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Smart and sustainable mobility at once? How Mobility-as-a-Service models contribute to sustainable mobility

A case study about the "Easy to Be" model in Gothenburg

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Abstract

Urban areas today experience tremendous mobility challenges including traffic congestion, increasing greenhouse gas emissions, and inefficient transport systems. Continuously growing population in cities, in combination with the consequences of climate change, present key challenges in transportation, calling for sustainable and efficient mobility solutions. In recent years, the concept of Mobility-as-a-Service (MaaS) has gained global attention, both from public authorities and private transport agencies. Driven by technological developments, MaaS offers a seamless trip by combining different transport services into one digital interface. By providing an alternative to private car ownership, MaaS envisions to offer a promising sustainable mobility solution. However, empirical research on concrete MaaS developments from a sustainability perspective is scarce. To address this knowledge gap, this study analyzes the MaaS initiative of EC2B in Gothenburg based on sustainability criteria. The study is guided by the following research question: *In what ways does the EC2B Mobility-as-a-Service project within the European Union's IRIS Smart City program in Gothenburg, contribute to sustainable mobility?* The findings of the in-depth interviews carried out in this thesis reveal that the EC2B project fulfills several sustainable mobility aspects. First, the MaaS model predominantly generates environmental benefits and decreases transport related CO_2 emissions. Second, the EC2B pilot provides a positive societal impact by constituting an accessible and affordable mobility alternative. Last, by developing a functional business model and generating new customers, EC2B produces economic advantages. Therefore, the EC2B project can be classified as a promising sustainable mobility option, which thus calls for scaling up the model to tackle larger urban mobility challenges.

Keywords: Mobility-as-a-Service, sustainable mobility, Smart Mobility, Sustainability perspective, urban mobility, shared mobility

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List of Abbreviations

CO_2	Carbon Dioxide
EU	European Union
MaaS	Mobility-as-a-Service
PT	Public Transport
IRIS	Integrated and Replicable Solutions for Co-Creation in Sustainable Cities
EC2B	Easy to Be
ICT	Information and Communication Technologies
SQ	Sub-Question
RISE	Research Institute of Sweden

1 Introduction

Cities, as the centers of political and economic development as well as the place for innovation and job creation, are characterized by a deepening process of urbanization causing several challenges for sustainable urban development. More than 65 per cent of the population will be living in cities by 2050, with urban areas accounting for 60-80 per cent of the global energy consumption (United Nations, 2014). This concentration of people in one place "[…] can impair sustainability due to urban sprawl, pollution, and environmental degradation" if inadequately managed (United Nations, 2018, p.3). Therefore, with the alarming state of global warming paired with massive urbanization, well-managed urban growth by policymakers is necessary to reduce negative environmental consequences and maintain the resilience of cities.

In the context of urbanization, mobility has become a central issue for society due to traffic congestion, increasing fossil-fuel emissions, and worsening air quality (Mola et al., 2020). The environmental impact of mobility is highlighted as one of the biggest contributors to the increasing emissions. While the carbon dioxide (CO_2) emissions of transport account for 22 per cent of the greenhouse gas emissions, this contribution will continuously rise with the steady concentration of the population in cities (Zawieska & Pieriegud, 2018). Thus, the European Commission (2020) has called for a systemic change aiming at zero-emission mobility through sustainable mobility, smart mobility including, multimodal transport systems, and incentivizing users towards this transition. Particularly, the European Union (EU) underlines the potential of innovation and technology in contributing to a more sustainable transport system. Developing sustainable and resource-efficient mobility is essential to tackle the transportation problems and drive urban development while also considering the vital notion for citizens to move freely, quickly, and affordably throughout the city.

Smart mobility, as a part of the domain-overarching Smart City model, is being promoted as a possible pathway to sustainable mobility. Most authors argue that intelligent technologies in transport can encourage the reduction of greenhouse gas emissions while promoting sustainable development (Zawieska, 2018). Specifically, the emergence of Mobility-as-a-Service (MaaS) as an alternative to owning a car has been proposed as a radical and innovative solution to overcome these mobility and sustainability challenges. The core idea of MaaS entails the combination of different mobility services, such as public transport (PT) and car-sharing, for instance, into one digital platform where users can book and pay for their journey in one seamless step (Sochor et al., 2018). This technology driven MaaS concept is regarded as the next paradigm change in transportation, with the potential to decrease the use of private cars, offering efficient, sustainable, and accessible travel opportunities tailored to individual user preferences (Giesecke et al., 2016). However, MaaS could also result in more travel and distances covered by car due to the increased access and convenience of car-sharing (Transport Catapult, 2016).

The most prominent research and innovation program of the EU focusing on reaching carbon neutrality and promoting Smart City development, was the Horizon 2020 program. Within this program, the IRIS Smart Cities project received considerable funding for tackling the "urgent need to deliver energy and mobility services in their cities that are cheaper, better accessible, reliable, and that contribute to a better and more sustainable urban quality of life" (p.1). As an abbreviation for "Integrated and Replicable Solutions for Co-Creation in Sustainable Cities", IRIS started in October 2017 in the three Lighthouse Cities, Utrecht, Gothenburg, and Nice Côte d'Azur, followed by other cities replicating the solutions. The project's main objective of improving urban life by introducing smart solutions that integrate energy, mobility, and Information and Communication Technologies (ICT) in a demonstrator setting, was complemented by smart e-mobility schemes as a main pillar of the program. More specifically, the city of Gothenburg piloted a MaaS solution called Easy to Be (EC2B) in an apartment setting, targeting sustainable development (European Commission, 2017).

Regarding the IRIS project in Gothenburg, the EC2B model combines intelligent mobility technologies with a sustainability vision. Specifically, this study will explore to what extent MaaS initiatives can diffuse sustainable mobility approaches on behalf of the case study of EC2B, which leads to the following research question:

In what ways does the EC2B Mobility-as-a-Service project within the European Union's IRIS Smart City program in Gothenburg contribute to sustainable mobility?

Previous studies have reported the theoretical contribution to sustainable mobility by MaaS initiatives. Despite the ambitious environmental, social, and economic benefits of MaaS, the concept is still in its infancy and underexplored regarding the empirical evidence to support the sustainability claims. Most studies in the field of integrated mobility have examined the technological aspects and the role of ICT connected to MaaS, while a tailored sustainable mobility perspective has been underdeveloped. My study aims to close the identified research gap and investigate the actual sustainability outcomes based on the EC2B case study in Gothenburg, thereby narrowing the empirical uncertainty around the topic.

Regarding the societal relevance of the study, overcrowded cities and the negative impacts of climate change present key issues of urban mobility. People living in the city are curtailed in their mobility patterns due to traffic congestion and limited transport capacity. Therefore, there is an urgent need for clean, efficient and innovative transport systems in cities. MaaS could constitute a sustainable and smart mobility tool to counteract these developments by providing a comprehensive urban mobility solution. Regarding the collaborative frame of the project being integrated into an EU network, a successful implementation and promising sustainability outcomes could encourage other cities to replicate the mobility solution. Also, based on the findings, best practices and recommendations across public administrators, science and innovation hubs, and transport agencies could be spread. The MaaS project offers high potential for upscaling, which would positively influence developing business models, transportation providers, and the way people can move around in cities.

The empirical research question needs additional descriptive and exploratory sub-questions to structure the study and systematically answer the research question. Therefore, the thesis is broken down into three sub-questions (SQ):

(SQ1): How can Mobility-as-a-Service models generate sustainable mobility outcomes?

(SQ2): Can the EC2B pilot provide environmental, social, and economic sustainable mobility benefits?

(SQ3): How does the EC2B pilot perform as a smart and sustainable mobility solution?

The study is structured into six chapters, including this introductory chapter. The second chapter lays out the theoretical foundation for the case study. It provides a description of MaaS preceding with the sustainability benefits that MaaS can generate and ending with an analytical framework that will guide this study. The third chapter is concerned with the methodology, including a description of the selected case. The fourth chapter presents the findings of the EC2B demonstrator by employing the analytical framework to the empirical data, focusing on the three key themes of environmental, social, and economic benefits. Subsequently, Chapter Five critically discusses the results and the limitations of the research. The final chapter concludes by answering the main research question and includes the implications of the findings and areas for future research.

2 Theoretical Framework

The following chapter aims to develop the theoretical framework for analyzing the MaaS EC2B pilot of the IRIS project in Gothenburg. The chapter contains findings from the literature on the key concepts of ‘sustainable mobility’ and ‘Mobility-as-a-Service’. Most importantly, as an attempt to answer the research question, is the discussion of the relationship between MaaS programs and their anticipated contribution to sustainable outcomes. Therefore, it addresses the first sub-question: *“How can Mobility-as-a-Service models generate sustainable mobility outcomes?”*

2.1 Sustainable Mobility

Sustainable mobility is often associated with the reduction of CO_2 emissions in transport and the promotion of non-motorized forms of mobility. The key article of David Banister (2007), “The sustainable mobility paradigm”, shows that several factors differentiate and characterize sustainable mobility from conventional mobility. Whereas traditional transport planning on travel relies on two principles, namely seeing travel as a derived demand and the minimizing travel cost (both in time and cost), sustainable mobility focuses on the social dimension of travel. It promotes the accessibility of travel and commits itself to involving people in the transport planning process, therefore striving to increase public acceptability for policy changes.

Within the sustainable mobility literature, the key characteristics are classified into three sustainable urban development pillars. The three-fold structure of sustainability, including the global environment, quality of life, and economic success, which can be more commonly categorized as the environmental, social, and economic pillars, is applied to the mobility sector (see Jain & Tiwari, 2017; Ou et al., 2017; Gillis et al. 2015). The **global environment dimension** concerns the cross-border impact of urban mobility on the environment and an obligation of cities to reduce the environmental harm of their mobility system. Thus, low environmental impacts and reduced demand in energy form key objectives in this category (WBCSD, 2013). Particularly, the key goals within the environmental pillar are the employment of environmentally friendly transport modes, reduced traffic congestion, and the reduction of air pollution, noise, and visual nuisance (Erl and Feber 2000, as cited in Campos et al., 2009). Similarly, Banister (2007) outlines the sustainable mobility approach by requiring necessary actions to “reduce the need to travel (less trips), to encourage modal shift, to reduce trip lengths and to encourage greater efficiency in the transport system.” (p. 75). These actions can result in slowing down movement instead of speeding up traffic. The sustainable mobility paradigm focuses on the key drivers for a successful implementation of measures, rather than on the specific policies and modes of sustainable transport itself.

Instead, the **quality-of-life dimension** places the individual and their needs in the center of the mobility frame, referring to the societal implications of mobility including health and affordability for instance (Gillis et al., 2015). Specifically, the social sustainability dimension aims at "accelerat[ing] and extend[ing] access to safe, reliable and comfortable mobility for all whilst having zero traffic accidents" (p.2), as well as guaranteeing the affordability of transport systems (WBCSD, 2013). Furthermore, ensuring social equity and equal transport opportunities for everyone is central to this pillar (Erl and Feber 2000, as cited in Campos et al., 2009). The importance of the individual is highlighted by the engagement of key stakeholders and the community in the decision-making process, discussion, and implementation, which is vital for a successful outcome of any innovative sustainable mobility scheme (Banister, 2007).

Lastly, the **economic success dimension** describes the welfare enhancement of the city through mobility systems (Gillis et al., 2015). This contains the notion of creating new businesses and a wealthy and healthy urban economy characterized by an economic growth cycle (WBCSD, 2013; Campos et al., 2009). So, ideally the economic value creation can be enhanced by developing sustainable mobility models.

In summary, the core objectives of sustainability mobility comprise reducing the negative environmental impact of transport, improving resource efficiency in transport infrastructures and transport modes, as well as ensuring equal access to public transportation with the most significant goal of reducing private car use (Campos et al., 2009). Consequently, the characteristics of sustainable mobility form an interplay of the different sustainable development dimensions, which seek a harmonious relationship between the people, the planet, and the profit.

2.2 A Brief Introduction to Smart Mobility

With the main objective of improving the quality of life of citizens, promoted by the Smart City concept, one of the most critical aspects for the effective functioning of a city is mobility. While transport generates multiple negative impacts, such as pollution, congestion, long traveling, and high public transport costs, Smart Mobility proposes to lower these consequences and generate benefits for the quality of life of urban populations (Benevolo et al., 2016). According to Papa and Lauwers (2015), Smart Mobility can be split into two main aspects: a techno-centric part that encourages infrastructural innovation and a consumer-centric part that focuses on the end-users' needs. The techno-centric approach places emphasis on hardware and assumes that applying ICT is the keystone in building up intelligent mobility, while maximizing efficiency is the core objective.

Furthermore, the consumer-centered Smart Mobility approach emphasizes the human aspect, aiming at satisfying their individual needs. Within this approach, innovative technologies in infrastructure, vehicles, and services are seen as "enabling tools" (p.546) for the end-users of these innovations. Consequently, consumer-centered Smart Mobility applications intend to optimize the user's mobility behavior through ICTs (Papa & Lauwers, 2015). Moreover, Lyons (2018) defines Smart Mobility as "connectivity in towns and cities that is affordable, effective, attractive and sustainable" (p.9). Therefore, Smart Mobility is a diverse and multilayered concept driven by data-sharing characteristics with the main aim of increasing connectivity, efficiency, and sustainability in transport. The implementation of ICT into the transport infrastructure enables Smart Mobility developments.

2.3 The Concept of Mobility-as-a-Service

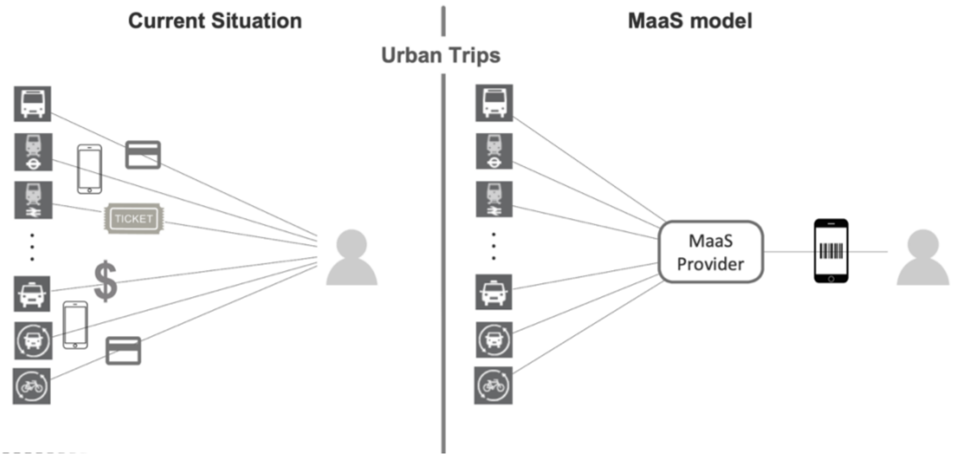
In recent years, there has been an increasing volume of literature on Mobility-as-a-Service, initiating a paradigm change in travel. As a result of the growing offerings of transport services in cities and developments in technology and ICT, the concept of MaaS emerged (Koźlak & Pawłowska, 2019). As all forms of Smart Mobility, MaaS is enabled by technology. However, due to its wide scope and focus on consumer-centricity, it is an interesting and promising prospect for fulfilling the society's needs in urban mobility. Notably, the development of MaaS is stimulated by the rise of the sharing economy and viewed as a major disruption in the transport sector (Burrows et al., 2015). Therefore, the people-centered Smart Mobility concept of MaaS, brought forward by the current trend of a collaborative econom,y is suitable for analyzing the transport innovation on behalf of sustainable mobility criteria.

Being a relatively recent topic in literature, the MaaS definitions emphasize different aspects from technology to sustainability and consumer-based approaches lacking a formal definition. MaaS platforms aim to provide an alternative to private car ownership, with popular modes of transport being carpooling, car-sharing, or bicycle-sharing (Paiva et al., 2021). A brief, first description of MaaS was given by Hietanen (2014) who characterized MaaS as a distribution model that bundles different mobility services into one single interface offered by a service provider, which satisfies user's transport needs. More specifically, "MaaS is the integration of various forms of transport services into a single mobility service, which is accessible on demand. To meet a customer's request, a MaaS operator facilitates a diverse menu of transport options, be they public transport, ride-, car-, or bike-sharing, taxi or car rental/lease, or a combination thereof." (Maas Alliance, 2017, p.1). Comparing these two definitions, the most essential prerequisites of MaaS are consumer centricity and the multimodal characteristics.

The core elements of MaaS are summarized by multimodality, consumer-centricity, cooperation, customization, technology integration, and unified platform. Multimodal services describe the selection and combination from various transport options. Further, the consumer-centricity is underlined by considering the user's individual preferences, which result in a tailored transport solution by reviewing customer experience before, during, and after traveling. Next, the cooperation between different mobility providers including public and private companies, and their willingness to share data, is the most differentiating element compared to conventional transport models. Also, MaaS requires the integration of different technologies, such as e-payment systems and data management, resulting in one single digital platform covering the complete customer process (Wittstock & Teueberg, 2019). A conceptual, simplified comparison between MaaS and traditional transport is illustrated in *Figure 1*.

Additionally, each MaaS platform is unique in the set of services it offers. The MaaS interfaces can vary in terms of their integration level, which can be classified in a topology of four levels being: 0. single, separate services, 1. integration of information, 2. integration of booking and payment, 3. integration of the service offer and 4. integration of societal goals (Sochor et al., 2017). Depending on the level of integration, different mobility bundles and services, such as monthly subscriptions are offered, which increases the user's convenience. In summary, encouraged by technological advancements, MaaS can connect public and private transport services and integrate different travel modes into one trip, allowing for an accessible, flexible, reliable, and cost-effective mobility service for its consumers (Kamargianni & Matyas, 2017). Therefore, MaaS initiatives show a lot of potential of becoming a comprehensive and user-friendly mobility solution, initiating a paradigm change in transportation for the future of cities.

Figure 1. A conceptual view of MaaS compared to traditional transport services



Source: Kamargianni & Matyas (2017, p.5)

2.4 Sustainability Benefits of Mobility-as-a-Service

Many authors highlight the potential contribution to sustainable mobility of MaaS models. The main arguments that support this concept revolve around the delivery of sustainability benefits in the form of reduced congestion and greenhouse gas emissions, improved accessibility, and the delivery of economic gains through the growth of new business models and innovation opportunities (Sarasini et al., 2017). The definition of MaaS, as "multimodal and sustainable mobility services addressing customers' transport needs by integrating planning and payment on a one-stop-shop principle" (p.12), stresses the incorporation of sustainability aspects in MaaS (Karlsson et al., 2017). Thus, this section will help answer SQ1 as it discusses the potential contributions to sustainable mobility through MaaS.

The authors Karlsson et al. (2017) categorized the potential benefits of MaaS into different impact areas, namely environmental, social, and economic impacts. They described environmental impacts as a change to the environment (positive or negative), resulting from an organization's activities that interact with their natural surroundings, such as air or land. Further, social impacts contain the effects that influence people's social and economic well-being, which can be derived from the user experience, for example. Lastly, economic impacts are 'effects on the level of economic activity in a given area' (Weisbrod & Weisbrod, 1997, as cited in Karlsson et al., 2017). I will apply this classification in a broader sense and categorize the sustainability benefits of MaaS discussed in the literature.

2.4.1 Environmental Benefits

The first group of benefits deals with the aspect of environmental impacts. The first most evident benefit that MaaS provides, is the **reduction of private car ownership** (Wittstock & Teuteberg, 2019; ERTICO, 2019; Karlsson et al., 2017). More specifically, MaaS can encourage a **modal shift** from using private cars to using public transport (Karlsson et al., 2017). Thus, it increases the modal share of more environmentally friendly and efficient transport alternatives (ERTICO, 2019). The public transport system functions as the foundation of the MaaS model, while other transport modes from private transport providers complement the fleet.

In an effort to encourage the use of **more sustainable modes of transport**, the MaaS providers can **incentivize users** through different means. With the employment of gamification and nudging techniques, sustainable travel behavior can be rewarded (ERTICO, 2019). For instance, by providing users with information on the environmental impact of the modal choice (Karlsson et al., 2017), or integrating smart tariffs that penalize more environmentally damaging modal choices (Cruz & Sarmento, 2020), users can make an environmentally aware decision on their preferred modal option. However, the introduction of MaaS can bring adverse sustainability effects bearing the risk that prior public transport users are inclined to exchange PT for car-centric solutions (Fioreze et al., 2019).

Another potential benefit is the **reduction of the number of total trips** due to the efficient planning of trips with MaaS (Sarasini et al., 2017). Additionally, fewer short and spontaneous trips could be made as a consequence of not owning a private car (Sochor et al., 2016). Also, the number of trips can be further decreased by a shift to a need-based travel (König et al., 2016). However, these developments can be counteracted by an increased access to transport and more use of car-sharing through MaaS (Karlsson et al., 2017). Due to limited empirical evidence of the MaaS implementation outcomes it must be investigated if it can ultimately reduce the number of trips in a specific case.

Furthermore, several authors identify the **reduction of transport-related emissions** as a benefit of MaaS (Paiva et al., 2021; Karlsson et al., 2017; Gould et al., 2015). The reduction of emissions is tied to the reduced number of trips made, as well as to the aforementioned modal shift from fossil-fueled cars to more sustainable modes of transport (Karlsson et al., 2017). The ecological footprint can be further diminished by using MaaS as an opportunity to profilerate electric vehicles in the city and incorporating them into the fleet (Gould et al., 2015).

Lastly, MaaS can promote **resource efficiency**. With the overall decrease in private car ownership and the promotion of shared vehicles and public transport, less parking space will be needed. Also, fewer vehicles are in circulation thus reducing traffic congestion (Giesecke et al., 2016). Hence, using shared resources in transport increases resource efficiency in terms of land usage, traffic flow, and matching the user demand dynamically to the available transport capacity (Karlsson et al., 2017).

Therefore, MaaS can generate environmental benefits by reducing the number of fossil-fuel cars, expanding the use of other (more sustainable) modes of transport, encouraging sustainable travel behavior, decreasing emissions and by promoting resource efficiency.

2.4.2 Social benefits

The second group of benefits deals with the aspect of social impacts. Previous studies have reported that MaaS **improves citizens' accessibility to transport** and other services (Sarisini et al., 2017; Wittstock & Teuteberg, 2019). One of the key objectives of MaaS is equity and improved mobility, which can be accomplished through less dependency on ownership of expensive vehicles providing "…benefits for social inclusion, reduced isolation and improved access to services, education, employment and social interaction." (ERTICO, 2019, p.11). Through the **shift from ownership-based to access-based transportation** by shared mobility services the accessibility and equity in transport can be enhanced (Jittrapirom et al. 2017).

Users can customize their travel and can choose from a wide range of alternative modes, which offers benefits for **vulnerable people.** Elderly or disabled people, who are generally disadvantaged in mobility schemes, can view information on the transport options and select a tailored mobility option (ERTICO, 2019).

In addition, several authors identify the cost-saving nature of MaaS. By having a subscription to a MaaS provider, ridesharing, and taxi services can become **more affordable** as they are incorporated into the system (Utriainen & Pöllänen, 2018). Also, by combining different modes of transport and having a clear and transparent description of each mobility option, users can travel more economically (ERTICO, 2019). The total cost of travel per individual or household can be decreased through a subscription to a MaaS provider as the investment, maintenance and use of a private car significantly exceeds the cost of a yearly MaaS subscription (Karlsson et al., 2017). Nevertheless, the cost savings depend on the user's mobility profile.

Next, the users' **comfort and convenience** can be elevated through Mobility-as-a-Service. Based on the intelligent nature and the ICT background of MaaS, users can personalize their travel in terms of speed, convenience, comfort, and cost to their liking (ERTICO, 2019). Consequently, MaaS users can select their travel mode depending on their activity (e.g., shopping, picking up people) and weather conditions, for instance. The customer's experience can be further enhanced by having access to real-time information of different transport providers merged into one application. This can minimize waiting times, travel times and ease the use of transport for users. (Cruz & Sarmento, 2020).

2.4.3 Economic benefits

The third group of potential benefits of MaaS implies an economic perspective. MaaS can deliver economic benefits by being an innovation opportunity and encouraging **new business models in transport** (Sarsini et al., 2017). With the shift from private cars to other travel modes, such as car-sharing and public transport, **these transport providers can benefit from new customers using their services** (Karlsson et al. 2017). Previous results from evaluations of unimodal schemes, such as bike-sharing, suggest that unimodal transport is less likely to replace car ownership than the multimodal MaaS offers (Karlsson et al., 2017). Consequently, more private, as well as public, mobility service providers would benefit from new customers if they collaborated on building a multimodal offer.

In general, MaaS is expected to produce **revenue growth for transportation providers** (Paiva et al., 2021). It directs former private car owners to use shared mobility services and increases the attractiveness of public transport operators, which in turn "ease the financial burden of the local public transport operators and authorities and thus reduce the need of subsidies" (MaaS Alliance, 2017, p.20). Therefore, MaaS can financially benefit both, private, and public transport providers. By opening up potential reductions in subsidies for PT services MaaS can contribute to the local economy. Furthermore, the **revenues could be increased by reducing costs and running effective operations** (Karlsson et al., 2017). Burrows et al. (2015) suggest dynamic pricing as an example for benefitting the operations of the MaaS providers. This mechanism discourages people from traveling at peak times, therefore resulting in a more balanced usage over time. Consequently, MaaS models can spread the demand and lead users towards a specific mobility solution to benefit their operations.

2.4.4 Sustainability Evaluation Criteria

By discussing the overlaps between MaaS benefits and sustainable mobility within the three impact areas of environmental, social, and economic benefits, it is evident that MaaS can deliver multiple sustainable mobility criteria in theory. The sustainable transport characteristics (2.1.), entailing the reduced need to travel, modal shifts, improved accessibility, comfortable and safe mobility, reduced traffic congestion and environmental impact, affordability, and potential economic gains have been covered to different degrees by the MaaS models. In the context of this research, MaaS can contribute to sustainable mobility outcomes in several ways depending on which lenses – environmental, societal and economic – is being focused at as shown in this thesis.

Since the development of MaaS solutions is a recent topic in literature, their benefits have yet to be substantiated. My thesis aims at closing this gap by collecting empirical data on a specific MaaS case and validating which sustainability benefits MaaS can provide. Based on my review of the literature regarding the benefits of MaaS initiatives from a sustainable mobility perspective, *Table 1* systematically classifies the criteria that build the foundation for my empirical analysis of the EC2B project.

Table 1. Sustainability evaluation criteria for MaaS

Factors	Source
Factors related to environmental sustainability	
E1. Reduction in private car ownership	Wittstock & Teuteberg, (2019); ERTICO (2019); Karlsson et al. (2017)
E2. Modal shift to more environmentally friendly modes of transport (e.g., Public transport, bicycle-sharing)	Karlsson et al. (2017), ERTICO (2019);
E3. Nudging users towards sustainable travel modes	Karlsson et al., (2019); ERTICO (2019); Cruz & Sarmento (2020)
E4. Reduction in the number of total trips and km travelled	Sarasini et al. (2017), König et al. (2016)
E5. Reduction of transport related emissions	Paiva et al. (2021); Karlsson et al. (2017); Gould et al. (2015)
E6. Increase in resource efficiency in terms of land usage and traffic flow	Karlsson et al. (2017); Giesecke et al. (2016)
Factors related to social sustainability	
S1. Improved accessibility to transport	Sarisini et al. (2017); Wittstock & Teuteberg (2019); ERTICO, (2019); Jittrapirom et al. (2017)

S2. Affordability	Utriainen & Pöllänen (2018) ERTICO, (2019); Karlsson et al. (2017)
S3. Increased comfort and convenience	ERTICO (2019); Cruz & Sarmento (2020)
Factors related to economic sustainability	
EC1. Customer generation for transport providers	Sarsini et al. (2017); Karlsson et al. (2017)
EC2. Revenue growth for transportation providers	Paiva et al. (2021); MaaS Alliance (2017); Karlsson et al. (2017)

3 Methodology

This chapter aims at explaining and justifying the chosen methods for answering my research question. First, the research design will be laid out. Second, the case of my research will be described and the motivation for the case selection will be given. Third, the data collection process of selecting interviewees will be described, followed by outlining the data analysis method of theory-based coding and the coding method by Mayring and Fenzl (2019).

3.1 Research Design

In line with the research question that aims to uncover the ways the EC2B MaaS project in Gothenburg can contribute to sustainable mobility outcomes, this study is designed as an exploratory single case study. A case study is usually applied for testing or developing a theory, understanding and defining new phenomena, concepts, actors or processes, and is ideal if you have a lower number of observations, qualitative or mixed data (George & Bennett, 2005). A case study aims to gain in-depth knowledge about a specific case, and simultaneously uses the case to generalize the outcome across a more extensive set of units (Gerring, 2004). With the EC2B pilot in Gothenburg being one of the demonstrator projects in the IRIS Lighthouse Cities, which develop and test integrated solutions on a local scale, the results of my study could encourage the replication of the Smart Mobility solution in other cities. However, since the case and project implementation are unique and bound to national regulations on transport, this study does not attempt to generalize its findings. Instead, the generated knowledge can serve as a basis for formulating best practices, recommendations, and guidance for other MaaS models.

An exploratory nature of inquiry is applied, which can be described as a method to gain knowledge about "what is happening; to seek new insights; to ask questions, and to assess phenomena in a new light" (Robson, 2002, p. 59). By assessing the specific case of the EC2B

Mobility-as-a-Service solution based on sustainable mobility criteria, it is expected to find valuable contributions of integrated mobility practices to sustainability especially due to the limited empirical evidence of MaaS initiatives. Furthermore, case study research usually implies working with qualitative data, which applies to my thesis. Using expert interviews primary data is generated, coded, and analyzed together with an implementation document in the analysis part. To convert the data into units of analysis, it is coded and systematically analyzed based on the sustainability evaluation framework (see chapter 2.4.4., Table 1). Within this framework, MaaS outcomes are divided into three categories: environmental, social, and economic sustainability benefits, which are applied to investigate the EC2B case. By contrasting the sustainability evaluation framework to the empirical data of EC2B, the process of answering the research question is determined to be deductive.

3.2 Case Description

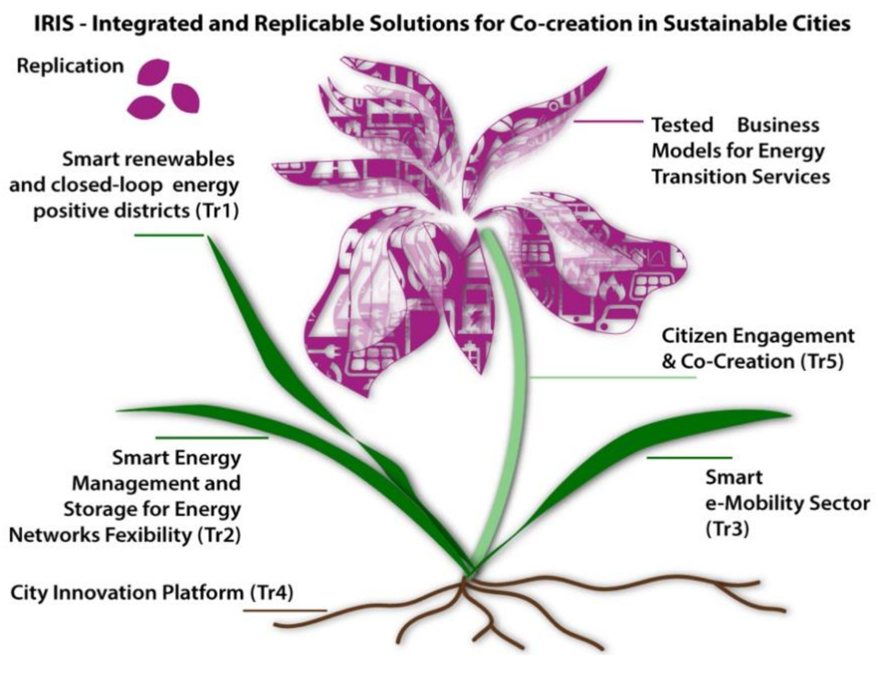
This study examines the EC2B Mobility-as-a-Service project in Gothenburg, Sweden, which is part of a wider European Union frame called the Horizon 2020 program. The European Union's commitment to the environment, urban issues, and aspirations toward Smart City development, has been formalized with the Horizon 2020 Strategy, which is the EU's biggest research and innovation program (European Commission, 2022). The Horizon 2020 program funded the five-year-long IRIS Smart Cities project, which aimed at introducing innovative, efficient, and replicable integrated solutions to fight climate change (European Commission, 2017). The IRIS project was initiated in 2017 and developed in the three "Lighthouse Cities" – Utrecht, Gothenburg, and Nice, which acted as living laboratories for demonstrators of integrated solutions. These Lighthouse Cities test the innovative sustainable solutions on a district scale to share best practices with Follower Cities, which adapt the solutions to their local conditions (IRIS Smart Cities, 2018).

The main ambition of the IRIS project is to support cities in "address[ing] their urgent need to deliver energy and mobility services in their cities that are cheaper, better accessible, reliable, and that contribute to a better and more sustainable urban quality of life" (para.1) and encouraging the co-creation and replication of solutions (European Commission, 2017). One of the project's Transition Tracks is dedicated to smart e-mobility (see *Figure 2*). My study assesses the implementation of the MaaS service called EC2B in Gothenburg, which provides the customers with an alternative to owning a private car.

The EC2B service was developed by the transport consultancy Trivector, which closely worked with IRIS members. A significant aspect of the project is its collaboration with the real estate developer Riksbyggen, where the MaaS service is piloted and integrated into the positive footprint housing of Brf Viva. The housing complex consists of 132 apartments and is designed to encourage the use of shared vehicles, purposefully lacking residential parking for private cars. Instead, the EC2B service, which includes electric vehicles, a light e-vehicle, electric cargo bikes, electric bikes, and public transport, is offered to the tenants who can book their preferred modal option through a phone application (see *Figure 3*). By providing the residents with sustainable and flexible mobility and creating a low-car housing concept, customers and public authorities benefit from the EC2B solution (Lund, 2020).

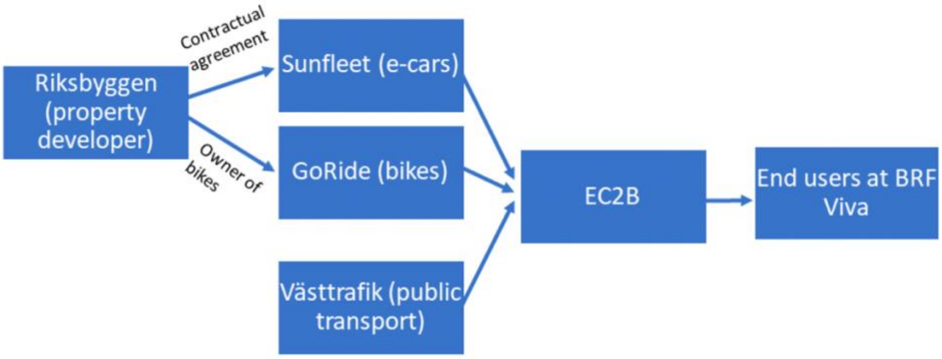
Different actors and stakeholders are involved in the creation, implementation, monitoring, and evaluation of the EC2B initiative, including the Municipality of Gothenburg, the Johanneberg Science Park, and Trivector Traffic, among others (IMCG, 2020). Hence, the case study on the EC2B pilot and outcomes of the thesis are potentially valuable and relevant for several organizations.

Figure 2. IRIS solution structure



Source: European Commission (2017)

Figure 3. Organizational scheme of relations between EC2B, property actor, mobility service provider and end users in Brf Viva



Source: Lund (2020, p.30*)*

3.3 Case Selection

The EC2B model in Gothenburg can be replicated by other cities and tailored to their national policies and infrastructure. Therefore, the outcomes of my study can provide a broader implication of the sustainability aspects of integrated mobility schemes, while the findings of this thesis do not particularly aim for generalization. Instead, the analysis of this case aims at filling the identified research gap by gathering empirical data on MaaS implementation outcomes. The case selection is justified and motivated by three substantive arguments.

Firstly, the IRIS program represents an overlap between Smart City development and sustainability, which consequently lays the foundation for the design of the EC2B model. Thus, with the paramount objective of sustainable mobility by deploying innovative MaaS schemes, the EC2B model fits the research objective of exploring the actual relationship between these two paradigms and analyzing the fundamental benefits provided by EC2B. Secondly, the case selection is supported by Sweden's dedication and commitment to sustainability policies. As a frontrunner for sustainability practices in Europe, a successful implementation could inspire other cities and encourage the replication of the project in other countries. Thirdly, by examining the different Smart Mobility initiatives of the Lighthouse, as well as Follower Cities within the IRIS program, the EC2B program appears to have the highest societal relevance. With my prior interest in multimodal mobility services, I was already familiar with the subject matter and highly interested in the project. Therefore, the motivation in selection of EC2B is, in part, due to practical reasons.

3.4 Data Collection

The thesis draws on two main sources of data. The first source of evidence is the collection of primary data generated through conducting in-depth expert interviews. The interviewees were selected based on their involvement in the EC2B creation, implementation, and evaluation in Gothenburg. In total, four interviews were conducted. The first interview was conducted with an employee at the Research Institute of Sweden (RISE), who was involved in the IRIS project through the monitoring of Key Performance Indicators. The second interview was conducted with an employee of the traffic and mobility consultancy Trivector. The Lund-based company Trivector Transport designed the EC2B application and followed the implementation process in Rikbyggen’s apartment complex. Also, they maintained a connection to the demonstrator project and its users following the initial rollout. The third interviewee was working as a project coordinator for the Johanneberg Science Park. This urban development facility coordinates the IRIS project on behalf of the city of Gothenburg. The fourth interviewee was also employed at RISE as an expert in mobility and transformation and remained in close contact with EC2B for an additional period. A precise overview of the interview partners, the date, and length of the interviews can be found in Appendix A.

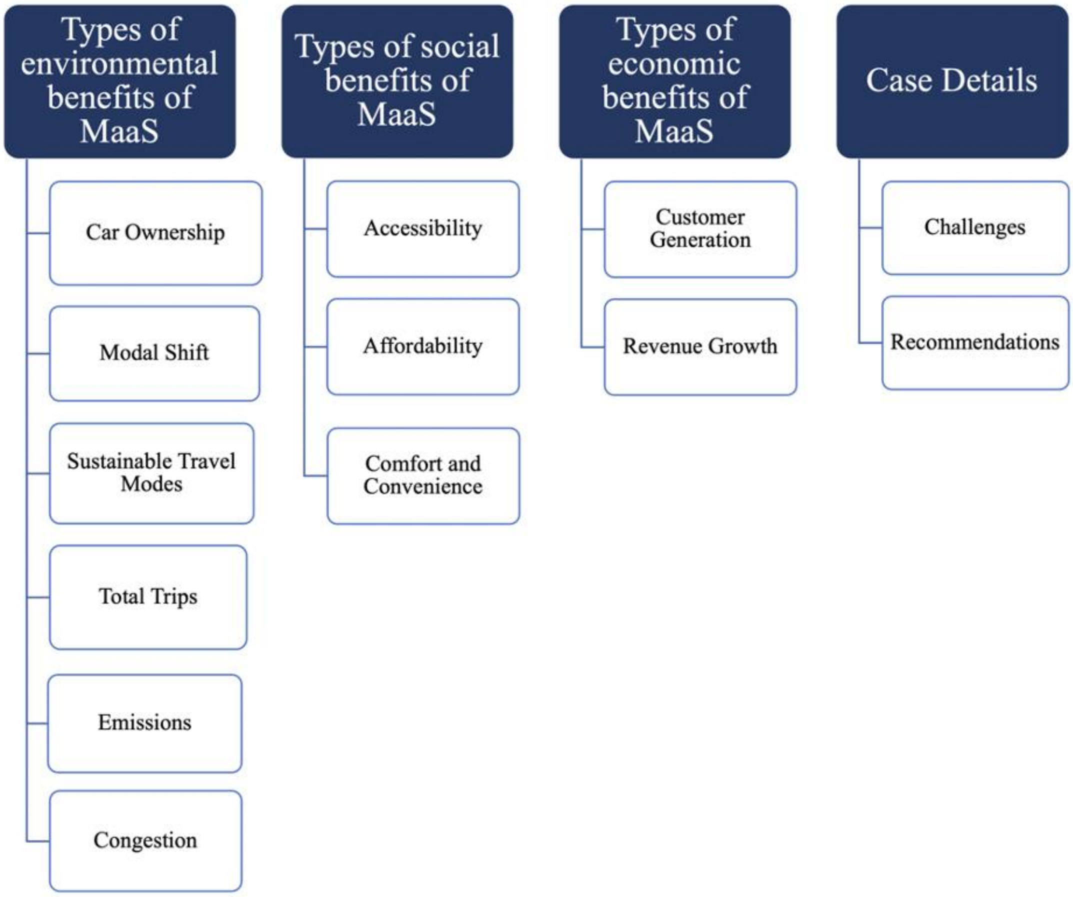
The method of semi-structured interviews, which allowed for a flexible construction and adjustment of questions during the interviews, including the follow-up questions for further clarifications. In accordance with semi-standardized questions, where questions are asked “in a systematic and consistent order, but the interviewers are allowed freedom to digress” (Lund & Berg, 2017, p. 69). I could tailor questions according to my theoretical framework and add questions during the interview that were relevant to my research. The primary purpose of these interviews was to gather insights and expert views that were unavailable in other project documents. All the interview questions were deductively derived from the analytical framework, structuring the interview questions into five parts. The first part served as an introduction to my work, the position of the interviewee, and the main objective of the project. Next, the project's theoretical sustainability benefits (environmental, social, and economic) were discussed in parts two to four. The fifth part comprised questions about challenges and potential improvements regarding the project implementation. The interview questions can be found in Appendix B. The interviews took 40-60 minutes and were conducted via video conference on Microsoft Teams. With the interviewees' consent, the interviews were audio-recorded and stored on a secure server.

The second source of evidence is a mix of materials, with the main document being a detailed implementation report of the IRIS smart e-mobility project in Gothenburg. The report was created in 2020, thereby containing findings from the first three years of the implementation. Furthermore, I was provided with preliminary quantitative data on the Key Performance Indicators collected by IRIS coordinators. In addittion, I attended the IRIS Smart Cities conference in the “Stadskantoor” in Utrecht on the 31.05.2022 where I met all member city participants and coordinators in person. Throughout the day, presentations were held by intelligent mobility experts from Utrecht, and Site visits were offered. By participating in the event, I collected more insights on the general project objectives of the IRIS program with regards to the mobility track.

3.5 Data Analysis

To analyze the data, a qualitative content analysis is employed which is the “nonnumerical examination and interpretation of observations, for the purpose of discovering underlying meanings and patterns of relationships” (Babbie, 2013, p. 390). In preparation for the content analysis, the interviews were transcribed and anonymized, removing any filler words and duplications that disrupted the flow of reading. The interview transcripts are attached in a separate file (see Appendix C). A two-phase coding process was applied for the interviews and the document. As described by Mayring & Fenzl (2019), the deductive category assignment, as well as inductive category formation, was used for the analysis. First, applying the deductive category assignment method, a theory-driven codebook was created and employed to analyze empirical data. Accordingly, the analytical framework was broken down into specific codes using keywords and coding rules. Second, the theoretical codes were applied to the interview transcripts and the document using the Atlas.ti software. Third, the inductive category formation was employed on the software during the coding procedure. The codebook was extended by adding new codes, while ensuring that all necessary keywords for answering the research question were included. With the operationalization of the theoretical background into codes, the overall concepts, such as “environmental benefits”, “social benefits”, and “economic benefits” of MaaS were filtered out and subcategories were attached. In order to get a more holistic view on the EC2B demonstrator, the coding group of “challenges” and “recommendations” were added but not used for the analysis (see *Figure 4*). The coding scheme including a subordinate category, subcategories, the coding rule and an example from the data is attached in Appendix D.

Figure 4. Coding scheme



Source: Own illustration

4 Analysis

In this chapter, the findings that were derived from the expert interviews and document are presented. The chapter is structured by the results of different code groups in accordance with the theoretical framework and the case study of the MaaS demonstrator EC2B. The data analysis aims to determine the sustainable mobility outcomes of the EC2B model, including environmental, social, and economic impacts. Hence, the second sub-question, *"Can the EC2B demonstrator provide environmental, social, and economic sustainability outcomes?"* is answered.

4.1 Environmental sustainability of EC2B

The following section analyzes the findings on the environmental sustainability impacts of the EC2B demonstrator. The analysis of the data shows that EC2B can (1) reduce car ownership, (2) encourage a modal shift from fossil fuel to e-vehicles, PT, cycling or walking,

(3) incentivize the use of sustainable travel modes, (4) reduce the number of total trips by car, (5) lower CO_2 emissions, and lastly (6) partially improve land use. These benefits form the environmental ambitions of the EC2B project.

4.1.1 Car Ownership

Among the tenants of the Brf Viva Housing Complex, the car ownership has been measured before and after they moved into their apartments in Viva. By providing the EC2B mobility scheme and lacking parking spaces, the number of cars was reduced from 64 to 32 in the first year of implementation (Interview 1). They either sold their vehicles when moving into the new apartments, considered selling their cars in the future, and generally seemed to be less dependent on them (Interview 4). Interviewee 3 observed that people with two cars were more likely to eliminate one car, as a minimum. Furthermore, many interviewees mentioned that the Brf Viva tenants owned significantly fewer cars compared to the tenants of similar buildings in the neighborhood. However, several people kept their private vehicles and tried finding parking facilities in the area (Interview 2).

Another driver for the reduction in car ownership constituted the flexible parking norm in Gothenburg, which allowed property developers to provide alternative mobility solutions (Lund, 2020). As a result, the EC2B concept was developed with the property actor of Riksbyggen who built the apartments without constructing garages for private cars (Interview 3), creating an actual demand for shared vehicles (Lund, 2020). With regards to this ambitious no-parking concept, another interviewee pointed out that "the most interesting part for me is that it seemed to help people accept the lack of residential parking [...]" (Interview 4, p. 10). Therefore, even if some tenants did not immediately abandon their private cars, they were open to moving into a space that did not provide any services for their vehicles.

The people who kept their cars did not seem to use them daily and drove less than before (Lund, 2020). One argument for holding onto the cars was special occasions, especially the Swedish tradition of reaching their summer houses (Interview 1). These summer cottages are located far outside; thus driving with the shared electric car could pose a challenge (Interview 1).

4.1.2 Modal Shift

Further environmental benefits were created by a partial modal shift towards the shared modes of transport provided by EC2B. Most people in the houses adapted the EC2B service and used the shared vehicles to commute to their daily work (Interview 1). Also, a travel survey on behalf of the IRIS project presented that, even the people owning a private car, increasingly traveled by public transport, bicycle, or simply by walking (Interview 2). Some attention was also drawn to the internal motivation for wanting to use the car less often. By moving into apartments without residential parking, the tenants forced themselves into changing their travel habits (Interview 3).

Drawing from the tenants' statements, they increasingly traveled with the EC2B mobility options, including PT and biking, in contrast to using their cars (Interview 4). Moreover, the empirical data collected by the IRIS coordinators from Gothenburg for monitoring KPIs, on the number of kilometers driven per year of all tenants, supports this behavioral travel shift. Whereas the number of kilometers driven per year in 2018, before the move to Brf Viva, totaled about 1.1 million km/year, the tenants significantly decreased their car use after the implementation of the EC2B service to less than 600.000 km/year in 2019. Consequently, people supplemented their travels with different, more sustainable modes of transport offered by EC2B and changed their overall transport pattern.

The explanations on what facilitated the transformation and adaption of the MaaS pilot varied among the interviewees. Due to the elaborate introduction to the service from the EC2B developers, Riksbyggen, and the vehicle sharing companies "[...] the usage of the car-sharing services was quite high, quite early in the project compared to other projects that they had." (Interview 2, pp. 6). The tenants adapted quickly to the MaaS offering encouraged by the extensive dialogue they had about the new services.

Another interviewee reported that the service's level of acceptance and use was tied to the burden or convenience the modal shift causes them (Interview 1). So, with the EC2B service being built into the housing and a bus stop closely located to the apartments, the burden for the end-user was lowered. Similarly, Interviewee 4 stated that the combination of moving to a new place, the centrality of the apartments, the lack of residential parking, the vicinity to public transport, and walking distances to essential services, all encouraged sustainable travel behavior (Interview 4). However, the specific contribution of the EC2B application is difficult to determine.

4.1.3 Encouragement of Sustainable Travel Modes

According to the implementation plan of IRIS, it was initially planned to include mobility management elements into the service. Hence, the EC2B experience should be augmented by giving the tenants “[...]personal advice on how to achieve a more sustainable travel pattern” (Lund, 2020, p.9) and including “nudging” features that should steer users towards more sustainable transport modes. Although these specifically named features were not present in practice, other incentives for sustainable transport modes were deployed. The EC2B service motivated people towards PT and installing the EC2B app by giving rebates on PT tickets if they bought them on the app (Interview 2, Interview 3). This reduction in PT costs stimulated walking to the closest bus stop and taking the bus, instead of using their own vehicles.

Moreover, users were financially incentivized towards using the e-bikes since they were free: “What we have been doing, using the shared bikes was free from the beginning, whereas the car-sharing obviously had a cost.” (Interview 2, p. 6). Regarding the lack of parking space, the tenants were more inclined to use the transport infrastructure, provided by EC2B than their private car parked in the distance. One interviewee emphasized the importance of the spatial proximity of the MaaS service by saying that “if you have good opportunities to use other means of transport than your private car from where you live, that is a good place to kind of nudge the users to choose other means of transport.” (Interview 2, p. 4).

The EC2B pilot contributed indirectly to developing environmental conscience in mobility. The tenants could participate in seminars and introductory events about the EC2B service and were offered a consultation talk (Interview 2). Even though they did not precisely aim at advertising the vehicles with the lowest carbon footprint, they showed them all the different transport options to get them acquainted with this new transport sharing system.

Also, the EC2B application developers were hesitant to build a feature into the app that favors more sustainable forms of transport over others. By encouraging the customers to use one specific mobility option over another one, it can be problematic for stakeholder relations: “[...]I think if we would kind of encourage the tenants to use the bike-sharing facility more than the car-sharing facility, for example, that wouldn't be appreciated by the car-sharing provider.” (Interview 2, p. 6). Furthermore, Sweden's cold and icy weather conditions made it challenging to promote the use of bikes in the winter (Interview 1).

4.1.4 Total Trips

The number of trips has not been measured and compared to the average of people living in the same area, hence, so there is no empirical data available (Interview 1). However, observational and anecdotal evidence from the tenants implies that the manner of using the car has changed benefitting the environment. The number of short and spontaneous trips seems to have lessened because of the lack of residential parking space. Due to the increased reluctance to using their private car by having to go outside the house, some tenants combined their trips and errands into one trip: “So, instead of running one errand, they combined that into perhaps three different ones.” (Interview 4, p. 5). Also, the people who kept their cars would not use them every day, but “[...] they would go once a week maybe, to do all the different errands that the needed to do with the car at once.” (Interview 2, p. 5). Thus, through the consolidation of different trips into one trip, the number of total trips appears to have been reduced after the move to Brf Viva.

4.1.5 Emissions

The EC2B demonstrator specifically aimed to reduce emissions by rolling out electric vehicles (Lund, 2020). All interviewees reported CO_2 savings with the introduction of EC2B. Approximately 64 tons of CO2 emissions per year have been reduced since the mobility project started in 2018 (Interview 1). This calculation was based on replacing km driven in fossil-fuel cars with the electric car-sharing provided by EC2B (Interview 2).

A critical finding during the CO_2 calculations for the IRIS project was “that the main part of the projects' reduction of carbon dioxide, did not come from the shifting of car trips from conventional cars to e-cars, but rather from the change in transport pattern that people would travel less by car compared to the average for Gothenburg.” (Interview 2, p. 7). Additionally, the cars were charged with PV electricity during the day, which created additional positive environmental impacts (Interview 1). The positive environmental impact on emissions was enhanced by the station-based nature of EC2B (Interview 2).

4.1.6 Congestion

The results are mixed regarding the traffic congestion component, including road, vehicle, and land use. The initial idea of combining a property actor and a shared mobility service to create a carless housing concept presented a case for more efficient land use. The tenants were provided with the opportunity to use a car while saving parking spaces, which contributes to enhanced resource efficiency (Interview 2). Indeed, the EC2B solution positively impacted the traffic in the street and neighborhood of the Brf Viva houses (Interview 4). However, due to the small size of the EC2B pilot, it is difficult to determine if it has influenced the traffic in Gothenburg (Interview 4).

Furthermore, one interviewee pointed to the reverse effects of EC2B on congestion due to the occupancy of parking spaces in the neighborhood by people who kept their cars. Another issue that appeared to be causing negative effects on land use was the frequent use of home delivery services, which created a queue of vehicles in front of the houses: „So, I've seen at least two photos of when there was a queue of delivery vans outside the building." (Interview 4, p. 6).

4.2 Social sustainability of EC2B

The social benefits of EC2B that were mentioned by the interviewees include (1) improved accessibility, (2) more affordable transport options and (3) increased comfort and convenience. The extent of the positive impacts on the user depended on the target group definition and personal perception.

4.2.1 Accessibility

Overall, every individual living in the Brf Viva apartments is guaranteed access to the EC2B service, which forms the project's target group. The shift from an ownership-based to an access-based transportation system is underpinned by describing EC2B as a tool "[...] to a carefree mobility without the need to own a car." (Lund, 2020, p.3). All interviewees reported that, especially people who didn't own a car previously, benefitted more from the service as their mobility has substantially improved with the introduction of EC2B. Further, EC2B provided the tenants with new ways of complementing the PT system, enabling them to choose a tailored mobility option for their needs. While the e-bikes were suitable for everyday commuting to work and other activities, the cargo bikes were convenient for running errands, whereas the e-moped and the e-cars were more fun to drive (Interview 4). However, the accessibility benefits depended on the person asked. For instance, the EC2B concept worsened the perceived accessibility for the people who owned a car since they needed to find parking spaces outside their apartments (Interview 4).

When asked about the degree of accessibility for vulnerable groups, such as the elderly or mobility impaired groups, the statements varied among the interviewees. Generally, the interviewees lacked information about other residents to to provide realistic and helpful information. One interviewee noted that the access to mobility options for people with disabilities and the elderly has improved with EC2B due to the proximity to their houses (Interview 3). Another interviewee mentioned that the EC2B service provides parking for people with special permits but was not aware informed if any residents used these spaces (Interview 4).

Furthermore, the elderly encountered several obstacles that adversely affected their adaption to the EC2B service. They used the mobility service to a lesser degree due to several reasons: they were not comfortable with using the new e-cars or e-bikes, for instance, they did not have the digital capabilities for downloading the different apps, and they were overwhelmed by the different ways of registering for the services (Interview 4). These entry barriers were especially a hindrance to accessibility for older tenants. Next, one of the student residents was excluded from the car-sharing service due to his insufficient credit score (Interview 4). Therefore, while the accessibility to mobility options improved for most people, in some specific cases for the elderly and student experienced certain drawbacks in their accessibility.

4.2.2 Affordability

The use of EC2B should be stimulated by financing of the service for a period by the property developer Riksbyggen (Lund, 2020). One interviewee supported this proposition by noting that the application was less costly during the initial months (Interview 1). Most interviewees generally viewed the EC2B service as a more affordable alternative to owning a car. Initially, the implementers compared the cost of owning a vehicle and the cost of using EC2B to demonstrate the new service's cost-saving options (Interview 2). Next to the km driven and the gas prices, the hidden costs of car ownership were listed, including "[...] the cost of parking, the insurance, the value degradation of the car and so on." emphasizing advantage and the ease of EC2B (Interview 2, p. 9). However, a comprehensive analysis, including a financial comparison by the tenants, has not been carried out yet.

One noteworthy remark was made about the motive of using EC2B: the interviewee explained that the "[...]people who can afford to live in that building can afford to have a car if they want." (Interview 1, p. 7). Instead of seeing the EC2B service from an affordability perspective, they viewed it from an environmental point of view, wanting to consciously make a change towards more sustainability. Another interviewee had a diverging view on the cost aspect of EC2B, stating that "[...]the cars are quite expensive to use." (p. 8) but ambivalently mentioning the affordability of the free e-bikes, moped, and PT tickets (Interview 4). Thus, the affordability is dependend on the mode of transport the tenants regularly choose.

4.2.3 Comfort and Convenience

During various stages of the implementation process of EC2B, both the real estate developer and the transport consultancy displayed outstanding commitment to engaging with the future users of the mobility service, and in turn, regularly exchanged information with them. Trivector Traffic conducted orientation workshops and seminars for the tenants regarding this service prior to and after they had moved into the apartments (Interview 3). Additionally, feedback was collected from the potential users at these informational gatherings to improve the service and help achieve hassle-free mobility (Lund, 2020). The tenants were offered personal traveling counseling sessions and the representatives of the different mobility providers were present in some meetings to explain the practical aspects of the models and answer questions. . As a result, the tenants were already familiar with the EC2B system when they moved into their new houses, which greatly enhanced their user experience.

Furthermore, the EC2B composition of vehicles was updated several times and tailored to match the needs of the end users. For instance, they tested the three-wheeled electric moped for a while and eliminated it from service due to lower-than-expected usage rates (Interview 3). The customer satisfaction status was monitored through follow up questionnaires and it was observed that users generally enjoyed using the service (Interview 2). Also, the housing developer regularly checked in on the users' experiences with the service (Interview 3). Overall, all stakeholders were invested in responding to the customers' needs and trying to improve the service whenever possible.

A few interviewees argued that the onboarding process was complicated due various applications required, separate passwords for car-sharing and the EC2B app, as well as diverging registration requirements. Since the e-car sharing was not integrated in time into the EC2B app, it posed inconveniences for the users (Interview 2). Additionally, the applications were only available in Swedish, which was a disadvantage for people who did not speak the language (Interview 4).

4.3 Economic sustainability of EC2B

The data shows that there are a few positive economic effects of EC2B, including the (1) generation of new customers for the service, and limited (2) revenue growth tendencies depending on the stakeholder perspective.

4.3.1 Customer Generation

As reported in the implementation document, the EC2B service generated 125 new customers following its introduction in Brf Viva (Lund, 2020). Regarding the total number of 132 apartments in Brf Viva and an estimate of 200 tenants, the number of people reached by the project is considered satisfactory. As part of the IRIS project, EC2B aimed to help mobility service providers to attract new customers and reach into an affluent market (Lund, 2020). More tenants were incentivized to use the platform once the collaboration with the Public Transport Company Västtrafik was integrated into the service (Interview 2). Further, due to the pilot nature and building-limited concept of the EC2B model, acquiring new customers additional new customers has been challenging. Therefore, an implication for future planning could be a neighborhood based EC2B project to reach a bigger market and a more extensive customer population (Interview 2).

4.3.2 Revenue Growth

The delivery of economic benefits for transportation providers in terms of revenue growth is limited. One interviewee stated that "it is difficult to construct a service that creates economic benefits" (p. 11) and to get the MaaS services running (Interview 2). Regarding the costs of developing and maintaining a mobility platform, in combination with the low margins of transport providers, the financial returns are limited in theory (Lund, 2020). Due to the few PT tickets sold through the platform, another interviewee reckoned that the EC2B service did not provide direct revenue for mobility service providers, but indirectly provided value for their brands (Interview 4). The primary focus of the EC2B demonstration was to balance the different needs of the actors involved, designing a business model that simultaneously satisfied end-users, property actors, and transport service providers (Lund, 2020). Interestingly, one interviewee referred to the potential negative impact on car companies caused by EC2B (Interview 3).

One indication of the economic potential of the EC2B model was the founding of Trivector's sister company "Easy to Be Mobility" during the project. The transport consultancy is also working on another EC2B project in Lund and has secured additional contractual agreements with other property actors (Interview 2). At the start of the project, Trivector was a small-sized company and subsequently grew as the project progressed (Interview 2). Furthermore, property developers of entire areas are showing increased interest for the EC2B model (Lund, 2020). Even though the EC2B pilot has been organized with people already employed at Trivector, the scaling up of the project in the future offers new job prospects (Interview 3). Thereby, the local economy could benefit in the future by replicating EC2B projects involving multiple stakeholders to participate in the business model design.

Given the pilot nature of EC2B and its categorization as an innovation project, it is difficult to realize any economic growth tendencies during the trial period: "I think that the two small demonstrations are too small to have an effect from the local economy perspective." (Interview 3, p. 11). The real estate developer attained the biggest financial gains and avoided significant costs by providing an alternative to expensive car parking (Interview 2). It is important to note that the economic advantages for the property actor were directly related to the agreement with the municipality (e.g., waiving the cost for parking spaces), while the EC2B project played a minor role.

5 Discussion

This chapter places the results from the analysis into the sustainability evaluation criteria from the theory chapter. The comparison between the empirical observations of EC2B and the literature serves to answer the third sub-question: *"How does the EC2B pilot perform as a smart and sustainable mobility solution?".* The question of whether the EC2B model fulfills the requirements of a sustainable mobility solution can be provided by contrasting the findings of the analysis with the sustainability benefits of MaaS solutions presented in the theory section (2.3).

Within the theoretical framework, the sustainable mobility criteria were broken down into three dimensions: environmental, social, and economic sustainability. The potential contribution of MaaS models in meeting these sustainability objectives was described and tested empirically. Concerning the environmental sustainability benefits of the EC2B pilot, all findings are consistent with the theory. The case study results confirm that during the project period: 1. car ownership among users has significantly been reduced, 2. most tenants have adapted their travel behavior to using more sustainable modes of transport, 3. the number of km driven, as well as the number of trips has decreased, 4. the CO_2 emissions were lessened, and lastly 5. the project partially contributed to more efficient land use. Therefore, these results suggest that EC2B successfully fulfilled all criteria within the environmental sustainability pillar by reducing the environmental harm of the mobility system.

The analysis also reveals that the progress towards sustainable mobility and the tenant's willingness in experimenting with new mobility service is not solely linked to the single EC2B case, but rather to a combination of factors. The project findings stand in conjunction with other sustainability-enhancing factors, including the flexible parking norm in Gothenburg and the subsequently reduced parking opportunities in Riksbyggen, the centrality of the apartments, the proximity of PT, and the residents' profiles. Therefore, the EC2B pilot, as the means to sustainable travel along with the scarcity of residential parking and the dense location of residential buildings, has sparked this ecological travel shift. This approach provided new insights into station-based MaaS models.

Regarding the social sustainability impact, the findings mostly align with the theory. As expected, the EC2B service extended mobility opportunities, especially for people who didn't own a car. In theory, all residents were granted access to the service. However, the scope of perceived accessibility differed for vulnerable people. Using the service was challenging for elderly due to the complexity of the system, such as different registration requirements. Also, it is unclear if, and to which extent, mobility-impaired people took advantage of the offer, but they appeared to have received special permits which ensured social equity. In accordance with the sustainability evaluation criteria, the affordability of EC2B was met, although this was not the main incentive for deploying the EC2B service in the first place. Generally, the users were satisfied with the EC2B pilot, especially given the efforts invested in the extensive informational meetings and user dialogue. One aspect that reduced the residents' convenience was the complex onboarding process at the beginning of the pilot. As a result, the individual was placed in the center of the mobility frame with some exceptions being elderly who encountered procedural difficulties of using the service.

Due to the nature and modest scope of the EC2B demonstrator, the findings for the economic impact area were scarce. The introduction of the EC2B project to a new segment of potential customers generated new users for the platform. Since the case study is a pilot project, my research cannot support the direct revenue growth for the different transportation providers by the MaaS program. During the short time frame of the EC2B project, the economic advantages for transportation companies were limited. Instead, the harmonious relationship among the different stakeholders, as well as the balancing of interests of all parties, was prioritized in order to establish a reliable foundation for scaling up the project in the future. The EC2B model promises economic potential, especially because of its current and future replication stages and growing interest by property developers. Overall, these results indicate that the EC2B projects' primary focus was directed towards the environmental sustainability aspects, compared to the economic outputs it can generate.

By successfully fulfilling most of the criteria of sustainable mobility suggested in the theory, the EC2B service performs well as a smart and sustainable mobility solution. The economic shortcomings are mostly related to the small size of the project.

Table 2. Summary of main results

Sustainability Dimension	Results of EC2B
Environmental Sustainability	• Reduction in car ownership among residents • Shift in travel behavior to using more sustainable transport options • Reduction of the number of km driven in fossil-fuel cars • Lessened CO_2 emissions • More efficient land use due to less vehicles in circulation
Social Sustainability	• Extended mobility ecosystem increasing the accessibility in urban transport • Increased affordability compared to private car ownership • Extensive support services
Economic Sustainability	• Customers generation • Business model development with multiple stakeholders • High economic growth potential

6 Conclusion

The conclusion section is divided into five sub-sections in order to systematically answer the research question. First, I am summarizing the findings of the empirical part. Second, I lay down the limitations that the thesis faces. Third, potential avenues for further research are being presented. Fourth and last, I discuss the implications of this thesis' findings with regards to policymakers and governance.

6.1 Answer to the Research Question

In this study, I have discussed the role of the smart mobility solution of Mobility-as-a-Service in achieving sustainable mobility goals. The study aimed at (1) identifying objectives thereof and the ways in which they can generate sustainable mobility outcomes. Thereafter, I have analyzed the MaaS project in Gothenburg using in-depth interviews and an implementation document to (2) determine their environmental, social, and economic benefits. Lastly, the findings were used to (3) evaluate the performance of Easy to Be (EC2B) as a smart and sustainable mobility solution.

The intelligent EC2B demonstrator in Gothenburg was proposed as a MaaS model that can potentially fulfill several sustainable mobility criteria. Thereby, the study set out to determine *in what ways the EC2B project of the IRIS program in Gothenburg can contribute to sustainable mobility.* By collecting data and analyzing the in-depth interviews on the case study, the overarching research question can be answered. The empirical findings indicate that the EC2B outcomes in the Brf Viva house complex align with the three-fold sustainable mobility criteria which I have used throughout the research findings. Next, the extent of benefits created depend on the sustainability dimension. While the project's main aim is drawn to the environmental benefits, the results show that the EC2B solution also fulfills other factors of sustainable mobility.

By comparing the implementation outcomes of EC2B to the sustainability evaluation criteria, the study has shown that EC2B can contribute to sustainable mobility in several ways. First, the EC2B creates environmental benefits including the reduction of car ownership, a modal shift to sustainable travel, the reduction of trips by car, CO_2 emission savings and last, more efficient land use. As a result, the EC2B project decreases the negative impact of urban mobility on the environment. Second, the EC2B pilot creates social benefits by increasing the accessibility to various transport options, providing a more affordable transport service compared to private car ownership and offering support functions including workshops, introduction meetings and on-demand assistance to attend to the customers' needs. These benefits ensure equal transportation opportunities, which are consumer-focused. Third, EC2B also generates a couple of economic benefits by attracting new customers to the mobility service and developing the business model with multiple stakeholders. Even though, the economic scope is limited due to the pilot stage of EC2B, the potential for scaling up and replicating the model in other areas, thus creating economic growth appears promising.

The present study extends the knowledge about the practical implications of MaaS models in many ways. First, the explorative research design in conjunction with the in-depth interviews allow for a detailed analysis on the sustainability aspects of EC2B. Much of the existing MaaS literature has examined the theoretical opportunities and the technological dimension of the intelligent mobility solution. So far, scholarly work on the sustainability of MaaS was presented from a general view while neglecting the collection of empirical evidence. In capturing the emerging phenomenon of MaaS in urban mobility from a sustainable mobility perspective with a detailed case-study, I have addressed this research gap and added to the body of knowledge on the MaaS concept.

6.2 Limitations of Research

Regarding the limitations of my research, the thesis is subject to methodological constraints. Due to the qualitative nature and single-case study design the findings are not generalizable to other MaaS models targeting the wider population. The EC2B case is atypical, given the project's uniqueness. The EC2B project received generous EU funding and targeted a very specific customer segment. Hence, the findings only provide indications, transferability and could serve as starting points for further research.

Additionally, the study faced data constraints. Since the EC2B project is still piloting, the evaluation reports that have been produced are scarce. Due to the lack of a final evaluation report, my findings were supported by a monitoring document created halfway through the project. Connected to this, the data collected by the private transportation consultancy on parameters such as bookings, chosen transport modes, and customer satisfaction, were unfortunately not available for the wider public. Therefore, my findings, being based on assumptions and general impressions from experts could deviate from the final evaluation report on the project.

Last, the thesis was limited by the sample of interviewees. Given that I had to obey the GDPR rules, I was not able to interview the residents of Brf Viva who actually *used* the service. Therefore, my report is based on what my interviewees' observations about the tenants, which – quite naturally – is limited due to the subjective and personal views of them. In addition, I was not able to interview a person from the property developer agency with whom I could have explored the economic dimension of the project in more detail. Therefore, the findings could be sharpened by conducting interviews with further experts of the topic, such as the tenants of Brf Viva, and persons from Riksbyggen. Nevertheless, given the infancy of research on the topic at hand, the interviews presented and analyzed in this thesis are an original and significant contribution to the scholarly community.

6.3 Recommendations for Further Research

Further research could apply other data collection methods to explore the relationship between MaaS models and sustainable mobility. For instance, a quantitative analysis on the environmental impact of MaaS could be interesting to strengthen the empirical validity of the qualitative results. In addition, a comparative case study research on the EC2B case and another MaaS initiative could contrast the sustainability performance and assess which factors enhance and which limit the sustainability results. Also, a study on the social implications of MaaS schemes could significantly contribute to the MaaS literature. The research could employ focus groups and create surveys for users to gain in-depth knowledge about the accessibility, affordability, and customer satisfaction. Given the homogenous group of residents in the Brf Viva setting, it would be valuable to explore the social equity perspective to these transport innovations for a heterogenous constellation of people that differ in their demographic characteristics, income levels and gender, for instance.

6.4 Implications for Policy Makers and Governance

Smart Mobility is currently receiving increasing attention both from the public sector and private transport agents. The evidence from this study suggests policymakers and public administrators to take a closer look at Mobility-as-a-Service initiatives and incorporate them in their urban mobility planning process. The value propositions of MaaS for cities include sustainable low-carbon mobility and the reduced use of private cars, for instance. These could help solving the cities' urban densification problems. The innovative mobility concept could initiate a paradigm change in travel – from traditional and environmentally harmful mobility to a sustainable mobility option – thus fulfilling the paramount objective of sustainable development. From a business perspective, municipalities could encourage the replication of MaaS models by providing facilitating conditions for their implementation such as flexible parking policies and distributing financial grants. From a consumer perspective, public administrators could establish favorable settings for the adaption of MaaS such as financial incentives. At a practical level, this study calls for the development of more MaaS initiatives and appeals to governance practitioners to encourage the use of these innovative and sustainable mobility solutions.

References

Babbie, E. R. (2013). *The practice of social research* (13th edt.). Wadsworth: Cengage Learning.

Banister, D. (2008). The sustainable mobility paradigm. *Transport policy*, *15*(2), 73-80.

Benevolo, C., Dameri, R. P., & D'auria, B. (2016). Smart mobility in smart city. In *Empowering organizations* (pp. 13-28). Springer, Cham.

Campos, V. B. G., Ramos, R. A. R., & de Miranda e Silva Correia, D. (2009). Multi-criteria analysis procedure for sustainable mobility evaluation in urban areas. *Journal of Advanced Transportation*, *43*(4), 371-390.

Cruz, C. O., & Sarmento, J. M. (2020). "Mobility as a service" platforms: A critical path towards increasing the sustainability of transportation systems. *Sustainability*, *12*(16), 6368.

ERTICO (2019) – ITS Europe (editor), Mobility as a Service (MaaS) and Sustainable Urban Mobility Planning

European Commission (2017). *Integrated and Replicable Solutions for Co-Creation in Sustainable Cities: Reporting*. Retrieved April 23, 2022, from https://cordis.europa.eu/project/id/774199

European Commission (EC). . (2020). *Sustainable and Smart Mobility Strategy—Putting European Transport On Track for the Future*. Retrieved June 28, 2022, from https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX%3A52020DC0789

European Commission. (2022). *Horizon 2020: What Is Horizon 2020*. European Commission. Retrieved June 28, 2022, from https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls_en

George, A. L., & Bennett, A. (2005). Case studies and theory development in the social sciences. MIT Press.

Gerring, J. (2004). What is a case study and what is it good for? American Political Science Review, 98(2), 341–354. https://doi.org/10.1017/S0003055404001182

Giesecke, R., Surakka, T., & Hakonen, M. (2016, April). Conceptualising mobility as a service. In *2016 eleventh international conference on Ecological Vehicles and Renewable Energies (EVER)* (pp. 1-11). IEEE.

Gillis, D., Semanjski, I., & Lauwers, D. (2016). How to monitor sustainable mobility in cities? Literature review in the frame of creating a set of sustainable mobility indicators. *Sustainability*, 8(1), 29.

Hietanen, S. (2014). Mobility as a Service. *the new transport model*, *12*(2), 2-4.

IMCG. (2020). *EU-Project: IRIS. Innovation Management and Market Impact for IRIS*; Impact Management Consulting Group (IMCG): Retrieved June 28, 2022, from https://imcginternational.com/en/project/eu-project-iris/

Jain, D., & Tiwari, G. (2017). Sustainable mobility indicators for Indian cities: Selection methodology and application. *Ecological Indicators*, *79*, 310-322.

Jittrapirom, P., Caiati, V., Feneri, A. M., Ebrahimigharehbaghi, S., Alonso González, M. J., & Narayan, J. (2017). Mobility as a service: A critical review of definitions, assessments of schemes, and key challenges.

Kamargianni, M., & Matyas, M. (2017). The business ecosystem of mobility-as-a-service. In *transportation research board* (Vol. 96). Transportation Research Board.

Karlsson, M., Sochor, J., Aapaoja, A., Eckhardt, J., & König, D. (2017). Deliverable 4-Impact Assessment: MAASiFiE project funded by CEDR. Conference of European Directors of Roads (CEDR).

König, D., Eckhardt, J., Aapaoja, A., Sochor, J. & Karlsson, M. (2016). *Business and operator models for Mobility as a Service (MaaS)* (Deliverable 3 to the MAASiFiE project). Brussels: Belgium.

Koźlak, A., & Pawłowska, B. (2019). Mobility-as-a-Service for improving mobility in smart cities–a comparative analysis of selected cities. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, *63*(10), 31-46.

Lund, E. (2020). *Deliverable 7.5. Launch of T.T. #3 Activities on Smart e-mobility (Gothenburg)*. IRIS—Integrated and Replicable Solutions for Co-Creation in Sustainable Cities. Horizon 2020 Research and Innovation Program. https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5cafae463&appId=PPGMS

Lyons, G. (2018). Getting smart about urban mobility–aligning the paradigms of smart and sustainable. *Transportation Research Part A: Policy and Practice*, *115*, 4-14.

MaaS Alliance. (2017). MaaS Alliance White Paper: Guidelines & Recommendations to create the foundations for a thriving MaaS Ecosystem. Retrieved May 10, 2022 from https://maasalliance.eu/library/

Mayring, P., & Fenzl, T. (2019). Handbuch Methoden der empirischen Sozialforschung. In *Handbuch Methoden der empirischen Sozialforschung*. Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-21308-4

Mola, L., Berger, Q., Haavisto, K., & Soscia, I. (2020). Mobility as a service: An exploratory study of consumer mobility behavior. *Sustainability*, *12*(19), 8210.

Paiva, S., Ahad, M. A., Tripathi, G., Feroz, N., & Casalino, G. (2021). Enabling technologies for urban smart mobility: Recent trends, opportunities and challenges. *Sensors*, *21*(6), 2143.

Papa, E., & Lauwers, D. (2015). Smart mobility: Opportunity or threat to innovate places and cities. In *20th international conference on urban planning and regional development in the information society (REAL CORP 2015)* (pp. 543-550).

Qu, M., Yu, S., & Yu, M. (2017). An improved approach to evaluate car sharing options. *Ecological indicators*, 72, 686-702.

Robson, C. (2002). Real world research: A resource for social scientists and practitioner-researchers. Wiley-Blackwell.

Sarasini, S., Sochor, J., & Arby, H. (2017). What characterises a sustainable MaaS business model. In *1st international conference on Mobility as a Service (ICOMaaS), Tampere* (pp. 28-29).

Sochor, J., Karlsson, I. M., & Strömberg, H. (2016). Trying out mobility as a service: Experiences from a field trial and implications for understanding demand. *Transportation Research Record*, *2542*(1), 57-64.

Sochor, J., Arby, H., Karlsson, M., 2017. The topology of Mobility as a Service: A tool for understanding effects on business and society, user behavior, and technical requirements, in: 24th World Congress on Intelligent Transportation Systems. Montreal.

Sochor, J., Arby, H., Karlsson, I. M., & Sarasini, S. (2018). A topological approach to Mobility as a Service: A proposed tool for understanding requirements and effects, and for aiding the integration of societal goals. *Research in Transportation Business & Management*, *27*, 3-14.

Transport Systems Catapult . (2016). *Mobility as a service - exploring the opportunity for Mobility as a Service in the UK*, Milton Keynes: Transport Systems Catapult. Retrieved June 28, 2022, from https://cp.catapult.org.uk/wp-content/uploads/2021/07/Exploring_the_Opportunity_for_Mobility.pdf

United Nations. (2014). World Urbanization Prospects, 2014 revision, The highlights, United Nations. Department of Economic and Social Affairs (NY).

United Nations. (2018). World Urbanization Prospects 2018, The highlights. Retrieved May 10, 2022, from https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/undes_pd_2020_popfacts_urbanization_policies.pdf

Utriainen, R., & Pöllänen, M. (2018). Review on mobility as a service in scientific publications. *Research in Transportation Business & Management*, *27,* 15-23.

WBCSD. (2013). *Sustainable mobility 2.0 Project - WBCSD*. Retrieved June 28, 2022, from https://www.cbcsd.cz/wp-content/uploads/2015/06/WBCSD-2013-LD-Meeting-Update-Sustainable-Mobility-2.0.pdf

Wittstock, R., & Teuteberg, F. (2019). Sustainability impacts of mobility as a service: A scoping study for technology assessment. *Progress in Life Cycle Assessment 2018*, 61-74.

Zawieska, J., & Pieriegud, J. (2018). Smart city as a tool for sustainable mobility and transport decarbonisation. Transport Policy, 63, 39-50.

Appendix

A. Overview of the Interviews

Interview	Respondents	Position	Date	Length
Interview 1	Interviewee 1	Researcher at RISE institute	23.05.2022	01:01:24
Interview 2	Interviewee 2	Employee at Trivector	24.05.2022	00:56:45
Interview 3	Interviewee 3	Employee at Johanneberg Science Park	08.06.2022	00:57:49
Interview 4	Interviewee 4	Researcher at RISE institute	14.06.2022	00:39:41

B. Interview Guideline

Introduction

1. What is your position within the IRIS Smart Cities program and what is your connection to the EC2B Mobility-as-a-Service pilot in Gothenburg?
2. Can you tell me something about the origin of the IRIS Smart Cities progam? So, in general: Why did Gothenburg decide to join the program and what were their main ambitions and objectives in the start of the project?
3. Who are the main actors/stakeholders within the EC2B project and how do they cooperate?

Environmental impact

4. How does the EC2B model in Gothenburg create environmental benefits? Has the travel behavior of the tenants transformed into a more sustainable travel behavior with the introduction of MaaS?

   4.1 Has the MaaS project introduced any incentives or nudging towards sustainable travel behavior?
5. Does the electric car-sharing solution substitute the private car use of most tenants?
6. Could you observe a reduction in the number of total trips after the introduction of EC2B in Riksbyggen's Brf Viva?
7. It is argued that MaaS can be a pathway for resource efficiency and less congestion. Have you calculated any energy savings and carbon dioxide reduction for EC2B? Also, have you observed improvements in land usage?
8. There is some ambiguity about if MaaS produces negative environmental impacts by facilitating travel, how would you evaluate this statement?

Social impact

9. What are the main advantages of EC2B for the end-users?
10. Has the access to vehicle sharing solutions improved by your project? How were vulnerable people such as elderly of mobility-impaired people respected in planning for a MaaS solution?
11. How would you assess the affordability of EC2B for users?

12. How many people were reached by the project, and did it align with the project's objectives? Have you introduced any incentives throughout the duration of the pilot to reach more people and was it successful?
13. In general, were the residents satisfied with the service? If not, what are the main challenges and hurdles of using MaaS for the people?

Economic impact

14. MaaS is also billed as an innovation opportunity, underpinned by the development of new business models in transport. Which economic benefits has EC2B created so far?
15. To what extent did the MaaS project create local jobs, and do you see further employment opportunities and growth by the service provider?
16. How did the MaaS project perform in generating revenue? Was economic growth an objective of the pilot?

Challenges and Recommendations

17. Which aspect of the EC2B project is given most priority to? Which impact area is the most important one?
18. What were the main challenges in the implementation of the EC2B model and how did you overcome them?
19. What advice would you give to cities who want to implement a similar mobility service? What steps must be taken to successfully create a MaaS platform that attracts a lot of customers?

C. Interview Transcripts

This appendix presents the four interview transcripts. To systematically quote from the transcript, each transcript contains page numbering.

This appendix is handed in with a separate zip file found in the *Data Appendix file*.

D. Codebook

Codegroup	Categories	Explanation/Coding rule	Example	Code
Types of environmental benefits of MaaS	Car ownership	Code if private car ownership of tenants is mentioned	"That means when they moved in, they sold their cars or in general, the whole building has less cars than an average building with the same amount of tenants." (Interview 1)	Env_car
	Modal shift	Code if a change in travel behavior is mentioned	"I think that without having the empirical evidence for it, but drawing on their own perception and statements, I think the tenants, they use public transport more. They use mobility services more, they walk more, they bike more, and they used their cars less after moving to, at least in the beginning when they moved to Brf Viva." (Interview 4)	Env_modal shift
	Sustainable travel modes	Code when discussing encouragement of more sustainable travel modes	"What we have been doing using the shared bikes was free from the beginning, whereas the car sharing obviously had a cost. We also worked during a period with giving a rebate for buying public transport tickets within our app to encourage them to use that." (Interview 2)	Env_sustainable travel modes
	Total trips	Code if trip length or number of trips are mentioned	"So that meant that it was somewhat more of a burden to use the car. Due to this, they told me that they combined more of the car trips." (Interview 4)	Env_trips
	Emissions	Code when discussing any transport related emissions and air pollution	"The demonstrator will contribute directly to the goals of rolling out electric vehicles and reducing transport-based CO2 emissions, and indirectly also to the goal of increasing local air quality." (Lund, 2020)	Env_emissions
	Congestion	Code any factors linked to road congestion including land usage, parking space,	"But I think also the EC2B concept where there is such a clear connection to accommodation in that case, it makes sense that is kind of a station-based car sharing scheme,	Env_congestion

		number of vehicles per passengers, traffic flow	which provides an alternative to having a private car. So that would mean that you still have the opportunity to use a car for the type of errands where you need it. So, in that case, I think it could contribute to more resource efficiency.” (Interview 2)	
Types of social benefits of MaaS	Accessibility	Code if it refers to equity in transport and perceived effects on their access to EC2B	“In general, there are entry barriers to MaaS. You need to have a smartphone. You need to have the digital capabilities. You need to have a credit card.” (Interview 4)	Soc_accessibility
	Affordability	Code when discussing the travel cost per individual/household and cost savings	“So, I would say people who can afford to live in that building can afford to have a car if they want. It's more a choice of them: they want to be more environmentally friendly than thinking they can save money if they don't have their own car.” (Interview 1)	Soc_affordability
	Comfort and convenience	Code if ease of use of the system, user experience and customer satisfaction are mentioned	“They have been very active and always try to develop the application further. So, it would be very easy to use and they have had regular information meetings with the tenants as well when needed.” (Interview 3)	Soc_comfort
Types of economic benefits of MaaS	New customers	Code when discussing new customer for transport sharing providers and public transport providers	“For mobility service providers, it might attract new customers. The driver is thus a potential value proposition for all involved parties.” (Lund, 2020)	Ec_new customers
	Revenue growth	Code when discussing revenue growth, value creation and return on investment for MaaS providers and other involved stakeholders	“I think that the two small demonstrations are too small to have an effect from the local economy perspective.” (Interview 3)	Ec_revenue

Case Details	Recommendations	Code if advice and drivers for MaaS implementation are mentioned	"I think the most important point for me is that you should implement it in an area where people are willing to change their behaviour, maybe due to environmental factors. Because they want to travel more environmentally friendly, but they don't maybe want to reduce their convenience." (Interview 1)	MaaS_recommendations
	Challenges	Code if barriers and burden of MaaS implementation are mentioned	"I know, for example, it was a bit difficult to implement the service from Västtrafik into the application. In the end it did function so well. Of course, there are always technical challenges." (Interview 3)	MaaS_challenges