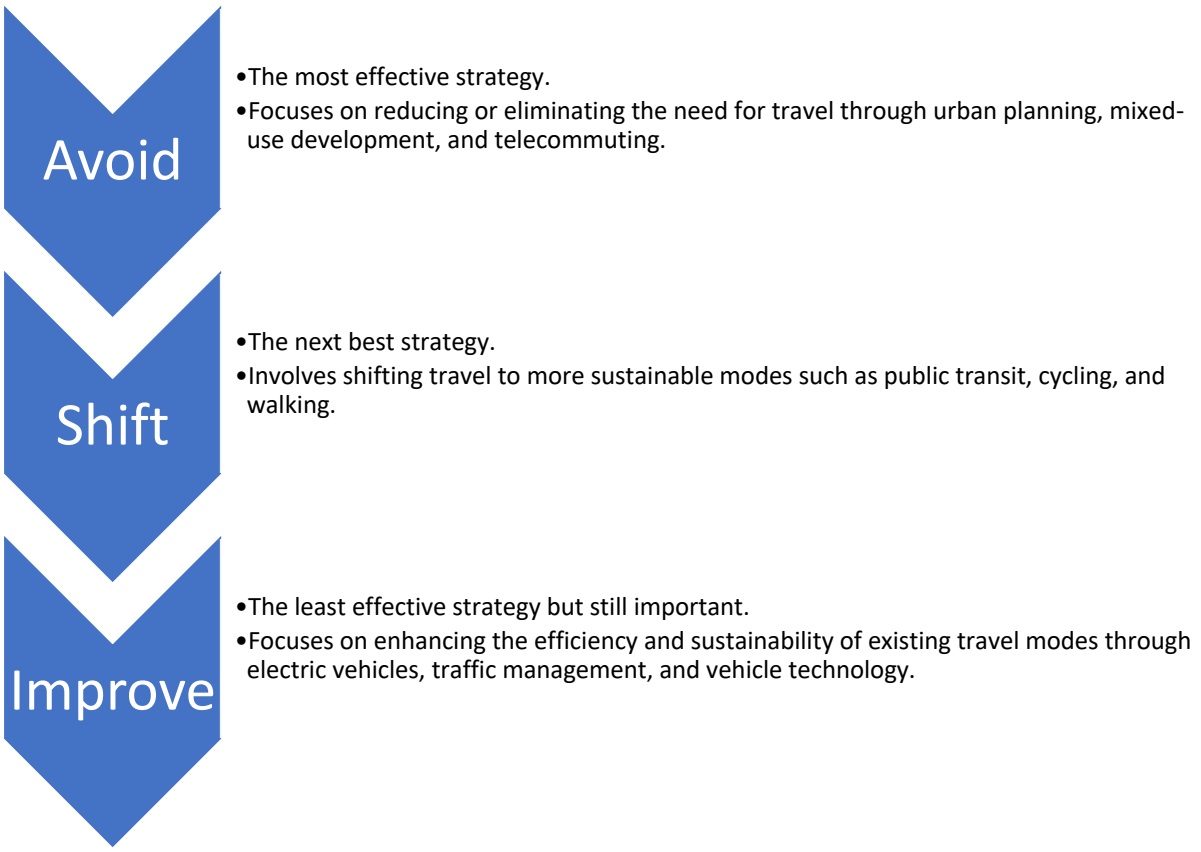

Diagram 1 : Avoid-Shift-Improve" (ASI) framework

This hierarchical approach emphasizes prioritizing the strategies from avoiding travel to shifting modes and finally improving the existing transportation systems.

An important point about the "Avoid-Shift-Improve" (ASI) model is the prioritization of its strategies to maximize sustainability and efficiency. Firstly, "Avoid" is considered the most effective approach as it seeks to reduce or eliminate the need for travel altogether. This can be achieved through urban planning that promotes mixed-use developments, telecommuting, and digital solutions, thereby minimizing the environmental impact and congestion from the outset. If avoiding travel is not feasible, the next best strategy is to "Shift" travel to more sustainable modes of transportation such as public transit, cycling, or walking. This shift reduces reliance on private cars, thereby lowering emissions and improving urban air quality. Lastly, if avoiding and shifting are not viable options, the "Improve" strategy comes into play, which focuses on enhancing the efficiency and sustainability of the remaining travel modes. This includes

upgrading vehicle technology, optimizing traffic management systems, and encouraging the use of electric vehicles. By following this hierarchical approach, the ASI model provides a structured pathway to achieve sustainable mobility, emphasizing that avoiding travel is the most beneficial, followed by shifting modes, and finally improving existing transportation systems when the first two options are not possible.

Sustainable mobility necessitates a comprehensive strategy encompassing land use, urban planning, and technological advancements. The Avoid-Shift-Improve (ASI) model encapsulates this approach by advocating avoidance of unnecessary travel, promoting the use of sustainable transportation modes, and enhancing existing transportation systems. By discouraging excessive mobility through telecommuting and mixed-use development, encouraging public transit, cycling, and walking, and investing in cleaner vehicle technologies and traffic management, the ASI model aims to reduce environmental and social impacts while fostering more resilient and equitable transportation solutions.

In essence, the ASI model represents a holistic framework for achieving sustainable mobility by addressing both the demand for travel and the means of transportation. Through a blend of avoidance, shift, and improvement strategies, it seeks to minimize environmental degradation, enhance social well-being, and promote economic vitality. By prioritizing these principles, policymakers and urban planners can work towards creating more sustainable and inclusive transportation systems that benefit present and future generations. This model provides a structured pathway for achieving sustainable mobility, highlighting that avoiding travel is the most beneficial strategy, followed by shifting travel modes, and finally improving transportation systems when the first two options are not possible.

4. Methodology and methods:

4.1. Research design:

Traditionally, micro-mobility has been associated with walking or cycling, but the emergence of e-scooters has introduced a new mode of transport that appeals particularly to younger demographics. While some individuals may still prefer walking for its health benefits, e-scooters are gaining popularity among adolescents and those under forty due to their convenience offering users flexibility and accessibility while occupying minimal space.

The primary objective of this research is to evaluate the sustainability of e-scooters as a mode of transport in Bergen municipality, with a focus on understanding their impact on urban mobility patterns and identifying the socio-demographic factors influencing their adoption. The study will quantify the extent to which e-scooters replace other modes of transport such as car usage, walking, cycling, and public transportation. By doing so, it aims to provide insights into the overall contribution of e-scooters to sustainable transportation.

Additionally, this research seeks to investigate the socio-demographic factors that drive individuals' preferences for e-scooters over other transport options. By examining variables such as age, income, and residential location, the study will identify key determinants influencing e-scooter adoption among different population segments. Furthermore, the research will assess the broader implications of e-scooter integration into urban transportation systems, exploring both the potential benefits, such as enhanced mobility and reduced environmental impact, and the challenges, including safety concerns and regulatory issues.

Ultimately, the study aims to provide actionable recommendations for policymakers and urban planners to optimize the role of e-scooters in achieving sustainable urban mobility goals, balancing their benefits while addressing potential drawbacks.

To achieve my research objectives, I chose to follow the survey method, a well-established approach in geographic research. Surveys serve as a valuable tool for gathering insights into people's attitudes, opinions, behaviors, and social interactions (McLafferty, 2003). This method is particularly effective for capturing data on a wide range of social, political, and

environmental issues, such as neighbourhood quality of life and environmental risks. By conducting surveys, I can collect detailed information on complex behaviors and social interactions related to e-scooter usage in Bergen municipality. Furthermore, the survey method provides a way to collect information about individuals' lives that may not be accessible through published sources (Clifford et al., 2010). This is crucial for understanding the socio-demographic factors influencing e-scooter adoption and preferences, as well as the impact of e-scooters on urban mobility patterns. By utilizing surveys, I aim to gather comprehensive data that will enable me to analyze the sustainability of e-scooters and assess their benefits and challenges. This approach ensures that the research captures the diverse perspectives and experiences of the population, leading to a more thorough understanding of e-scooter integration into urban transportation systems.

I found a questionnaire survey is particularly suited to this research because it allows for the collection of customized and relevant data pertaining to the specific topic under investigation. Questionnaires are central to survey research as they can be tailored to address the research objectives directly, containing a set of questions that are pertinent to understanding the impact and sustainability of e-scooters in Bergen municipality. The formulation and wording of questions in a questionnaire are crucial as they significantly influence the responses received. Established methodologies for creating effective questionnaires emphasize the importance of crafting clear, unbiased, and impactful questions (Fowler Jr, 2013).

In the field of geography, questionnaire surveys have a long-standing tradition, initially used within behavioral geography to investigate environmental perceptions, travel behavior, and consumer choices (Rushton, 1969, Gould and White, 2012). This methodology has since been extended to various branches of human geography and is now integral to a human geographer's research toolkit. A well-designed questionnaire ensures that the information gathered is relevant to the research questions while minimizing potential biases and leading questions.

Survey responses are valuable as they reflect the depth and breadth of participant feedback. The format of the questions can significantly impact the quality and type of data collected. Open-ended questions allow respondents to articulate their thoughts and opinions freely, providing comprehensive insights into their perspectives. On the other hand, fixed-response questions offer predefined options, making it easier for respondents to answer and for researchers to analyze the data efficiently. While fixed responses facilitate straightforward data

interpretation, they may not capture the detailed nuances of individual viewpoints (Fink, 2015). Therefore, my questionnaire includes a combination of fixed-response and open-ended questions. This approach ensures that the survey captures both quantitative data, which is essential for statistical analysis, and qualitative data, which provides deeper insights into attitudes, preferences, and emotions. By combining these types of questions, the survey aims to produce rich, multifaceted data that will enhance the research findings and provide a comprehensive understanding of e-scooter usage and its implications for sustainable urban mobility in Bergen.

To ensure the effectiveness and clarity of the questionnaire, a crucial step involved conducting pre-testing, or pilot testing. During this phase, the questionnaire was administered to a small sample group to evaluate question clarity, response options, layout, and instructions. This process aimed to identify and rectify any issues related to the comprehensibility of questions, the adequacy of response options, the clarity of instructions, and the overall length of the questionnaire. Additionally, the pre-testing phase helped to ensure that no questions caused discomfort or unease among respondents. By refining the questionnaire through this pre-testing phase, the research aims to enhance the reliability and validity of the data collected during the main data collection phase (Clifford et al., 2010).

The initial step in sampling involved identifying the sampling frame, which consisted of individuals with the potential to be included in the sample (Fowler Jr, 2013). The focus was on the e-scooter user group to collect primary data relevant to the research objectives. A random sampling process was employed to select e-scooter users. The questionnaire was generated electronically using Google Forms, and a leaflet with a QR code was prepared. By scanning the QR code, e-scooter users could easily fill out the electronic questionnaire and submit their responses. The questionnaire was designed to be convenient for participants, taking approximately 2-3 minutes to complete.

After data collection, the raw data was categorized and coded for further processing. Both quantitative and qualitative analyses were considered to analyze the data, using pie charts, bar charts, histograms, and descriptive statistics to present the findings comprehensively. This mixed-methods approach ensures a robust analysis, capturing both numerical data and detailed personal insights to provide a thorough understanding of the impact and sustainability of e-scooters in Bergen.

4.2. Data collection:

Two methods were used to gather data: an online survey targeting e-scooter users residing in Bergen and a field survey conducted within the city. The online survey was disseminated via social media platforms, particularly Facebook, where a QR code was shared among selected Bergen-based groups to access the questionnaire. Additionally, leaflets containing QR codes were distributed directly to e-scooter users or affixed to the scooters themselves. This approach helped to collect a total of 211 valid responses from individuals who had used e-scooters at least once.

The questionnaire was designed to be concise and straightforward, ensuring clarity and ease of completion. Most questions were mandatory, with the exception of the email ID, to maintain high response rates and consistency across all questions. The online questionnaire was accessible from December 2022 to August 2023, allowing for data collection across both winter and summer seasons to capture a wide range of user experiences and perspectives.
The design of the questionnaire directly corresponds to the research questions, ensuring that the data collected will provide comprehensive insights into the sustainability of e-scooters as a mode of transport in Bergen.

First Section: Users' Attitudes and Behavioural Patterns

This section addresses the sub-question, "What modes of transport do e-scooters replace?" It includes questions about the average distance travelled, trip purposes, alternative modes of transportation in the absence of e-scooters, frequency of e-scooter use, and potential integration with public transport. These questions aim to quantify how often e-scooters substitute for other transportation modes, such as cars, walking, cycling, and public transportation. By understanding the patterns of e-scooter use and their integration with other modes, this section provides key data on their contribution to sustainable urban mobility, thereby also addressing the main research question regarding the sustainability of e-scooters.

Second Section: Factors Influencing Willingness to Use E-Scooters

This section features an open-ended question designed to identify factors influencing users' willingness to use e-scooters. It allows participants to share their experiences and factors not covered by fixed-response questions, providing deeper insights into the socio-demographic factors that affect e-scooter adoption. This directly addresses the sub-question, "What socio-demographic factors affect an individual's preference to replace other transport?" The qualitative data gathered here will help to uncover the underlying reasons behind users' choices and preferences, offering a nuanced understanding of how different demographic groups perceive and use e-scooters, thereby contributing to the main question of their sustainability.

Third Section: Demographic and Socio-Economic Characteristics

This section collects general information about the respondents, including demographic and socio-economic characteristics. This data is crucial for analyzing the socio-demographic factors influencing e-scooter adoption, addressing the sub-question about individual preferences. Understanding the demographic profile of e-scooter users allows for the identification of patterns and correlations between user characteristics and their transportation choices. This demographic analysis is essential for interpreting the broader implications of e-scooter usage for sustainable urban mobility.

By structuring the questionnaire to cover these specific areas, the survey is designed to collect data that will thoroughly address the research questions. It ensures that both quantitative and qualitative data are gathered, providing a comprehensive analysis of the extent to which e-scooters can be considered a sustainable mode of transport, the modes of transport they replace, and the socio-demographic factors influencing their adoption.

4.3. Limitations:

Initially, my plan was to collect data by distributing leaflets directly to e-scooter users as they started or finished their rides. However, this approach proved ineffective as most individuals were too busy to engage with me, often giving me looks of discomfort as if I were soliciting financial support. This experience was quite discouraging.

As a result, I revised my strategy. I began posting the leaflets in e-scooter parking areas and on social media platforms, specifically Facebook. These methods yielded better results, with a few completed questionnaires. However, I realized that non-e-scooter users could potentially fill out the survey, which would compromise the data's validity. To address this, I attached the leaflets directly to the e-scooters, ensuring that only riders who had used the scooters would see and potentially participate in the survey. This approach proved to be much more effective.

Despite this, a limitation remains: this study exclusively reflects the opinions, experiences, and expectations of e-scooter users. Non-users could provide valuable alternative perspectives, which are not captured here. Although the literature review partially addresses this gap, it remains a limitation of this thesis.

4.4. Ethical issue:

Adhering to ethical standards is crucial in geographical research, as it ensures the protection of individuals, communities, and the environment impacted by our studies. By upholding ethical principles, researchers can maintain social and environmental responsibility, thereby conducting valuable work that contributes positively to society and the planet (Clifford et al., 2010).

In this study, utmost priority was placed on preventing harm to participants, obtaining informed consent from them, respecting their privacy, and refraining from any form of deception within the research process. To safeguard participant confidentiality and autonomy, sensitive information such as email addresses was not mandatory for completion, and respondents were provided with the option ("Prefer not to say") to withhold demographic information if they preferred not to disclose it.

Addressing the ethical issues related to storing personal data is paramount in academic research, particularly when dealing with sensitive information. To mitigate risks, I designed the data collection processes based on the principles of data minimization, ensuring that only essential information necessary for the research purpose was collected (Xu et al., 2014). The questionnaire and overall data collection strategy were crafted to avoid gathering excessive personal data, adhering strictly to ethical guidelines. This approach not only respects the privacy of participants but also aligns with legal requirements for data protection.

Data security was a primary concern throughout the research process. Initially, data was collected using Google Forms and stored on Google Drive, providing a secure platform during the data collection phase. Once the data collection period ended, I transferred all data to a secure, personal computer that only I could access. This step was crucial to protect the data from potential cyber threats and unauthorized access, ensuring that the information remained confidential and secure throughout the analysis phase.

Furthermore, the management of data retention and deletion was meticulously planned to uphold data integrity and privacy (Goddard, 2017). Retaining data longer than necessary can increase the risk of breaches and misuse, so all raw data will be securely deleted upon completion of the academic thesis work. This comprehensive approach—encompassing strong security measures, informed consent, and adherence to relevant laws and ethical guidelines—ensures the protection of personal data. By prioritizing privacy, minimizing data collection, and maintaining transparency, I have effectively safeguarded personal data and upheld the integrity of the research.

5. Results:

In this chapter, the results of the fieldwork data will be presented, focusing on findings directly relevant to addressing the research questions. The survey data will be meticulously tabulated and presented graphically to facilitate a clear understanding of the results. The analysis will be structured around three main components:

Demographic Information: This section will delve into the individual and socio-economic characteristics of e-scooter users, including factors such as age, gender, education, and occupation. Understanding these demographic variables is essential for contextualizing the findings and identifying any potential patterns or correlations that may influence e-scooter usage.

E-Scooter Usage Data: This segment of the analysis will explore the patterns and preferences related to e-scooter usage, specifically focusing on the extent to which e-scooters are replacing other modes of transportation. By examining factors such as frequency of use and trip purposes, insights will be gained into the role of e-scooters in the urban mobility landscape.

Responses to Open-Ended Questions: The findings from the open-ended questions will be thoroughly examined to uncover the multifaceted aspects of e-scooters in the context of sustainability. Emphasis will be placed on elucidating the insights shared by residents of Bergen, providing a nuanced understanding of their perceptions, experiences, and expectations regarding e-scooter usage.

By systematically analyzing these three components of the survey data, this chapter aims to provide a comprehensive overview of the findings, shedding light on the sustainability implications of e-scooters and their role in the transportation system of Bergen.

5.1. Demographic Information:

Gender:

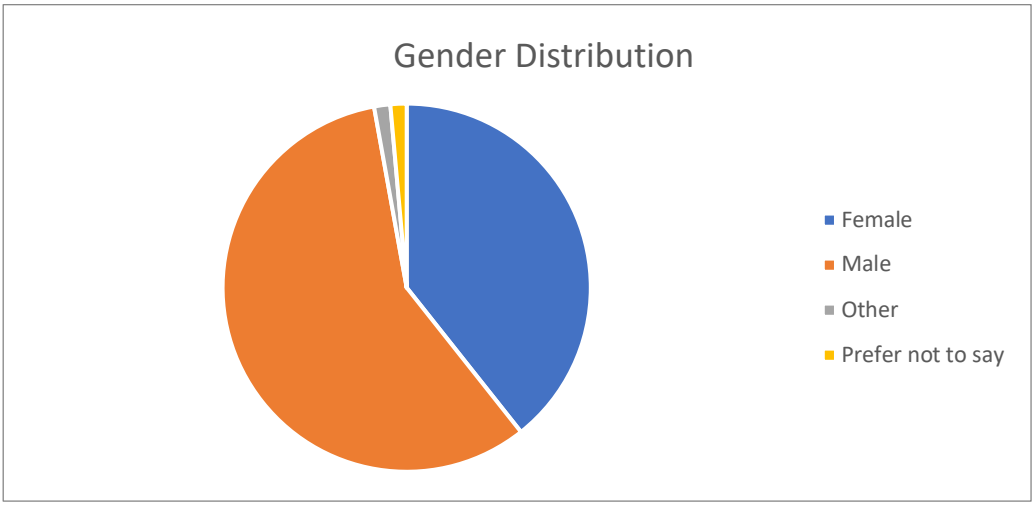

Figure 2 Gender distribution

Figure 2 illustrates the gender distribution among users of e-scooters, indicating that 58% of the primary users are male, while female users constitute 39% of the total user base. Notably, there appears to be an almost equal presence of both genders when observing their utilization on the road. This observation suggests a balanced popularity and acceptance of e-scooters among both men and women.

Comparatively, the Norway SSB report of 2023 highlights the demographic distribution in Bergen, indicating a population of 646,205, with 51% males and 49% females. However, based on the collected data from e-scooter users, there is a disproportion in favour of male respondents when compared to female respondents.

Age:

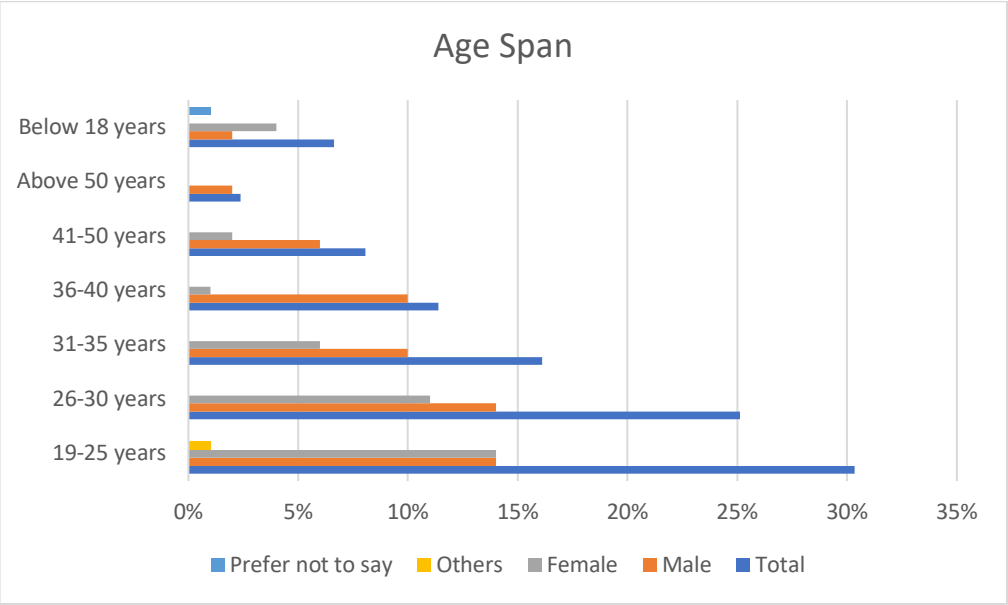

Figure 3 Age Span

The graph provides insights into user demographics based on age. It's evident that there is a significant concentration of users within the 19 to 30 age range, comprising a total of 55%. This distribution aligns with the on-road observations. Specifically, for the 19-25 age bracket, the male-female distribution is identical at 14%. The trend remains consistent for the 26 to 35 age groups, with a similar male-female ratio.

As users' ages increase, there is a noticeable decline in usage for both males and females, with a more pronounced decrease in female users. Notably, 7% of participants are under 18 years old, with females being the majority in this age group.

It's worth noting that the data primarily reflects users under 40 years old, as expected. However, there is a surprising discovery that 2% of users are above 50 years old.

Education:

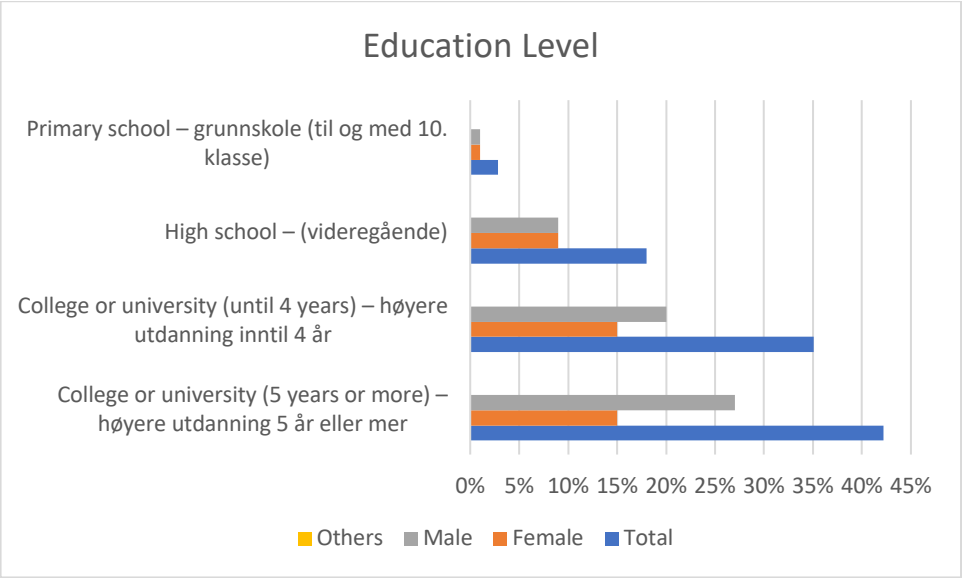

Figure 4 Level of education

From figure 4, we can see that a substantial portion of the respondents have attained higher education, totalling 77%. Interestingly, there were no significant gender differences at the primary and high school levels, with an equal male-female ratio. However, a shift occurs at the 4-year university level, where the number of female respondents drops to 15%, while male respondents increase to 20%. This trend continues in higher education areas, where females make up 15%, while males are slightly overrepresented at just above 25%. This data highlights a pattern of male dominance in the higher education categories.

Occupation:

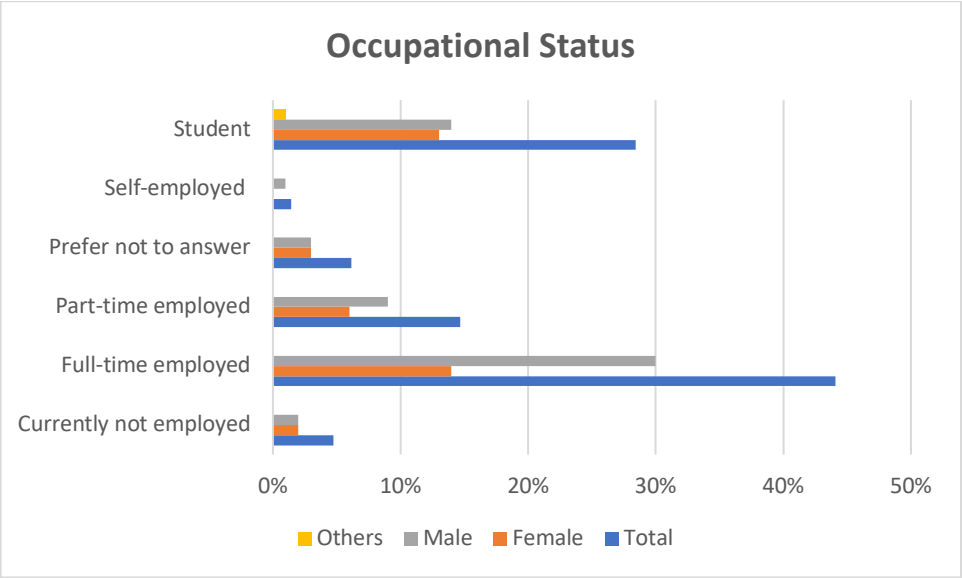

Figure 5 Occupational Status

Figure 5, which presents data on occupational status, clearly indicates a gender disparity in the workforce. Specifically, the data shows that a higher proportion of males are engaged in employment compared to females. Approximately 43% of males are employed, while females constitute nearly half of that figure at 23%.

In terms of student status, the data reflects a relatively balanced male-female distribution, with both genders comprising approximately 14%. However, this equilibrium shifts when examining part-time employment, where the male percentage stands at 9% and the female percentage drops to 6%, indicating a disparity in part-time work opportunities.

In contrast, in the category of full-time employment, there is a pronounced gender gap. Out of the total workforce, 44% are males, with 30% engaged in full-time work, while females contribute only 14%. This data underscores the clear gender imbalance in the labour force in Norway, despite the similar representation of both genders in student status.

Yearly Income:

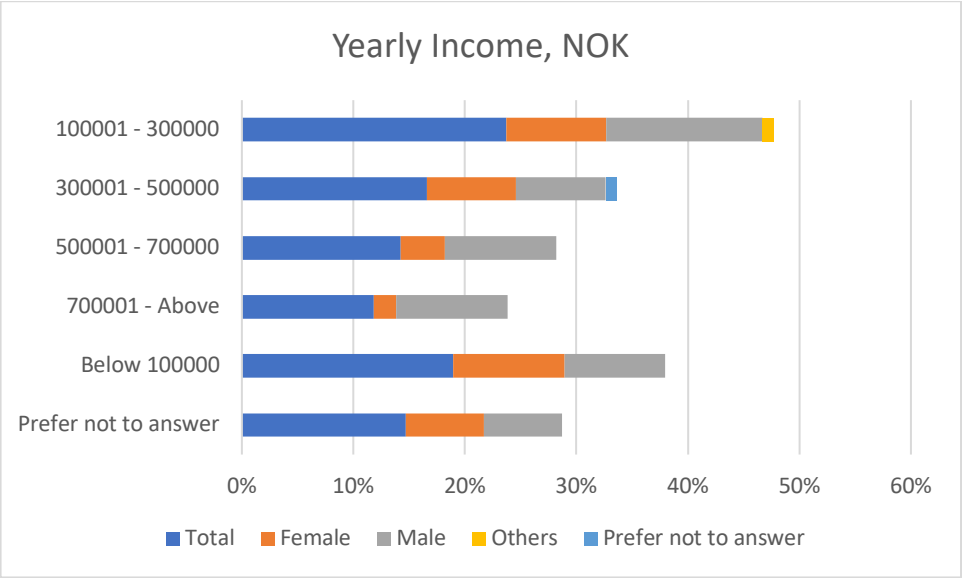

Figure 6 Yearly Income, NOK (Before Tax)

Figure 6 provides insights into the distribution of yearly income among survey respondents. Notably, a significant portion, constituting 43% of the total respondents, falls within the income range of less than 300,000. This suggests that a considerable number of e-scooter users belong to the lower income bracket.

Examining income distribution by gender reveals a noteworthy disparity, particularly in the higher income brackets. Males exhibit higher representation as income levels ascend. For example, in the income range of 700,001 and above, males constitute 10% of respondents, while females make up only 2%. Similarly, in the 500,001 income range, the male population is 10%, contrasting with a mere 2% of females. Interestingly, just below the 300,001 income range, both genders are evenly represented at 8%.

This data highlights a gender-based inequality in economic contribution within Norwegian society. Males not only outnumber females but also dominate the higher income brackets. Moreover, the Norway SSB report indicates the average yearly income for males at 675,000 NOK and for females at 591,360 NOK, with an average of 637,800 NOK. The male-female contribution ratio stands at 53% and 47%, respectively. It's notable that a significant proportion of respondents in the survey belong to the below-average income range of 300,000 NOK, comprising about 43% of the respondents. Consequently, it can be inferred that a substantial

majority of e-scooter users are individuals with incomes below the average, according to our gathered data.

5.2. E-Scooters usage data

Last usage:

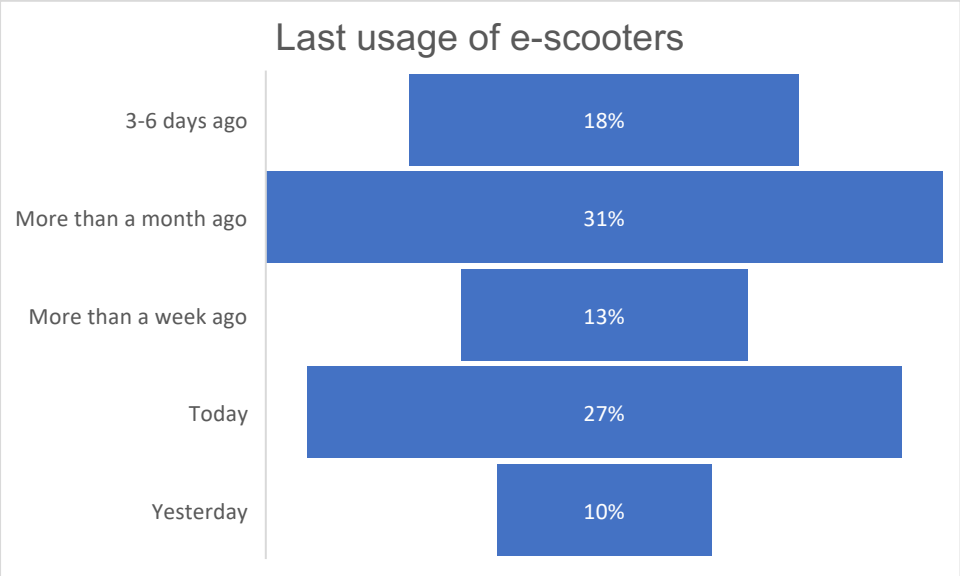

Figure 7 Last time e-scooter usage

The data regarding the last usage of e-scooters provides valuable insights into the frequency and patterns of e-scooter utilisation.

Notably, a significant portion, 55% of the participants, reported having used e-scooters within the past week. This group of individuals, who have used e-scooters within one week, can be considered regular users. This is particularly noteworthy as it comprises more than half of the respondents. Regular usage within such a short timeframe suggests a high level of acceptance and integration of e-scooters into their daily routines or transportation choices.

This data highlights the growing popularity of e-scooters as a means of urban transportation, and it underscores the importance of these devices in the daily lives of a substantial portion of the surveyed population.

E-Scooter searching time:

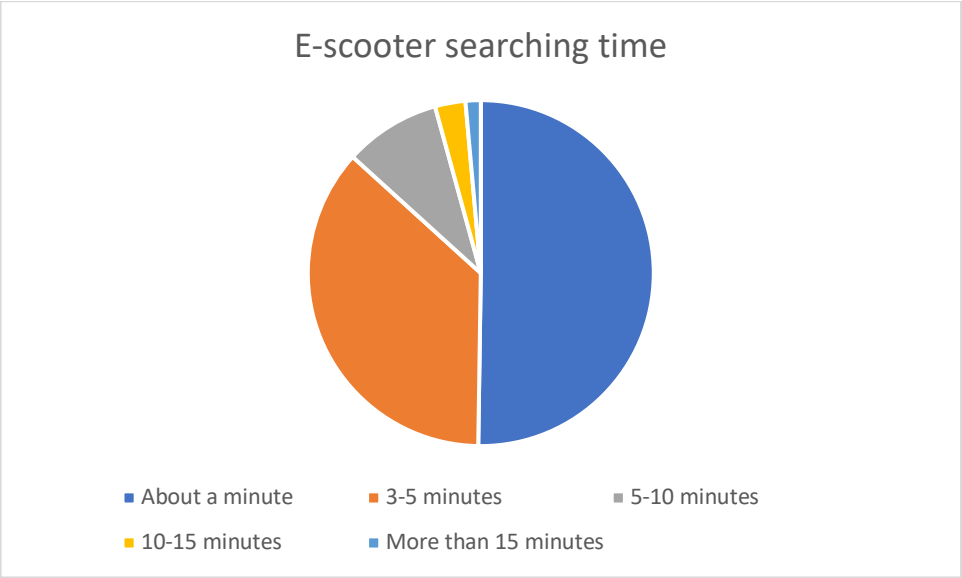

Figure 8 E-scooter searching time on the road

Figure 8, the dataset strongly supports the assertion that e-scooters are readily accessible on the road. A substantial portion of respondents, specifically 50%, reported successfully locating e-scooters within the remarkably brief timeframe of one minute. Additionally, the second-largest group, constituting 36% of participants, indicated that they typically identified e-scooters within a slightly longer but still quite reasonable period of 3 to 5 minutes.

This data underscores the prompt availability of e-scooters, highlighting their accessibility and convenience for users. Such swift and efficient access to e-scooters likely contributes to their popularity and widespread adoption as a convenient mode of urban transportation.

Usage time and trip combination:

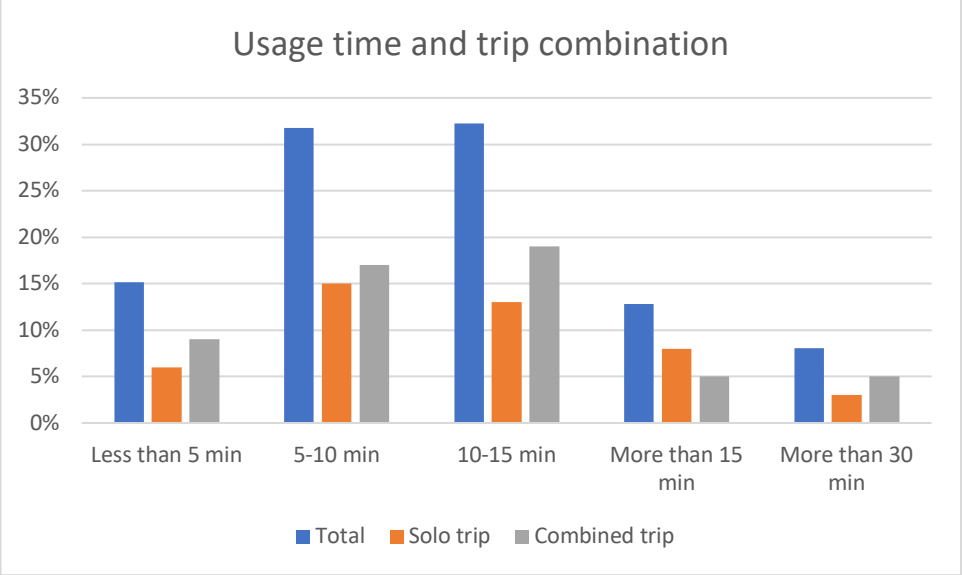

Figure 9 Single trip usage time, trip combination

In Figure 9, we observe that out of a total of 211 respondents, 55% opted to combine e-scooters with their regular trips, while the remaining 45% chose to use e-scooters for solo trips. A further examination of the dataset reveals that the majority of these trips fall within the time range of 5 to 15 minutes, accounting for approximately 64% of all trips. Notably, over half of these trips involve the combination of e-scooters with other forms of transportation. This suggests that combined trips may serve as a convenient last-minute solution, while solo trips are more typical for shorter, routine journeys, such as those to school or nearby grocery stores.

In more specific terms, 15% of respondents reported taking trips lasting less than 5 minutes on their most recent journey. Of this group, 9% combined e-scooters with other transportation methods, while 6% opted for solo e-scooter trips. On the other hand, trips lasting more than 15 to 30 minutes accounted for 13% of user preferences, with 8% of these respondents choosing to combine e-scooters with their trips.

This data provides valuable insights into user preferences and usage patterns, shedding light on the reasons behind the combination of e-scooters with regular trips and the role these scooters play in varying trip durations.

Trip purpose:

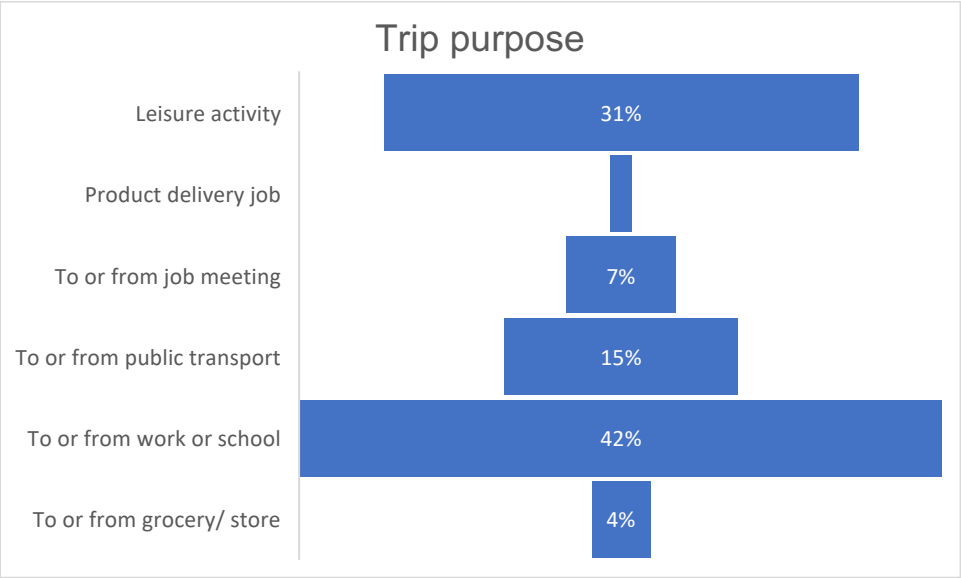

Figure 10 Purpose of the trip

Figure 10 presents an analysis of trip purposes based on survey data. The results indicate that the primary use of e-scooters by respondents is for commuting between work and school, accounting for approximately 42% of the reported trip purposes. Another notable usage scenario is for travelling to or from public transport, with 15% of respondents choosing this option. Additionally, e-scooters are embraced as a means of recreational transportation, as 31% of participants reported using them for leisure activities. Surprisingly, a small minority, 1% of respondents, reported utilising e-scooters for delivery purposes. These findings offer valuable insights into the diverse range of trip purposes for which e-scooters are employed, encompassing both routine commuting and recreational use.

Trip combination with other transport:

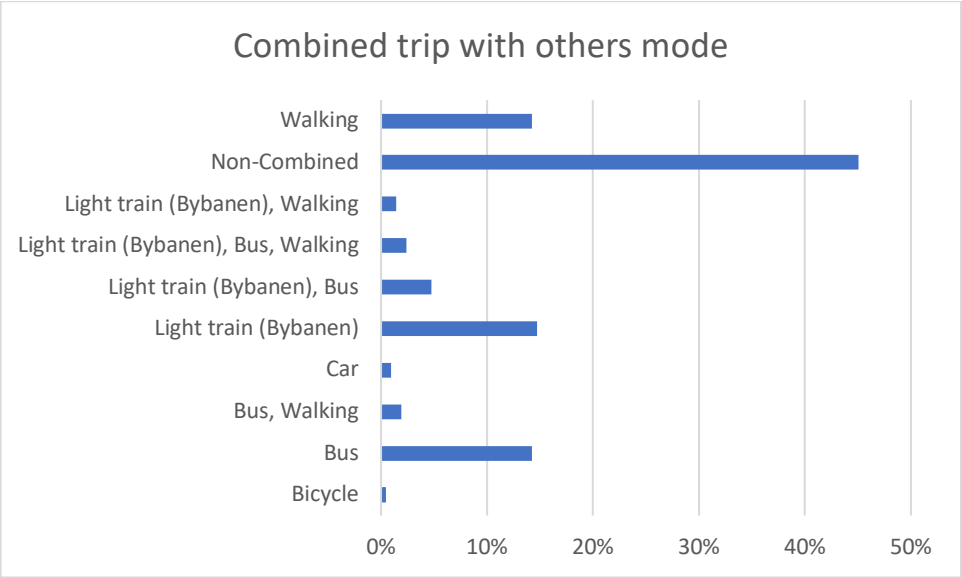

Figure 11 Trip combination with other modes

The data set presents valuable insights into how respondents combine e-scooters with other modes of transportation. It's clear from the data that 55% of participants prefer to use e-scooters as part of a larger multimodal journey, while 45% opt for solo e-scooter trips.

Among those who combine e-scooters with other transport options, 15% choose light trains as their complementary mode, while 5% use a combination of e-scooters, light rail (bybanen), and buses. A smaller group, 3%, opt for an even more diverse mix of e-scooters, light trains, buses, and walking. Additionally, 14% of respondents reported combining e-scooters with buses as their preferred travel approach.

This data emphasised the versatility and integration of e-scooters into existing urban transportation systems, providing users with flexible options for their daily journeys. The popularity of solo e-scooter trips also highlights the continued appeal of e-scooters for straightforward, short-distance travel.

Usage frequency:

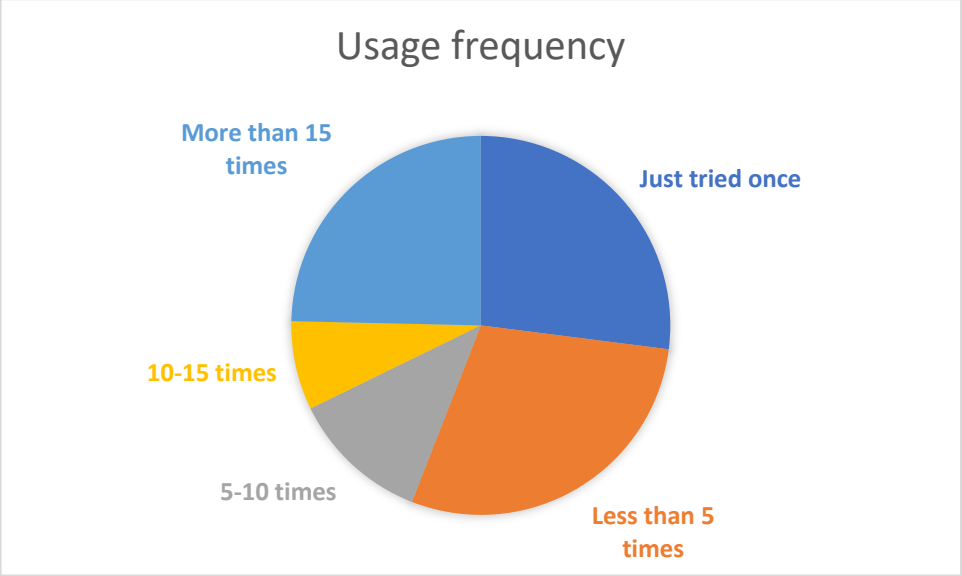

Figure 12 Usage frequency of e-scooters last month

Figure 12, provides us with a valuable perspective on the distribution of e-scooter users based on the frequency of their usage over the course of the last month. These user categories offer insights into the diverse patterns and motivations underlying e-scooter adoption and usage.

One notable group comprises the most frequent users, representing 33% of the total respondents. These individuals use e-scooters 10 to 15 times or even more than 15 times within a single month. It is apparent that these e-scooter users rely heavily on this mode of transportation, suggesting its integral role in their daily mobility choices.

Another group of users, comprising 12% of the respondents, falls into the category of regular users. These individuals employ e-scooters between 5 to 10 times in a month, indicating their consistent reliance on this mode of transportation, although not as extensively as the most frequent users.

The survey data also highlights a category of fun-seeker riders, accounting for a significant 27% and 29% of the participants, respectively. These users either tried e-scooters just once or used them less than 5 times within the last month. Their usage patterns indicate that e-scooters are primarily employed for recreational purposes, novelty, or leisure activities rather than serving as their primary means of transportation.

What else to use (if no e-scooters):

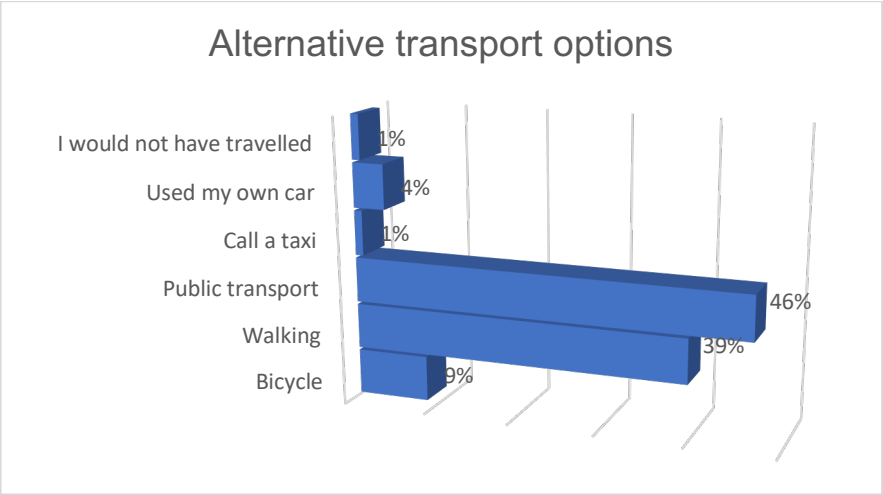

Figure 13 If no e-scooters, what else to use?

Figure 13 presents insightful data regarding the alternative transportation choices that respondents would make if electric scooters were not available. This information provides a glimpse into how e-scooters influence the transportation landscape and the potential impact on various modes of mobility.

The preeminent response, provided by a majority of 46% of respondents, indicates a preference for using public transport in the absence of electric scooters. This suggests that a substantial portion of respondents view public transport as a primary alternative mode of transportation, emphasizing its significance in the urban mobility landscape.

Interestingly, a notable 39% of respondents reported that electric scooters effectively replace walking as an alternative means of travel. This finding highlights the potential of e-scooters to serve as a competitive alternative for short-distance walking, reducing the reliance on pedestrian mobility for certain trips.

A comparatively smaller segment of respondents, constituting only 4%, would opt for driving a car if electric scooters were not an option. This data underscores the potential of e-scooters to mitigate car usage and potentially alleviate traffic congestion, particularly for short trips where e-scooters offer a sustainable and efficient alternative.

Moreover, a mere 1% of respondents indicated that they would choose to take a taxi as an alternative mode of transportation in the absence of e-scooters. This finding indicates a limited impact on taxi services from e-scooters and emphasizes the continued relevance of traditional taxi options in the urban transportation mix.

For 9% of respondents, their alternative choice would involve cycling on a conventional or city bicycle, supplanting the use of electric scooters. This highlights e-scooters as an alternative to traditional cycling for a subset of users, suggesting that e-scooters do not entirely replace the role of bicycles in the urban mobility system.

Lastly, 1% of respondents expressed that they would not travel at all if electric scooters were unavailable, signifying that these devices play a unique and irreplaceable role in their transportation choices, underscoring their importance in specific mobility scenarios.

E- scooter's effect on travel behaviours:

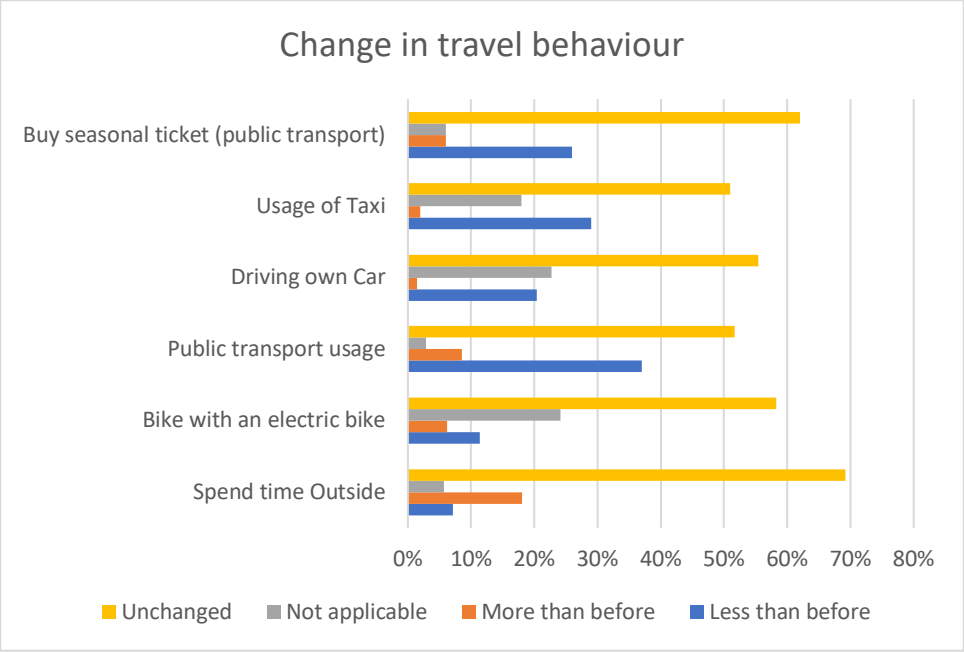

Figure 14 Change in travel behaviour due to e-scooters

Figure 14 provides insights into how electric scooters have influenced people's travel behaviour. It's important to note that these changes are self-reported by respondents and not necessarily observed behaviours.

The most significant change observed is that 37% of respondents reported using public transport less frequently due to electric scooters. This suggests that for a substantial portion of users, e-scooters have become a preferred alternative to traditional public transportation for their commuting needs. Furthermore, 26% of respondents indicated that they have reduced their use of seasonal public transport tickets, likely due to the convenience and cost-effectiveness of e-scooters for short trips.

A notable 20% of respondents reported using their own cars less often, which suggests that e-scooters have had an impact on personal car usage, potentially reducing traffic congestion and environmental impact.

Taxis have also felt the influence of e-scooters, with 29% of respondents stating they have used taxis less frequently, reflecting the competitive nature of e-scooters in the short-distance transportation market.

On the other hand, only 18% of respondents reported that they are spending more time outside their homes because of e-scooters, indicating that these devices encourage outdoor mobility and exploration for some users.

Lastly, electric bikes with an electric option saw a reduction in usage for 11% of respondents, which may be linked to the appeal and convenience of electric scooters.

In conclusion, the data illustrates how electric scooters can affect people's transportation choices, with notable changes related to public transport, car usage, and taxi services.

E- scooter's effect on Car usage:

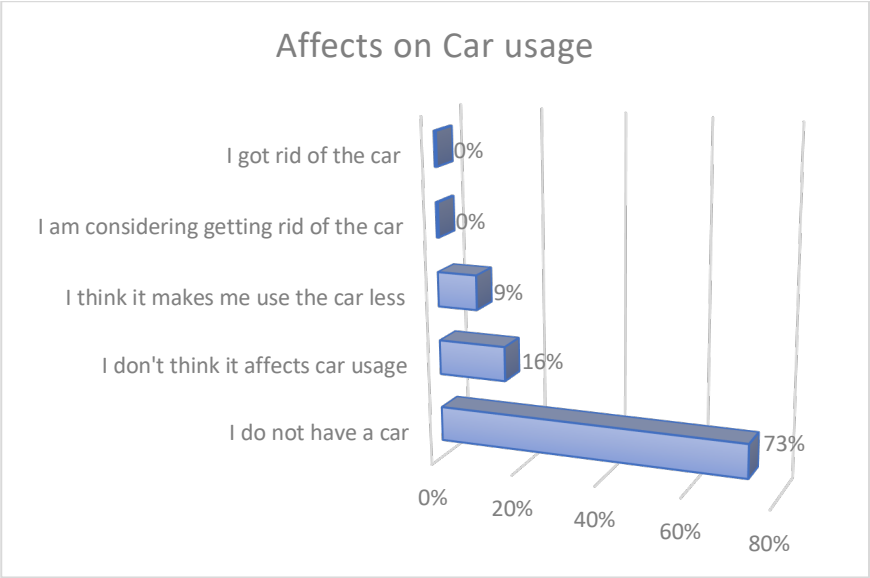

Figure 15 Effects on car usage

Figure 15 examines how electric scooters affect people's views on owning a car. The survey asked if people with cars have considered getting rid of them due to electric scooters. It's important to note that 73% of respondents don't own cars, so this question mainly applies to the 27% who do.

Among those car owners, 9% mentioned that electric scooters have made them use their cars less often. This suggests that for a small group, e-scooters have become a viable alternative, reducing the need for their cars.

On the other hand, 16% said that electric scooters have had no impact on their car use. This means that, for a significant number of car owners, e-scooters have not changed how often they use their cars.

It's essential to remember that most of the respondents in this survey don't own cars, so the question about e-scooters influencing car ownership is mainly relevant to a smaller group.

5.3. E-scooter users' opinions and experience:

E- scooter's contribution to a better city transportation system:

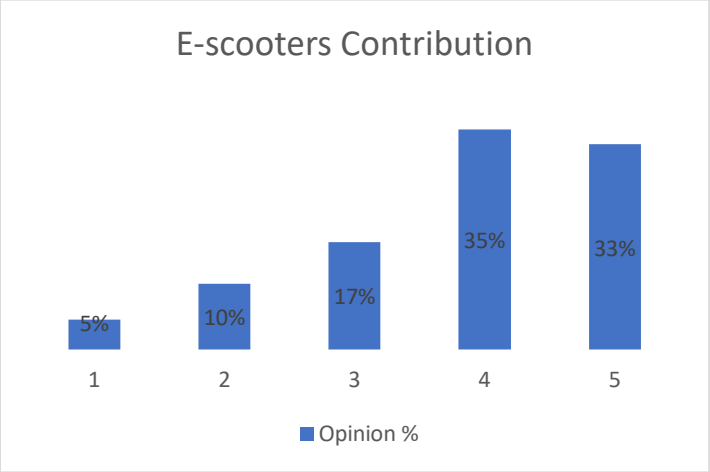

Figure 16 E- scooter's contribution to a better city transportation system (scale of 1-5, less to high value)

In Figure 16, the data provides insights into how respondents perceive the contribution of e-scooters to the city's transportation system. This perception is measured on a scale from 1 to 5, where lower values represent less appreciation, and higher values indicate higher appreciation. Approximately 33% of respondents gave a high rating, while 35% provided a positive rating for E-scooters' contribution to the city's transportation system. This indicates that a significant portion of the surveyed individuals view e-scooters favourably and appreciate their role in improving urban transportation.

Around 17% of respondents expressed a neutral opinion, implying that they neither strongly appreciate nor disapprove of the contribution of e-scooters to the city's transportation system. However, it's worth noting that 15% of respondents gave low ratings, marking scales 1 and 2. This suggests a nominal negative opinion regarding e-scooters' contribution, indicating that a large portion of respondents have reservations or concerns about their impact on the city's transportation system.

Reason to choose e-scooter over other transport:

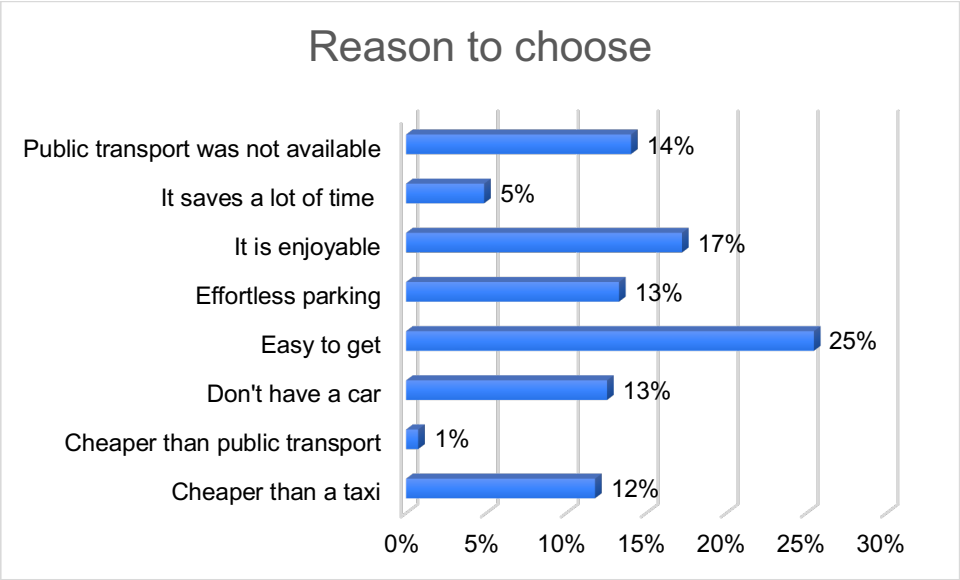

Figure 17 Last trip choice of e-scooter over other transport

Figure 17 provides insights into why people opted for e-scooters instead of other transportation options on their most recent trip. The data reveals several key reasons behind this choice. The most common reason for choosing e-scooters is their easy accessibility. Many people find e-scooters readily available, making them a convenient choice for getting around in the city. Another significant factor is the convenience of e-scooters compared to public transport. People appreciate the flexibility and the ability to avoid crowded buses or trains.

A notable 13% of respondents mentioned that they used e-scooters because they didn't have access to their own car. This highlights e-scooters as a practical alternative for individuals who don't own cars. Cost-effectiveness is also a driver, with 12% of respondents selecting e-scooters because they are cheaper than taking a taxi for short trips.

Effortless parking was cited as a reason by 13% of respondents. E-scooters can be easily parked in urban areas, offering a convenient solution compared to finding parking for personal cars. Finally, 5% of respondents appreciated e-scooters for saving them time on their last trip. The speed and agility of e-scooters in navigating through city traffic contributed to their popularity. In summary, the data suggests that people's choice of e-scooters is influenced by a combination of factors, including accessibility, convenience, cost, and time efficiency. These factors

collectively make e-scooters a preferred option for urban travel, particularly in comparison to other available transportation choices.

Answer to the open question:

Figure 18 presents the outcomes derived from an open-ended question designed to capture additional insights and opinions beyond the structured questionnaire regarding e-scooters. Within this open-ended space, users were encouraged to articulate their thoughts about e-scooters. These responses were then categorized, labelled, and represented in the graph provided.

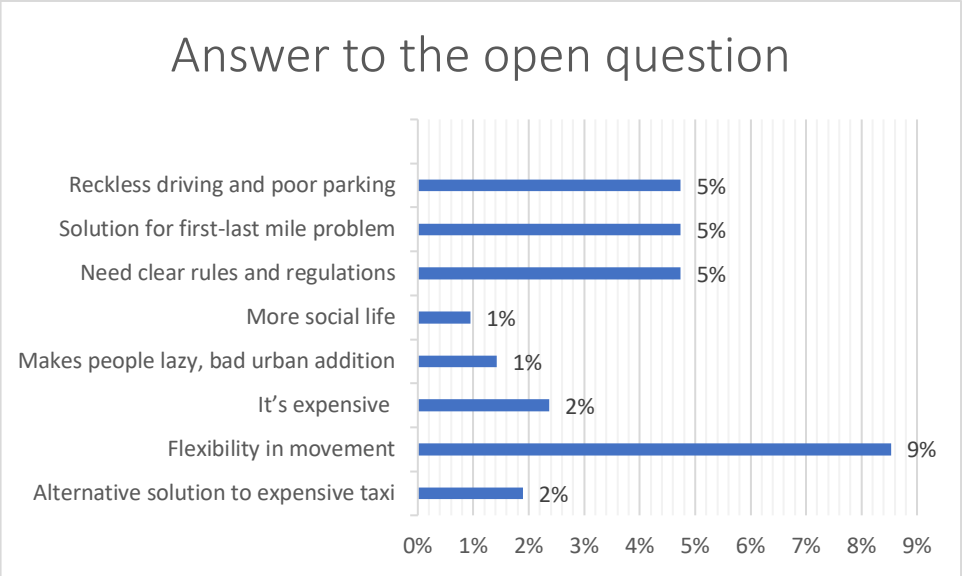

Figure 18 Answer to the open question

Out of the total 211 respondents, 149 individuals (about 71%) did not provide any supplementary comments in the open section. The remaining 62 participants offered opinions that are reflected in the aforementioned graph. Noteworthy among these responses, 9% of the respondents perceive e-scooters as a flexible and enjoyable mode of transportation, while 5% advocate for the implementation of proper rules and regulations governing this mode of transport. Approximately 5% of the participants consider e-scooters as a solution for the first-last mile transportation gap, whereas another 5% criticize this mode of transport for fostering reckless driving and inadequate parking practices. Moreover, slightly above 1% of respondents suggest that e-scooters are altering people's lifestyle choices, potentially inducing laziness. Interestingly, 1% of respondents claimed that their social lives had improved due to the utilization of e-scooters.

6. Discussions:

Urban transportation has seen a significant transformation with the introduction of electric scooters, commonly known as e-scooters. In Bergen, these trendy two-wheelers have become an integral part of the urban landscape, offering a convenient and eco-friendly means of transportation. As we delve into the details, we find compelling insights that help us understand how e-scooters are changing the way people move around the city.

6.1. Demographics of E-scooter Users

To begin, let's take a closer look at the demographics of e-scooter users. Our analysis reveals that e-scooters have an equal appeal to both genders in Bergen, with male and female users almost equally represented on the streets. This suggests that e-scooters have transcended traditional gender stereotypes in transportation choices. The open accessibility of e-scooters to people of all genders is indeed a step towards more inclusive mobility options.

When it comes to age, it's evident that the younger generation has embraced e-scooters with open arms. A significant chunk of users falls in the age bracket of 19 to 30, constituting 55% of all e-scooter enthusiasts. This generation's affinity for e-scooters aligns seamlessly with their presence on the streets. The male-female distribution remains consistent for the 19-25 and 26-35 age groups, showcasing a universal appeal among young adults. Interestingly, as the age groups advance, we witness a drop in usage, particularly among female users. Nevertheless, the data surprises us with a small but significant 2% of users who are above 50 years old. It's heartening to see e-scooters crossing generational boundaries and becoming an option for the young at heart.

According to the survey respondents, when it comes to educational backgrounds, an overwhelming 77% of users have attained higher education. The journey begins with equal representation of males and females at primary and high school levels. Still, as we progress to university and higher education, a gender shift occurs, with a drop in the number of female respondents. This survey illustrates the education trend underlining an area where males dominate in higher education categories.

Moving on to occupational status, the survey data draws our attention to a gender disparity in the workforce. Males are more engaged in employment compared to females. While approximately 43% of males are employed, females constitute nearly half of that figure at 23%. In terms of student status, we observe a relatively balanced male-female distribution, with both genders making up approximately 14%. However, this equilibrium shifts when examining part-time employment, where the male percentage stands at 9%, while the female percentage drops to 6%, indicating a disparity in part-time work opportunities.

In stark contrast, in the category of full-time employment, a substantial gender gap emerges. Out of the total workforce, 44% are males, with 30% engaged in full-time work, while females contribute only 14%. These numbers shed light on a clear gender imbalance in the labour force in Norway, despite similar representation of both genders in student status.

Financially, e-scooter users come from diverse income brackets. However, the data highlights an interesting trend when we break down income distribution by gender. Males tend to dominate in the mid-range to upper-income categories, particularly when income levels rise. In the income range of 700,001 and above, only 10% are male, while a mere 2% are female. Similarly, in the 500,001 income range, males make up 10%, while females comprise only 2%. Yet, just below the mid-level income range of 300,001, both males and females are evenly represented at 8%. This sheds light on a gender-based economic disparity in Norwegian society, where males not only outnumber females but also dominate in the higher income brackets.

6.2. E-Scooter Usage Patterns: A Glimpse into Daily Life

E-scooters have not only gained popularity among various socio-demographic groups but have also seamlessly integrated into the daily lives of Bergen's residents. By analyzing usage patterns, we uncover fascinating insights into how these electric scooters are being embraced by the city's inhabitants.

The recency of e-scooter use is an excellent indicator of their adoption. A significant 55% of users reported using e-scooters within the past week, highlighting a thriving community of regular users. These individuals have made e-scooters a part of their daily routines or transportation choices, showing the high level of acceptance and integration of e-scooters into their lives.

When it comes to accessibility, the survey data reinforces the notion that e-scooters are readily available on the streets of Bergen. A staggering 50% of respondents reported finding e-scooters within just one minute of searching. Additionally, the second-largest group, comprising 36% of participants, typically locates e-scooters within 3 to 5 minutes. This swift access underscores the convenience and efficiency of e-scooters as a mode of urban transportation. E-scooters have managed to create a sense of seamlessness in the daily lives of Bergen's residents, as users can access them without significant delays.

The duration of e-scooter usage and the way users combine e-scooters with their regular trips provide us with further intriguing insights. Among the 211 respondents, 55% preferred to combine e-scooters with their regular trips, while 45% chose to use e-scooters for solo trips. The majority of these trips, approximately 64%, fell within the time range of 5 to 15 minutes. This suggests that e-scooters are often used for last-minute solutions or for routine journeys such as going to school or nearby grocery stores. The high percentage of combined trips underlines the role e-scooters play as a convenient solution for multimodal journeys, complementing existing public transportation options.

Understanding the purpose of these trips is equally enlightening. The survey data shows that the primary use of e-scooters in Bergen is for commuting between work and school, accounting for approximately 42% of the reported trip purposes. This indicates that e-scooters have

become an essential part of the daily commute for a significant portion of users. Additionally, e-scooters are often chosen for travelling to and from public transport, with 15% of respondents making this choice. This not only complements public transportation but also indicates the critical role e-scooters play in solving the last-mile connectivity challenge in Bergen.

Furthermore, e-scooters are enthusiastically embraced as a means of recreational transportation. Leisure activities account for 31% of trip purposes, highlighting the role of e-scooters in promoting active and healthy lifestyles among Bergen's residents. Additionally, a small but notable minority of 1% of respondents reported using e-scooters for delivery purposes. This illustrates the versatility of e-scooters in catering to various trip purposes, from everyday commutes to leisurely rides and even small-scale businesses.

The survey data also unveils that among those who combine e-scooters with other modes of transportation, light trains are the most preferred complementary mode, with 15% of respondents making this choice. Another 5% use a combination of e-scooters, light rail (known as "bybanen" in Bergen), and buses. Additionally, a smaller group of 3% opt for a more diverse mix of transportation, combining e-scooters with light rails, buses, and walking. Last but not least, 14% of respondents reported combining e-scooters with buses as their preferred travel approach. This multifaceted approach underlines the flexibility and integration of e-scooters into the existing urban transportation system in Bergen. Users have the freedom to combine e-scooters with other modes of transportation, depending on the nature of their journey, demonstrating the adaptability of these devices to cater to diverse travel needs.

Usage frequency is another intriguing aspect of e-scooter adoption. Figure 12 provides a valuable perspective on the distribution of e-scooter users based on the frequency of their usage in the last month. These user categories offer insights into the diverse patterns and motivations underlying e-scooter adoption and usage.

One notable group comprises the most frequent users, representing 33% of the total respondents. These individuals use e-scooters between 10 to 15 times or even more than 15 times within a single month. It is apparent that these e-scooter users rely heavily on this mode of transportation, suggesting its integral role in their daily mobility choices. These users see e-scooters as more than just a transportation option; they are a way of life, providing them with flexibility, convenience, and cost-effectiveness in their daily routines.

Another group of users, comprising 12% of the respondents, falls into the category of regular users. These individuals employ e-scooters between 5 to 10 times a month, indicating their consistent reliance on this mode of transportation, although not as extensively as the most frequent users. This group finds e-scooters to be an attractive choice for their regular trips, making them a part of their standard travel options.

The survey data also highlights a category of fun-seeker riders, accounting for a significant 27% and 29% of the participants, respectively. These users either tried e-scooters just once or used them less than 5 times within the last month. Their usage patterns indicate that e-scooters are primarily used for recreational purposes, novelty, or leisure activities rather than serving as their primary means of transportation. For these users, e-scooters are a source of enjoyment and a novel way to explore the city. They represent a diverse group of people who may not rely on e-scooters for their daily commute but appreciate the occasional joyride.

6.3. The Impact of E-Scooters on Transportation Behaviour

We then delve into the impact of e-scooters on transportation behaviour and preferences.
Figure 13 reveals the alternative transportation choices respondents would consider in the absence of e-scooters. The predominant response indicates that public transport would be the primary alternative choice. Intriguingly, 39% of respondents reported that e-scooters effectively replaced their walking and 46% use of public transport, highlighting the E-scooter's potential as a competitive alternative to traditional public transportation in a negative sense.
Other findings indicate that 4% of respondents would resort to driving a car if e-scooters were not available, implying a reduction in car usage. Only 1% would opt for a taxi, demonstrating a minimal impact on taxi services. However, 9% of respondents would choose to cycle on a conventional bicycle instead of using an e-scooter, indicating that e-scooters are seen as an alternative to traditional cycling for a small portion of users. For 1% of respondents, not travelling at all in the absence of e-scooters is their preferred choice.

Figure 14 provides insights into how e-scooters have influenced people's travel behaviour. Notably, 37% of respondents reported using public transport less frequently due to e-scooters. This suggests that e-scooters have become a preferred alternative to traditional public transportation for a substantial portion of users. Additionally, 26% of respondents indicated

that they have reduced their use of seasonal public transport tickets, highlighting the convenience and cost-effectiveness of e-scooters for short trips. Car usage has also been affected, with 20% of respondents reporting that they use their cars less often, potentially reducing traffic congestion and environmental impact. Taxis have felt the influence of e-scooters, with 29% of respondents stating they have used taxis less frequently, reflecting the competitive nature of e-scooters in the short-distance transportation market. On the other hand, only 18% of respondents reported that they are spending more time outside their homes because of e-scooters, indicating that these transports encourage outdoor mobility and exploration for some users.

Figure 15 examines how e-scooters affect people's views on car ownership. It's important to note that 73% of respondents don't own cars, so this question mainly applies to the 27% who do. Among car owners, 9% mentioned that e-scooters have made them use their cars less often, suggesting that for a small group, e-scooters have become a viable alternative, reducing the need for their cars. On the other hand, 16% said that e-scooters have had no impact on their car use, indicating that, for a significant number of car owners, e-scooters have not changed how often they use their cars.

Lastly, we turn our attention to user opinions and perceptions regarding the role of e-scooters in the city's transportation system. Figure 16 presents the respondents' perceptions of e-scooters' contribution to the city's transportation system. Approximately 33% of respondents gave a high rating, while 35% provided a positive rating, indicating a significant portion of surveyed individuals view e-scooters favourably and appreciate their role in improving urban transportation. On the other hand, 15% of respondents gave low ratings, marking scales 1 and 2, reflecting a negative opinion regarding e-scooters' contribution.

Figure 17 offers insights into why people choose e-scooters over other transportation options on their most recent trip. The most common reason for choosing e-scooters is their easy accessibility, as they are readily available. Convenience compared to public transport is another significant factor, as it offers flexibility and helps users avoid crowded buses or trains. A notable 13% of respondents mentioned that they used e-scooters because they didn't have access to their own car, highlighting e-scooters as a practical alternative for individuals who don't own cars. Cost-effectiveness is also a driver, with 12% of respondents selecting e-scooters because they are cheaper than taking a taxi for short trips. Effortless parking was cited as a

reason by 13% of respondents, and 5% appreciated e-scooters for saving them time on their last trip. These factors collectively make e-scooters a preferred option for urban travel, particularly in comparison to other available transportation choices.

6.4. Findings on “Answer to the open question”:

The advent of electric scooters, or e-scooters, has ushered in a new era of urban transportation across the globe. In Bergen, these zippy two-wheelers have not only changed the way people move from one point to another but have also played a pivotal role in addressing issues related to sustainability and urban mobility. This analysis seeks to explore the multifaceted aspects of e-scooters in the context of sustainability, with a keen focus on the insights shared by Bergen's residents.

E-Scooters as Facilitators of Urban Connectivity: Addressing Mobility Gaps

The appeal of e-scooters in Bergen lies significantly in their capacity to address connectivity gaps, providing a swift and practical solution to transport challenges. Users in the city appreciate how e-scooters complement the existing transportation infrastructure by offering efficient mobility in areas that may not be adequately served by conventional public transport systems. This functionality proves particularly vital in Bergen, renowned for its complex topography characterised by fjords and challenging landscapes, creating limitations in accessibility through conventional means. E-scooters play a pivotal role as a vital link, enabling residents to navigate through areas of the city that are otherwise less accessible. For instance, a respondent highlighted, "E-scooters are a convenient addition, they allow fast movement between close areas that are not well-connected." This sentiment underscores the role of e-scooters in bridging geographical gaps and facilitating travel between locations with limited connectivity by traditional transportation methods.

Moreover, another respondent expressed a desire for e-scooter services to be integrated into the SKYSS ticket system: "I want to have an e-scooter from Skyss company so we can combine an e-scooter trip with a bus trip with a single ticket." This perspective emphasises the potential for synergising different modes of transportation within the city, envisioning a seamless

integration of e-scooters with existing public transit systems to enhance overall connectivity and ease of travel.

Balancing Convenience with Consideration

E-scooters have emerged as a convenient transportation option; however, their sustainability greatly depends on user behaviour. While acknowledging the positive attributes of e-scooters, it is imperative to underscore the impact of user conduct on their long-term viability as a sustainable mode of transport. Users' mindful utilization of these scooters plays a pivotal role in shaping their overall sustainability. Yet, there are concerns arising from certain individuals' behaviours that have implications for both safety and the acceptability of e-scooters as a sustainable means of transportation.

Instances of reckless riding and the failure to signal intentions have been observed, causing discomfort among pedestrians and other road users. Such behaviour poses challenges to the safety and comfort of residents, influencing the public perception of e-scooters' sustainability. To ensure their enduring sustainability, users must take accountability for their actions and operate e-scooters with due consideration for others' safety and comfort. For example, one respondent highlighted, "E-scooters are a good form of transportation if you are mindful of others. I know some people that use e-scooters wildly making some people uncomfortable because of their lack of signalling to people that they are passing." Similarly, another respondent expressed concerns about reckless parking, stating, "My only negative opinion about e-scooters is that they are often parked recklessly and idiotically so that they obstruct access (especially for wheelchair users and prams) and create a bit of chaos and partly dangerous situations in narrow, busy places."

These perspectives underscore the critical need for users to adopt responsible behaviour when using e-scooters, emphasizing the importance of adhering to safety protocols and exhibiting consideration towards other road users for the sustained viability of e-scooters as a sustainable transportation option.

Analysing e-scooters' contribution to sustainable mobility requires considering their potential benefits and drawbacks within the broader framework of sustainable transportation. E-scooters have the potential to reduce greenhouse gas emissions compared to conventional cars if they

replace car trips for short distances. This helps in reducing climate change impacts and enhancing air quality.

Sustainability in Late-Night Commutes

The utility of e-scooters becomes particularly conspicuous in late-night transit scenarios. In situations where traditional public transportation services are constrained, e-scooters serve as a vital resource for individuals working late hours or encountering instances where taxi services may not be accessible. This facet of e-scooters contributes significantly to enhancing the sustainability of urban transit systems by diminishing reliance on personal vehicles or less environmentally friendly commuting alternatives. Beyond offering a sustainable mode of transportation, e-scooters also play a role in bolstering safety measures for individuals navigating during unconventional hours.

Various opinions expressed regarding this aspect include sentiments such as, "A good way to get home if you're working until very late hours and there is no public transport, and the ASSHOLE of a boss won't pay for a taxi," highlighting the instrumental role of e-scooters in facilitating safe late-night travel. Another perspective emphasized the efficiency of e-scooters, stating, "Saves time when I am planning to walk but running late. I perceive it as safer than walking alone late at night." Additionally, another user shared, "Yes, very convenient on Sunday or after midnight. While other modes of public transport are less available or expensive taxi rides for short distances," illustrating the crucial role of e-scooters in bridging the gap left by limited public transportation during off-peak hours, thereby contributing to both convenience and safety in late-night commuting scenarios.

Enhancing Well-Being and Social Life

E-scooters have emerged as a transformative asset for individuals contending with anxiety issues and grappling with challenges associated with conventional public transportation systems. These individuals have found respite in the adaptable nature and swiftness offered by e-scooters, facilitating swift movement between secure locales and significantly enhancing their overall life satisfaction. Moreover, the introduction of e-scooters has facilitated social engagements, enabling users to effortlessly and promptly connect with friends situated in

different areas. This not only contributes to bolstering the well-being of residents but also plays a pivotal role in nurturing a sense of community and social sustainability within the urban landscape.

A respondent highlighted their experience, stating, "I struggle with anxiety, and public transport is difficult to take. When I'm travelling between work, school, and such, I use an e-scooter, and after they became available, I even started meeting friends more often. When I could move quickly from one safe location to another, my social life became better, and life quality improved." This testimony underscores the profound impact of e-scooters on enhancing the quality of life for individuals grappling with mental health challenges and the pivotal role these mobility options play in fostering social connections and community engagement.

Ensuring Effective Governance for Sustainable Integration

Despite the evident benefits introduced by e-scooters, their seamless integration into urban environments necessitates addressing prevailing challenges through stringent regulatory frameworks. Challenges such as indiscriminate parking and misuse necessitate robust governance measures. As articulated by a respondent, the implementation of clearer guidelines regarding permissible e-scooter parking areas and restricted zones is imperative. Enforcing well-defined regulations can significantly enhance the sustainability of urban mobility by averting obstruction to pedestrian access, particularly for individuals using wheelchairs or prams. Furthermore, stringent regulations contribute to mitigating disorder and potentially hazardous circumstances in densely populated and constrained areas. To sustain e-scooters as a viable urban mobility solution, responsible utilization and adherence to established parking protocols stand as crucial imperatives. One respondent aptly noted the necessity for improved regulations: "I think it helps with transportation, but I also think there should be better rules set up for parking the e-scooters, for where they can go and where they are not allowed."

Affordability and Time Savings: The Practical Appeal of E-Scooters

Users of e-scooters consistently highlight the pragmatic advantages these vehicles offer in their daily lives. Their emphasis revolves around the key factors of affordability, adaptability, and the enjoyable experience of using e-scooters, cementing their status as a preferred mode for

everyday commuting. The affordability aspect carries substantial weight when evaluating the sustainability of transportation alternatives, as it ensures that eco-friendly transportation options are accessible to a broader spectrum of users. Moreover, the time-saving aspect of e-scooters, particularly in urban areas riddled with traffic congestion, significantly boosts their appeal and contributes to establishing more efficient and sustainable mobility solutions. User testimonials reflect a diverse range of experiences that underscore the pivotal role of e-scooters in fostering a flexible transportation system. Examples provided by respondents such as "It's cheaper for us who live close to the city centre and faster than public transport", "Makes travelling in everyday life much more flexible, possible, enjoyable and affordable!", "They are a good solution to the last mile problem", and "Great for helping to carry heavy groceries" exemplify the practicality and utility of e-scooters in various everyday scenarios.

In summary, the unanimous consensus among e-scooter users regarding their cost-effectiveness, adaptability, and time efficiency positions these vehicles as potentially pragmatic and sustainable commuting solutions for urban residents, catering to a wide array of practical transportation needs while these are the feedback from the e-scooter users, but I believe that the non-users of e-scooters might have different perspectives to study further.

The Dark Side of Convenience

Despite the manifold advantages e-scooters offer, a respondent's viewpoint unveils underlying apprehensions regarding their broader impact on urban lifestyles. They express reservations, perceiving e-scooters as a potential catalyst for urban indolence and a detractor from the city's overall image. This perspective underscores the necessity for a nuanced approach to urban transportation planning.

While the convenience and efficiency of e-scooters are undeniable, the respondent's concern calls attention to the multifaceted considerations integral to urban transportation frameworks. These considerations extend beyond mere expediency and delve into the broader implications of transportation choices on public health, levels of physical activity, and the visual aesthetics of the urban landscape. This perspective serves as a reminder that while e-scooters may offer practicality and efficiency, their integration into urban settings necessitates a holistic evaluation of their societal impacts. Achieving an equilibrium between convenience and the broader socio-

cultural and aesthetic aspects of urban life is imperative for the sustainable incorporation of e-scooters into the urban fabric.

The respondent's viewpoint, exemplified by the statement, “Though I enjoy using them I don’t think we should have them. It makes us lazy and is a bad contribution to the urban image,” underscores the complexities involved in assessing the societal ramifications of e-scooter usage within urban environments.

Climate-Specific Challenges and Pandemic Resilience

The specific climate conditions in Bergen pose distinctive challenges for the utilization of e-scooters. Respondents highlight that e-scooters are most suitable during milder seasons such as spring, summer, and early autumn. However, their limited functionality during the harsher climate of Norway's autumn and winter underscores the necessity for versatile transportation alternatives that can accommodate varying local weather conditions. This aspect holds substantial importance in evaluating the sustainability of e-scooters, particularly in regions with inclement climates.

An intriguing insight from a respondent reveals that e-scooters emerged as their primary mode of transportation during the COVID-19 pandemic. This observation accentuates the adaptability and resilience of e-scooters in addressing unforeseen challenges. During critical periods like a pandemic, transportation solutions that offer alternatives to crowded public transit become crucial in upholding mobility while adhering to essential social distancing and safety protocols.

The respondent's perspective, as articulated by the statement, “Very good during spring/summer/early autumn, but not made for the Norwegian autumn and winter climate,” underlines the seasonal limitations of e-scooters in colder climates. Furthermore, their transition to e-scooters as the primary mode of transport during the pandemic elucidates the adaptive capacity of these vehicles in challenging circumstances since a respondent mentioned that “During the Covid pandemic outbreak, I made it my main mode of transport”.

A Glimpse into the Future

The views expressed by Bergen's residents provide a compelling insight into the influence of e-scooters on urban sustainability. As articulated by one respondent, "I like them a lot. They are convenient, affordable, and give a futuristic look to the cityscape." These compact and accessible modes of transportation have substantially altered the landscape of daily commuting, not only enhancing accessibility but also augmenting the overall experience for city residents. Looking ahead, as e-scooters undergo further advancements and regulatory frameworks are refined, they possess the potential to evolve into a more sustainable and deeply integrated facet of urban transportation. This future trajectory is contingent upon fostering responsible usage practices, addressing the challenges specific to Bergen's climate, and ensuring that e-scooters contribute as a supportive addition rather than undermining the city's aesthetic and well-being. Envisioning Bergen's future, it becomes conceivable that e-scooters will assume a pivotal role in fostering a more sustainable, interconnected, and vibrant urban environment. With appropriate measures and continued evolution, these vehicles have the capacity to significantly enhance mobility while contributing to the creation of a more futuristic and environmentally conscious urban landscape for its inhabitants.

6.5. Findings on research questions:

E-scooters have emerged as a disruptive force in urban transportation, offering an efficient and eco-friendly mode of mobility. This study aims to address specific and general questions concerning the adoption and impact of e-scooters in Bergen, Norway. Specifically, it delves into the extent to which e-scooters replace traditional transport modes, evaluates their sustainability within the existing transportation system, and explores the socio-demographic factors influencing individuals' preferences regarding transport replacement.

Specific Question: To what extent can e-scooters be considered a sustainable mode of transport?

The survey data reveals varied perceptions and experiences among e-scooter users in Bergen. Approximately 68% of respondents rated e-scooters positively for contributing to the city's transportation system, while 15% expressed low appreciation. Key reasons for choosing e-scooters include easy accessibility, convenience, cost-effectiveness, and time efficiency.

Additionally, an open-ended question revealed that 9% see e-scooters as flexible and enjoyable, 5% emphasize the need for proper regulations, and another 5% value their role in bridging the first-last mile gap. Criticisms include fostering reckless driving and inadequate parking. Overall, e-scooters are favored for their convenience and accessibility, despite some concerns. Furthermore, the survey data is from the e-scooter user only but non-user's opinions could change the analysis.

The findings reveal that e-scooters address connectivity gaps in the city's transportation network, particularly in areas with limited public transport access. E-scooter users appreciate their convenience and efficiency for short-distance trips. However, the study also highlights concerns regarding user behaviour and its impact on the long-term sustainability of e-scooters. Instances of reckless riding and inconsiderate behavior by some users raise safety concerns and negatively influence public perception of e-scooters. The study concludes that promoting responsible e-scooter use is crucial for ensuring their continued viability as a sustainable transportation option in Bergen.

Sub-Question 1: What modes of transport do e-scooters replace?

The survey data on e-scooter usage in Bergen reveals significant patterns of adoption and integration into daily urban transport. A majority of respondents (55%) report using e-scooters within the past week, indicating high frequency and regularity. E-scooters are notably accessible, with 50% finding them within one minute and 36% within 3-5 minutes. Users commonly combine e-scooters with other transport modes for trips lasting 5-15 minutes (55%), while solo trips are also prevalent (45%). The primary trip purposes include commuting to work or school (42%), leisure (31%), and accessing public transport (15%). E-scooters complement existing transport systems, with 55% using them alongside other modes like light trains and buses. Usage frequency varies, with 33% being frequent users and 55% using them occasionally. If e-scooters were unavailable, 46% would switch to public transport and 39% to walking, underscoring their role in reducing reliance on other modes. E-scooters have led to decreased public transport use (37%), reduced car usage (20%), and less frequent taxi use (29%), highlighting their potential to alter urban mobility patterns significantly. Additionally, their impact on car ownership is modest, with only 9% of car owners using their cars less due to e-scooters.

Overall, e-scooters are reshaping urban transport by promoting multimodal travel and reducing dependence on cars and taxis slightly, but mostly replacing other sustainable modes, especially public transport and walking.

Sub-Question 2: What socio-demographic factors affect an individual's preference to replace other transport?

Socio-demographic factors play a pivotal role in shaping the preferences of individuals regarding their choice of transportation. For instance, the age of users has a significant impact on e-scooter usage. The data shows a high concentration of e-scooter users within the 19 to 30 age group, highlighting their appeal to younger demographics. At the same time, the presence of users above 50 years of age, though a small segment, underscores the potential for broader age inclusivity in e-scooter adoption.

Gender-wise, e-scooters have achieved near-gender parity, with a nearly equal distribution of usage among males and females, emphasizing their appeal to both genders. Nevertheless, further analysis reveals gender disparities in education and employment. Specifically, education levels show a disparity in higher education categories, with males outnumbering females. Similarly, the occupational data reveal a gender imbalance, particularly in full-time employment, despite a more even representation in student status. These disparities underscore the need to address gender inequalities in education and employment opportunities in the region.

E-scooters have established themselves as an essential addition to Bergen's existing transportation system. They serve as an eco-friendly alternative for short-distance travel, replacing walking for a significant portion of users may have a bad influence in the long term on public health, but showing the slight potential to reduce car usage is promising. The widespread appeal of e-scooters across age groups and gender boundaries is remarkable, although attention must be paid to addressing gender disparities in education and employment. E-scooters have become an integral part of Bergen's urban mobility landscape and are widely perceived as contributors to the city's sustainable transportation system, reflecting the evolving dynamics of urban transportation.

7. Concluding Thoughts: The Role of E-Scooters in Bergen's Transportation Landscape

In conclusion, this comprehensive analysis provides valuable insights into the dynamics of e-scooter adoption in Bergen. The socio-demographic aspects reveal that e-scooters are popular across a broad spectrum of age groups and educational backgrounds. While gender disparities exist in employment and income distribution, e-scooters appear to be a preferred mode of transport for users regardless of their socio-demographic profile.

E-scooters have emerged as a transformative force in Bergen's transportation system, appealing to a diverse user base and significantly influencing travel behaviour. While some users primarily rely on e-scooters for leisure and novelty, a substantial portion integrates them into daily commuting patterns, reducing their reliance on traditional public transport. It has become an integral part of daily life for a significant portion of users in Bergen, with regular usage patterns and prompt accessibility being key factors in their popularity. They serve diverse trip purposes, from commuting to leisure activities, and are often combined with other modes of transport.

The impact of e-scooters on transportation behaviour indicates that they have the potential to replace traditional public transport for many users and even influence car ownership decisions. This points to the sustainability potential of e-scooters as part of the city's transportation system. E-scooters are not a standalone solution but an integral part of a multimodal transportation system. As evidenced by Figure 11, a substantial portion of users prefer to combine e-scooters with other modes of transport, such as light trains and buses. This highlights the versatility and integration of e-scooters into the urban mobility network. In this evolving landscape, e-scooters serve as the first and last-mile solution, seamlessly connecting users to other public transportation options. Their role in reducing car usage and easing traffic congestion reinforces their potential to contribute to a more sustainable and efficient multimodal future.

The diverse user opinions, ranging from highly appreciative to more critical, reflect the complex role of e-scooters in the urban landscape. The ease of access, cost-effectiveness, and convenience of e-scooters have made them a preferred choice for many, suggesting that they

are well-integrated into the existing transportation system. The analysis underscores the significant impact of e-scooters on Bergen's transportation landscape and the broader conversation around micro-mobility solutions. E-scooters have been integrated into the existing transportation system with few pros and cons image but offer convenience, accessibility, and cost-effectiveness to users. They have not only influenced individual transportation behaviour but have also left an indelible mark on the city's transport infrastructure. However, the environmental impact assessment of e-scooters throughout their life cycle, including production, operation, maintenance, and disposal would help to understand the overall sustainability of e-scooters beyond their direct use.

To assess whether e-scooters can be considered a sustainable form of transport, we can apply the "Avoid-Shift-Improve" (ASI) framework, which examines their potential to avoid unnecessary trips, shift to more sustainable modes, and improve existing transportation systems.

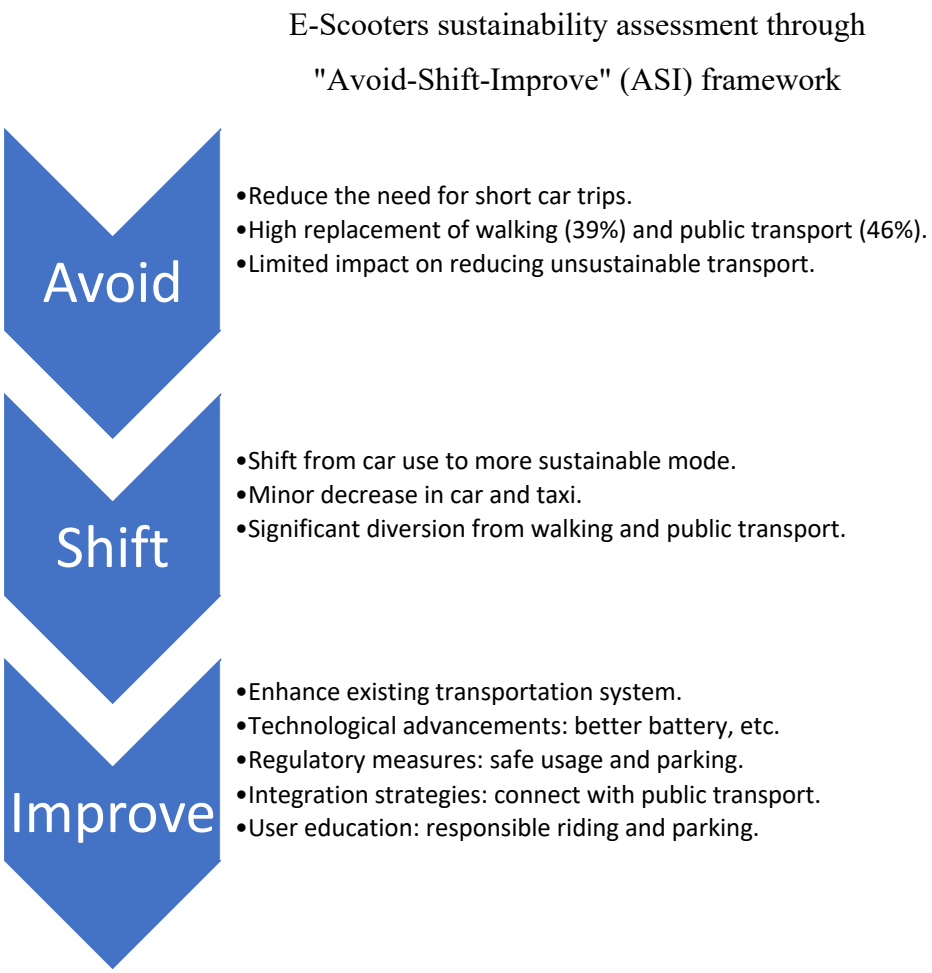

Diagram 2 : Sustainability Assessment of E-Scooters

Avoid

E-scooters have the potential to replace short car trips, which are often less fuel-efficient and more polluting. In Bergen, Norway, the data shows that e-scooters do replace some car and taxi trips, suggesting a potential reduction in greenhouse gas emissions. This aspect aligns with the "Avoid" component by reducing reliance on more polluting forms of transportation. However, the majority of e-scooter trips in Bergen replaced walking and public transport—modes that are already highly sustainable. Therefore, while e-scooters help avoid some car trips, the overall impact on reducing unsustainable transport modes is limited. This indicates that, at present, e-scooters are not significantly avoiding a substantial amount of unsustainable transport.

Shift

The "Shift" aspect of the ASI framework involves transitioning from individual car use to more sustainable modes of transportation. E-scooters offer an alternative to personal car use for short trips, which could help reduce car dependency. However, the data from Bergen shows a significant shift from public transport (46%) and walking (39%) to e-scooters. While e-scooters promote shared mobility and fill gaps in urban transportation, shifting from public transport to e-scooters can be counterproductive for sustainability. Public transport is generally more efficient for moving large numbers of people and produces lower emissions per passenger mile. Thus, while e-scooters contribute to the shift from private car use to some extent, they also divert users from more sustainable public transport options being a part of a multimodal trip.

Improve

Improving existing transportation systems through technological advancements and better practices is crucial for sustainability. E-scooters can benefit from enhancements in battery technology and manufacturing processes, making them more environmentally friendly. Efficient batteries with longer lifespans and better recycling methods can reduce the environmental impact of e-scooters. Moreover, addressing user behavior through education on responsible riding and proper parking can mitigate negative impacts on pedestrians and public spaces. Implementing regulations to manage e-scooter fleets and ensure safe use can further enhance their sustainability. Integrating e-scooters with public transport systems for first- and

last-mile connectivity can encourage public transport use for longer journeys, leveraging the strengths of both modes for a more sustainable urban transport system.

E-scooters have the potential to be a sustainable form of transport, but their current impact is mixed. They help avoid some car trips, which is beneficial, but also replace a significant number of walking and public transport trips, which are more sustainable. Enhancing the sustainability of e-scooters involves a balanced approach of avoiding unnecessary trips, shifting from car use, and improving technology and user behavior. With appropriate regulations, technological advancements, and better integration with public transport, e-scooters can become a valuable part of a sustainable urban transportation system. This comprehensive approach ensures that e-scooters can contribute positively to the sustainability goals of urban mobility.

Potential for Sustainability

E-scooters have shown considerable potential for sustainability, particularly in reducing reliance on more polluting modes of transport. In Bergen, Norway, survey data indicates that e-scooters are favored for their convenience, accessibility, cost-effectiveness, and time efficiency. About 68% of respondents rated e-scooters positively for contributing to the city's transportation system, highlighting their role in urban mobility. The "Avoid" component of the "Avoid-Shift-Improve" (ASI) framework emphasizes the avoidance of unnecessary trips and the reduction of greenhouse gas emissions. While e-scooters have replaced some car and taxi trips, which are often less fuel-efficient and more polluting, their overall impact is tempered by the significant number of trips replacing walking and public transport, modes that are inherently more sustainable. Nonetheless, the reduction in car and taxi usage—20% and 29% respectively—demonstrates e-scooters' potential to decrease reliance on traditional, more polluting transportation options.

Addressing Current Challenges and Implementation of Strategic Policies

Addressing current challenges and implementing strategic policies are crucial for realizing the full potential of e-scooters as a sustainable transportation option. One of the primary challenges identified in the study is user behavior, with instances of reckless riding and inadequate parking negatively impacting public perception and safety. Approximately 5% of respondents

emphasized the need for proper regulations to mitigate these issues. Promoting responsible use through education and stringent regulations is vital to ensure the long-term viability and acceptance of e-scooters. Additionally, the "Shift" component of the ASI framework involves transitioning users from private car use to more sustainable modes of transportation. While e-scooters do promote shared mobility and fill gaps in the urban transportation network, a significant shift from public transport (46%) and walking (39%) to e-scooters was observed. This shift can be counterproductive to sustainability goals, indicating a need for policies that encourage e-scooter use without displacing more sustainable modes.

Focus on Technology, Regulations, and Integration Needed for Maximizing Benefits

To maximize the benefits of e-scooters, a focus on technological advancements, effective regulations, and seamless integration with existing transportation systems is essential. Enhancements in battery technology and manufacturing processes can significantly reduce the environmental impact of e-scooters, aligning with the "Improve" component of the ASI framework. Efficient batteries with longer lifespans and improved recycling methods are crucial for minimizing environmental footprints. Implementing regulations to manage e-scooter fleets and ensure safe use is also critical. Regulations can address issues related to reckless riding and improper parking, enhancing the safety and public acceptance of e-scooters. Moreover, integrating e-scooters with public transport systems for first- and last-mile connectivity can encourage the use of public transport for longer journeys, leveraging the strengths of both modes for a more sustainable urban transport system. The survey data indicates that 55% of users combine e-scooters with other modes of transport, such as light trains and buses, underscoring the importance of integration in creating a comprehensive and efficient urban mobility network.

E-scooters have clearly left their mark on Bergen's transportation landscape, offering a convenient, accessible, and sustainable alternative for many residents. Their continued evolution and integration into urban transportation systems will be fascinating to observe as cities strive to create more efficient, sustainable, and accessible mobility options for their residents.

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Annexe

Questionnaire:

Usage Data and User Opinions:

1. Think about the last time you used an e-scooter.
   Today/ Yesterday/ 3-6 days ago/ More than a week ago/ More than a month ago
2. How long was your last trip?
   Less than 5 min/ 5-10 min/ 10-15 min/ More than 15 min/ More than 30 min
3. How long was the search time to get an e-scooter?
   About a minute/ 3-5minutes/ 5-10minutes/ 10-15minutes/ more than 15minutes
4. Purpose of the trip?
   To or from work or school/ To or from public transport/ To or from job meeting/ product delivery job/ leisure activity/ others ….
5. During your last trip, did you combine it with other modes of transport?
   Yes/ No
6. If yes, please specify (you can choose multiple).
   Light train (Bybanen)/ Bus/ Car/ Bicycle/ Walking/ Not applicable/ other ….
7. How many times did you use an e-scooter during the last month?
   Just tried once/ Less than 5 times/ 5-10 times/ 10-15 times/ more than 15 times
8. Why did you choose an e-scooter over other transport during your last trip (you can choose multiple)?
   Easy to get/ It is enjoyable/ Effortless parking/ Don't have a car/ Cheaper than a taxi/Public transport was not available/ other …
9. If you had no option to use an e-scooter, what other modes would you have used?
   Using own Car/ Called a Taxi/ Public transport/ Bicycle/ Walking/ I would not have travelled/ others…
10. Has the e-scooter caused you to change any of the below? (Scale: Less than before/ Unchanged/ More than before/ Not applicable)?
    - Spend time outside ……
    - Bike with an electric bike…
    - Usage of public transport …
    - Driving a car ……
    - Take a taxi ……
    - Buy a season ticket for public transport …

11. In your experience, how does the e-scooter affect how you use the car?

    I do not have a car/ I don't think it affects car usage/ I think it makes me use the car less/ I think it makes me use the car more/ I am considering getting rid of the car/ I got rid of the car/ Other

12. In your opinion, do you think that e-scooter contributes to a better city transportation system? (On a scale of 1-5, less to high value)? ……
13. Do you have any other experiences with e-scooters that you might share? ……

Demographic information:

1. Gender:

   Male/Female/ Other/ Prefer not to say

2. Age, years:

   Below 18 years/ 19-25 years/ 26-30 years/ 31-35 years/ 36-40 years/ 41-50 years/ Above 50 years

3. Education, highest level completed?
   - Primary school – grunnskole (til og med 10. klasse)
   - High school – (videregående)
   - College or university (until 4 years) – høyere utdanning inntil 4 år
   - College or university (5 years or more) – høyere utdanning 5 år eller mer
   - Prefer not to answer
4. Primary occupational status?
   - Currently not employed
   - Part-time employed
   - Student
   - Retired
   - Prefer not to answer
   - Other ….
5. Yearly Income NOK (before tax)?
   - Below 100000
   - 100001- 300000
   - 300001- 500000
   - 500001- 700000
   - 700001- Above
   - Prefer not to answer

Answer to the Open Question:

E-scooters are a convenient addition, they allow fast movement between close areas that are not well-connected.

E-scooters are a good form of transportation if you are mindful of others. I know some people that use e-scooters wildly making some people uncomfortable because of their lack of signalling to people that they are passing.

A good way to get home if you're working until very late hours and there is no public transport, and the asshole of a boss won't pay for a taxi.

I struggle with anxiety and public transport is difficult to take, when I'm travelling between work, school and such, I use an e-scooter, and after they became available, I even started meeting friends more often, when I could move quickly from one safe location to another my social life became better and life quality improved.

I think it helps with transportation, but I also think there should be better rules set up for parking the e-scooters, for where they can go and where they are not allowed.

I want to have an e-scooter from Skyss company so we can combine an e-scooter trip with a bus trip with a single ticket.

It's cheaper for us who live close to the city centre and faster than public transport.

Makes travelling in everyday life much more flexible, possible, enjoyable and affordable!

My only negative opinion about e-scooters is that they are often parked recklessly and idiotically so that they obstruct access (especially for wheelchair users and prams) and create a bit of chaos and partly dangerous situations in narrow, busy places. Even though the provider recommends parking "correctly", this is ignored by most users. I tend to move e-scooters that are parked recklessly... I'm an e-scooter parking-Karen.

Saves time when I am planning to walk but running late. I perceive it as safer than walking alone late at night.

They are a good solution to the last mile problem.

Though I enjoy using them I don't think we should have them. It makes us lazy and is a bad contribution to the urban image.

Very good during spring/summer/early autumn, but not made for the Norwegian autumn and winter climate.

Yes, very convenient on Sunday or after midnight. While other modes of public transport are less unavailable or expensive taxi rides for short distances. During the Covid pandemic outbreak, I made it my main mode of transport.

I like them a lot. They are convenient, and affordable and give a futuristic look to the cityscape.

Great for helping to carry heavy shopping.

Leaflet:

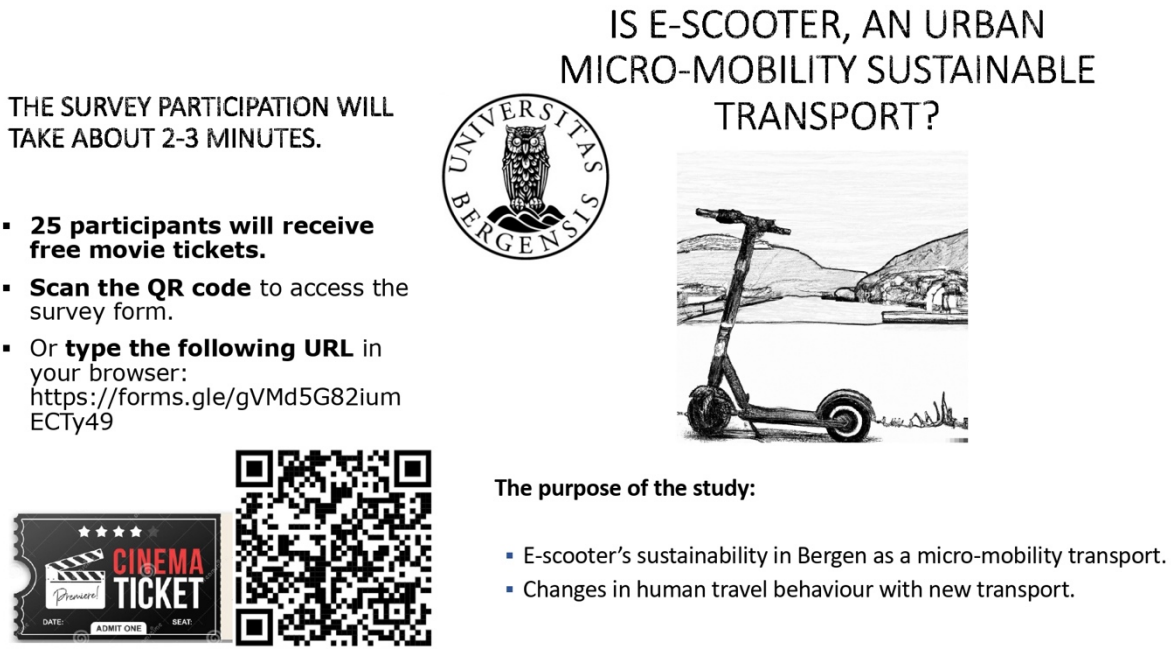

Figure 19 Leaflet containing QR codes for survey

Bergen Municipality's e-scooter regulations outline:

REGLER FOR ELSPARKESYKKEL

Gjelder både delte og privat motorvogn.

Statens vegvesen

Trygg kjøring er ditt ansvar

Du må være oppmerksom og forsiktig i trafikken
Det er ditt ansvar å sørge for at du ikke skaper farlige eller utrygge situasjoner for andre.

Det er forbudt å kjøre med promille
Inntak av alkohol eller andre rusmidler påvirker evnen til å kjøre på en trygg måte. Promillegrensen for bruk av elsparkesykler er 0,2.

Det er bare lov med én person på elsparkesykkelen
For din egen og andres sikkerhet er det ikke lov å kjøre med passasjer. Brudd gir deg bot på 3000 kroner.

Vis hensyn når du parkerer
Det er ditt ansvar å parkere elsparkesykkelen slik at den ikke står i veien for andre.
- Bruk oppmerkede plasser og stativ der det finnes.
- Sett den langs vegger eller kanter slik at den stikker minst mulig ut på fortauet.

Påbudt med hjelm for barn under 15 år
Det er anbefalt for alle å bruke hjelm. Det er stor forskjell på hvor mye du skader deg dersom du faller med eller uten hjelm.

Aldersgrense for å kjøre elsparkesykkel er 12 år.

Det er krav til ansvarsforsikring
både til utleie og privateide elsparkesykler.

Tekniske krav til elsparkesykkel

Dette må du tenke på før du skaffer deg egen elsparkesykkel.
Du er ansvarlig for at elsparkesykkelen oppfyller de tekniske kravene.

Elsparkesykkelen skal være utstyrt med en hastighets-sperre som gjør at du ikke kan kjøre fortere enn 20 km/t.

I tillegg skal elsparkesykkelen ha:
- Maksvekt 70 kg.
- Maksbredde 85 cm og makslengde 120 cm.
- Ringeklokke, hvitt lys foran, rød refleks bak og sikre bremser.

Konsekvenser av å bryte reglene

Kollisjon kan føre til alvorlig skade og dødsfall. Risikoen for å bli skadet i trafikken er høyere på elsparkesykkel enn for vanlig sykkel.

Brudd på vegtrafikkloven straffes med bøter, forelegg, tap av førerkort og/eller fengsel. Ved alvorlige lovbrudd er det straffeloven som avgjør hvor streng straff du får.

Lovbrudd vil stå på politiattesten din. Flere utdannelser og yrker krever plettfri vandel. Det kan også hindre deg i å reise til bl.a. USA.

Kjøring i veibane

Her må du følge trafikkregler for kjørende. Når du kjører i veibane eller sykkelfelt må du følge kjøreretningen.

Du har vikeplikt for kjøretøy som kommer fra høyre. Det betyr at du må senke farten eller stanse helt for å slippe dem frem. Dette gjelder ikke i forkjørsvei.

Stopp for fotgjengere ved gangfelt.

Stopp ved rødt lys.

Det er forbudt å kjøre på motorvei. Det kan være flere andre lokale begrensninger. Sjekk hvilke skilt som er satt opp der du kjører.

Følg skilt for kjørende. Her er noen av dem:

Sone / Gågate — Forbeholdt gående. Elsparkesykler kan ikke kjøre i mer enn 6 km/t i gågate.

Innkjøring forbudt.

Vikeplikt. Gi vei til trafikk i begge retninger.

Forkjørsvei. Kjørende fra sidevei eller kryssende vei har vikeplikt.

Kjøring på fortau, gågate og gangvei

Her må du følge trafikkreglene for syklende. Du kan **KUN** kjøre på fortauet så lenge du ikke er til hinder for gående. Gående, rullestolbrukere og barnevogner har førsteprioritet.

Når du kjører forbi fotgjengere må du **ALLTID** senke farten. Kjør sakte, tilsvarende normal gangfart, og ikke mer enn 6 km/t på fortau. Hvis det ikke er plass til å kjøre forbi og holde god avstand, må du gå av og trille forbi eller forflytte deg til veibanen.

Senk farten når du skal krysse veien. Du må gå av og trille over gangfelt for at bilene skal stoppe for deg (vikeplikt).

Følg skilt for sykkel og elsparkesykkel. Her er noen av dem:

Forbudt for elsparkesykkel.

Sone — Hold lav fart, maks 6 km/t.

Sone — Parkering forbudt.

Les mer om reglene på **vegvesen.no/els** og sett deg inn i lokale begrensninger som gjelder for din kommunen.

22-0498 visuell.kommunikasjon@vegvesen.no

Figure 20 Poster Source: Bergen Kommune, E-scooters Regulati

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