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OF ICELAND**

**Master Thesis
in Environment and Natural Resources**

Sustainable Public Transport in Iceland
Drivers and Barriers

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This thesis is equivalent to 60 ECTS towards an MSc degree in Environment and Natural Resources at the Faculty of Business Administration, School of Social Sciences, University of Iceland.

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Preface

The thesis is equivalent to 60 ECTS towards an MSc in the Environment and Natural Resources Program from the Faculty of Business Administration at the University of Iceland. The thesis was written under the supervision of Professor Lára Jóhannsdóttir, the current academic director of the Environment and Natural Resources Graduate Programme, and Mauricio Latapí, Assistant Professor at the Bisset School of Business at Mount Royal University.

When starting the Environment and Natural Resources Program, I planned on combining the knowledge gained from my previous bachelor's and master's in psychology with a stronger focus on the environment and sustainability. During the program, I learned more about the different aspects of sustainability. For example, after writing a paper on the railway system in Germany, I started to look more into the public transportation sector in Iceland.

I want to express my most profound appreciation to my supervisors, Lára Jóhannsdóttir and Mauricio Latapí, who provided me with not only valuable feedback and advice but also ideas on whom to contact for my interviews. Without their support, completing this thesis would not have been possible. Finally, thanks should go out to everyone who contributed to the thesis, granting me interviews and giving me insightful information. I am also grateful to my friends, who kept me motivated, joined some late-night writing sessions in Askja, and gave me some insightful suggestions when needed. Finally, a special thanks goes out to my family for supporting me throughout.

Abstract

Transportation is a significant contributor to greenhouse gas (GHG) emissions. One way to decrease these GHG emissions is by increasing public transportation. Therefore, Iceland's capital area needs to expand and make public transportation more sustainable, as most of the population is in this area. This study dives into the drivers and barriers of sustainable public transportation in Iceland, specifically focusing on public transportation companies. The research methods included using the Five C framework to analyze information relevant to three major public transportation businesses, Strætó, Reykjavík Excursions, and Gray Line. Additionally, semi-structured interviews were conducted with eight stakeholders, such as government and city representatives, company representatives, and other organizations involved in public transportation. The results show that there is a diverse set of drivers and barriers. External drivers include political motivation, which drives the sector forward, while internal drivers, such as personal beliefs and motivation, influence companies' sustainability. However, many barriers remain to overcome, especially regarding funding and financial support to upgrade bus fleets and provide renewable energy and zero-emission fuel infrastructure. Furthermore, while there have been some new developments with the so-called Borgarlínan project, there are still technical and economic barriers to consider. All this indicates that the capital area of Iceland has a long way to go to achieve sustainable public transportation. The study gives an overview of the public transportation sector in Iceland, which was previously an understudied topic. Additionally, it highlights the importance of companies to implement sustainable solutions by emphasizing transparency in the case of sustainability and relevant sustainable development goals and key performance indicators.

Keywords: public transportation, bus transport, sustainability, Iceland, barrier, driver, Five C framework

Útdráttur

Samgöngur eru verulegur þáttur í losun gróðurhúsalofttegunda (GHG). Ein leið til að draga úr losun gróðurhúsalofttegunda frá samgöngum er með því að auka almenningssamgöngur. Því þarf höfuðborgarsvæðið að efla og gera almenningssamgöngur sjálfbærari, þar sem flestir íbúar Íslands eru á þessu svæði. Í þessari rannsókn eru svokallaðir hvatar eða drifkraftar og hindranir sjálfbærra almenningssamgangna á Íslandi skoðaðar með sérstakri áherslu á fyrirtæki sem bjóða upp á almenningssamgöngur. Rannsóknaraðferðirnar fólu í sér að nota svokallaðan „Fimm S“ ramma til að greina upplýsingar viðeigandi upplýsingar sem snúa að þremur fyrirtækjum í þessum geira, en það eru Strætó, Reykjavík Excursions og Gray Line. Auk þess voru tekin hálfstöðluð viðtöl við átta mismunandi hagsmunaaðila, en þeir voru frá stjórnvöldum, Reykjavíkurborg, fyrirtækjum sem rannsóknin snýr að sem og stofnunum sem koma að almenningssamgöngum á Íslandi. Niðurstöðurnar sýna að það er hvatar og hindranir eru fjölmargar. Einn af ytri hvötunum er pólitísk hvatning sem knýr allan geirann áfram, en meðal innri hvata má nefna persónulegar skoðanir og áhugi á málefnum hafa áhrif á sjálfbærni fyrirtækja. Aftur á móti eru ýmsar hindranir sem þarf að yfirstíga, sér í lagi varðandi fjármögnun og fjárhagslegan stuðning til að uppfæra strætisvagna- eða rútabílaflota, auk þess sem endurnýjanlega orku þarf að vera til staða sem og viðeigandi innviðir sem stuðla að samdrætti í losun. Jafnframt, þó svo að einhver þróun eigi sér stað varðandi Borgarlínunni þá er enn þörf á takast á við tæknilegar og efnahagslegar hindranir verkefnisins. Allt bendir þetta til þess að höfuðborgarsvæðið eigi enn langt í land með að ná markmiðum um sjálfbærar almenningssamgöngur. Rannsóknin veitir yfirlit yfir almenningssamgöngugeirann á Íslandi, sem áður var vangreint viðfangsefni. Að auki undirstrikar það mikilvægi þess að fyrirtæki innleiði sjálfbærar lausnir með því að leggja áherslu á gagnsæi hvað upplýsingagjöf um sjálfbærni varðar, sem og viðeigandi heimsmarkmið og lykilframmistöðuvísa.

Lykilorð: almenningssamgöngur, strætósamgöngur, sjálfbærni, Ísland, hindrun, hvati, Fimm S rammi

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Abbreviations and Acronyms

AFC	Automated Fare Collection Systems
APC	Automatic Passenger Counter Systems
BEV	Battery Electric Vehicles
BRT	Bus Rapid Transit
CB	Customized Bus
CNG	Compressed Natural Gas
FCHEV	Fuel Cell Hybrid Electric Vehicles
GHG	Greenhouse Gas
GPS	Geographical Positioning Systems
HRV	Hybrid Electric Vehicles
ICE	Internal Combustion Engine
ICT	Information and Communication Technology
ISO	International Organization for Standardization
KPI	Key Performance Indicator
LCA	Life Cycle Assessment
NO _x	Nitrogen Oxides
PAYS	Pay as You Save
PHEV	Plug-in Hybrid Electric Vehicles
SBMI	Sustainable Business Model Innovations
SDG	Sustainable Development Goals
SUV	Sport Utility Vehicles
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
VAT	Value-Added Tax
ZEV	Zero-Emission Vehicle

1. Introduction

With increasing problems related to climate change, i.e., damage to freshwater, increased areas of wildfires, an increase of floods, and displacement of different species, it has become more critical to find solutions to issues such as greenhouse gas (GHG) emissions by finding more sustainable solutions (IPCC, 2022a). This especially goes for transportation, as it is one of the most significant contributors to GHG emissions. Data shows that it contributes 15% of the global direct and indirect GHG emissions (IPCC, 2022b) and continues to increase (IPCC, 2023). A critical step towards reducing emissions was the Kyoto Protocol, first introduced in 1997, an agreement established under the United Nations Framework Convention on Climate Change (UNFCCC). The first commitment period for this was set from 2008 to 2012, aiming to reduce emissions by 5% below the 1990 level of the participating countries by introducing binding emission reduction targets (UNFCCC, 1997). The second commitment period, from 2013 to 2020, aimed at reducing GHG emissions by 18% compared to 1990 levels (UNFCCC, 2012). This was followed by the Paris Agreement in 2015, aimed at limiting the global temperature increase to 1.5% (UNFCCC, 2015). Furthermore, in 2015 the 17 Sustainable Development Goals (SDGs) were developed and adopted by world leaders in 2016. This increased the need for change in the transportation sector with the introduction of Goal 9 (Industry, Innovation, and Infrastructure) and Goal 11 (Sustainable Cities and Communities) (United Nations, 2015).

Since then, there have been many changes in the transportation sector, especially with a focus on transitioning to more sustainable, low-carbon-emitting technologies, such as switching to electric-powered vehicles (Sovacool et al., 2019; Lin & Sovacool, 2020), which is also on the forefront in Iceland in case of energy transition (Keeling, 2020; Lin & Sovacool, 2020). This transition is critical for countries to achieve their decarbonization policy goals. To do this, different aspects are required, including, but not limited to, more developed infrastructure, changes in behaviors, technological changes, and traffic management (Lin & Sovacool, 2020). Related to this is public transportation. It is essential for many cities and countries to reduce their impact on the environment and society,

including reduced GHG emissions, economic efficiency, and equity and fairness (Miller et al., 2016a). Thus, there are many benefits to implementing and improving public transportation, as it can act as an essential driver for sustainability in the transport sector. Moreover, it can engage most of the critical aspects of sustainability, which are the environment, economy, and society (Pei et al., 2010; Miller et al., 2016a).

With a regulation that the European Parliament introduced in 2009 and adopted in 2019 (Directive 2009/33/EC), the hope is to limit GHG emissions, especially in the public transport sector. With the regulation, European countries must replace fuel-powered public bus fleets with more sustainable options, such as electric or hydrogen-powered ones (Brdulak et al., 2020). However, research shows that most European countries cannot completely upgrade their bus fleets until after 2050, with some only reaching the target in 2070 (Brdulak et al., 2020). The European Parliament has recently introduced newer policies, such as the Fit for 55 and REPowerEU initiatives (European Commission, 2021, 2022). With the former, the plan is to reduce the emissions of the EU by 55% by 2030. For the transport sector, this includes the switch to alternative fuels, increased infrastructure, and using green energy for ships and aviation (European Commission, 2021). The REPowerEU initiative also highlights the importance of switching to more sustainable fuels to increase energy efficiency and end dependency on Russian fossil fuels (European Commission, 2022).

More action is needed to align with the new regulations and make relevant changes (Brdulak et al., 2020). This goes especially for Iceland, with data from the European Environmental Agency showing that Iceland had the highest GHG emissions, 37.6 tonnes per capita, in 2020 (Eurostat, 2022). For this reason, investigating the drivers and barriers of sustainable public transport is an essential first step to knowing more about what still needs to be done. Especially public transportation in Iceland is understudied, and diving into the topic provides information on what is still required for the capital area to become more sustainable. For this reason, this will focus on the drivers and barriers to sustainable public transportation in the capital area of Iceland, including an analysis of the operation and activities of different companies involved in public transport.

1.1. Objectives

This research aims to expand the literature and knowledge on sustainable public transportation in Iceland. This is relevant to GHG emission literature, especially considering Iceland. The main objective of this thesis is focusing on, is to determine the drivers and barriers to sustainable public transit in Iceland's capital area.

1.2. Research Questions

Different research questions were developed to guide this thesis, according to the objective mentioned above:

1. What are the drivers of sustainable public transportation in the capital area of Iceland?
2. What are the main barriers to sustainable public transportation in the capital area of Iceland?
3. What are the main drivers that motivate public transportation companies in the capital area of Iceland to become more sustainable?
4. What are the main barriers public transportation companies face in Iceland's capital area to adopting sustainability frameworks?
5. How have public transportation companies in the capital area of Iceland included sustainability in their strategies and daily operations?

To answer these questions, the research draws on interviews with relevant stakeholders, including government representatives, the city authorities, companies, and institutions surrounding transportation in Iceland. Furthermore, secondary data from three businesses are analyzed using the Five C framework (Jóhannsdóttir & McInerney, 2018). This helps get a deeper understanding of the drivers and barriers from a theoretical point of view while also providing a more practical approach for the companies and other stakeholders. Thus, the exploratory nature of the research, especially the interviews, provides a unique insight into the topic and offers an overview of the opinion of the stakeholders involved. This, in turn, will lead to a well-rounded overview by better

understanding the different and most important drivers and barriers that are of relevance.

1.3. Structure of the thesis

The thesis is divided into six chapters. Chapter 1 is the Introduction, which includes an overview of the problem relevant to the study, the research objective and questions, and the structure. This is followed by Chapter 2, the Literature review. This chapter defines essential terms, such as sustainability in transportation and public transportation, to provide some background information. It dives into the evolution of sustainable public transport and how it is in Iceland and then focuses on previous research discussing sustainability in transportation companies. Chapter 3 discusses the research methods employed, the data collection process, and the data analysis. Chapter 4 consists of the results structured around the different research methods used. It shows the outcome of the interviews and determines the important drivers and barriers for public transportation, especially for companies. Chapter 5, Discussion, answers the research question and reflects on the relevant literature. Lastly, Chapter 6, the Conclusion, provides information about the theoretical and practical implications of the study, discusses its limitations, and provides pathways for future studies.

2. Literature review

2.1. Sustainable Transportation

While the term “sustainability” came forth in the late 1980s, previous literature by Manheim (1979) already mentioned the aspect in a holistic view, first indicating that it is not just environmental or technical aspects that can affect the later called sustainable transportation. As such, the term sustainability has been discussed for many years, with different definitions (De Gruyter et al., 2016). Most definitions of sustainable transportation include the three essential aspects of the environment, society, and economy. However, some definitions are more detailed, including aspects of technology or safety (May et al., 2001; Balasubramaniam et al., 2017; Wang, 2019). For example, one definition of sustainable transportation stems from the PROSPECT¹ project (May et al., 2001), which proposed five objectives, including *“liveable streets and neighborhoods; protection of the environment; equity and social inclusion; health and safety; support of a vibrant and efficient economy”* (Castillo et al., 2010, p. 179). A similar definition can be found in Gilbert et al. (2003), who provide an overview of the most critical aspects in detail, stating that sustainable transportation can be separated into three main aspects. First, primary access needs must be met safely, meaning that everybody should equally have access without harming nature or human health, thus highlighting the social aspects (Gilbert et al., 2003; Haghshenas & Vaziri, 2012). Second, sustainable transportation should be affordable, support the economy, operate efficiently, and have different transportation methods available, thus describing the economic aspect (Gilbert et al., 2003; Haghshenas & Vaziri, 2012). Third, Gilbert et al. (2003) state that for transportation to be sustainable, it should limit its emissions and waste while decreasing the use and consumption of non-renewable resources and limiting the use of renewable resources to

¹ PROSPECT stands for Procedures for Recommending Sustainable Planning of European City Transport Systems, which is a deliverable to provide guidance for cities on their transportation strategies (May et al., 2001).

a sustainable level. This also includes reusing and recycling components and reducing production noise and land use. Thus, the last aspect covers the environmental aspects.

Generally, sustainable transportation has been linked to affordability, having limited emissions, and offering direct access to society (Haghshenas & Vaziri, 2012). Current literature investigates different transportation methods to make it more sustainable, such as switching to alternative fuels, such as electricity, biofuels, or hydrogen (Lin & Sovacool, 2020). However, different aspects must be included for transportation to be seen as sustainable. As mentioned above, they can be divided into three significant aspects, environmental, economic, and social elements (Low, 2003; Miller et al., 2016a), also referred to as a “triple bottom line” (Pei et al., 2010; Miller et al., 2016a). Nonetheless, not just these three aspects play an essential role but also road traffic safety and driver/passenger safety (Balasubramaniam et al., 2017; Wang, 2019). A review by Balasubramaniam et al. (2017) showed that while most transportation methods included some of these aspects, no method had all the elements, and the need to increase sustainability in the transport sector, especially public transport, is still there. Furthermore, there are different types of transportation, especially when considering passenger transportation. For example, motorized methods include cars, light trucks, buses, railroads, motorcycles, domestic air transportation, and ferries (Millard-Ball & Schipper, 2011). Then there are also non-motorized transportation modes, such as biking or walking (Martin & Shaheen, 2011).

The importance of having and implementing sustainable transportation has also been highlighted in the United Nations (UN) Sustainable Development Goals, especially goal number 11, which is to “*make cities and human settlements inclusive, safe, resilient and sustainable*” (United Nations, 2015, p. 24). Target 11.2 primarily covers sustainable transportation, focusing on affordable, safe, and expanding public transportation systems by 2030. As such, transportation is also an important aspect and driver for the development of cities, especially in terms of economic and social development (Vuchic, 1999; Miller, 2016a). However, while it may lead to development in these areas, it also comes with challenges. One of the reasons why it is critical to move towards more sustainable options includes the increasing use of individuals vehicles, with research suggesting that the vehicles in the world will have at least doubled from 2003 to 2030,

with significant negative consequences for the climate and energy consumption (Winter & Weidner, 2003; Franzitta et al., 2017). Although the individual use of cars significantly impacts the environment, it is not the only aspect that has an effect, as tourism also plays a role, especially in Iceland (Saviolidis et al., 2021). Although tourism is just one fragment of the transportation sector, research showed that more than half of the emissions from tourism stem from transportation (Pan et al., 2018; Peeters & Dubois, 2010).

Various indicators are used to monitor sustainable transportation (Haghshenas & Vaziri, 2012). These indicators are usually quantitative, with different studies using and identifying various indicators (Castillo & Pitfield, 2010; Miller et al., 2016b; Dobranskyte-Niskota et al., 2007). In the past, sustainable transportation has been mainly focused on the economic aspect, having economic growth, rather than focusing on the social or environmental elements. However, there have been changes (De Gruyter et al., 2016). These changes can also be seen in the literature on sustainability indicators. Previous research shows that the more indicators are used, the more detailed the analysis will be (Miller et al., 2016b; Dobranskyte-Niskota et al., 2007). However, the more indicators used in a study, the harder it is to gather relevant data, as more data is required (De Gruyter et al., 2016).

Multiple studies have identified various indicators (De Gruyter et al., 2016; Castillo & Pitfield, 2010; Miller et al., 2016b), with one review from Dobranskyte-Niskota et al. (2007) describing important indicators that are being used as the base of follow up studies (De Gruyter et al., 2016). The review, which focused on the European Union (EU), identified 55 indicators split into five main categories, including economic, social, environmental, technical and operational, and institutional, used to investigate sustainable transportation across the region. As there are many different indicators, a model can be used to select the right indicators to analyze sustainable transportation, in this case, the Evaluative and Logical Approach to Sustainable Transport Indicator Compilation (ELASTIC) developed by Castillo and Pitfield (2010). With this, indicators can be identified which are most important to the researcher, and the framework allows varying objectives (Castillo & Pitfield, 2010). This is important in the transport sector as different aspects must be considered when considering public transportation versus private cars. The model uses five criteria to evaluate whether an indicator should be used. These criteria include measurability, ease of availability, the speed of when data is

available, how clearly it can be interpreted, and the possibility of isolating transport's impact (Castillo & Pitfield, 2010).

Since 2000, there has been a significant increase in research on sustainable transport. The study by Xianbo Zhao et al. (2020) showed that from the early 2000s until 2009, the number of journal articles on the topic was relatively low, with 9-19 articles published annually. The authors only considered journal articles published in English from the Web of Science database focused on green or sustainable transport or transportation. However, this changed in 2010, with the number increasing to 41 and in 2019 reaching 138 articles. While these numbers are based on a particular research sample, the authors highlighted the growing research. Some of the most discussed topics in the articles were sustainable transport indicators, which assess the sustainability and performance of transport methods (X. Zhao et al., 2020). Additionally, the discussion of policies, stakeholder involvement, environmental impact, travel behavior, strategic planning, new fuels, and public transportation was of importance.

Usually, researchers have separated transportation methods into four main aspects rail, road, air, and maritime transportation, with three primary energy sources typically used, which are fossil fuels, biomass, and renewable energy (Gray et al., 2021). In rail transportation, the past years have focused more on developing new energy sources besides diesel-powered trains as the electrification of the railway system has become more critical. Recent developments have been made with electric and hybrid traction systems, focusing on batteries and hydrogen fuel cells (Polater & Tricoli, 2022). As for aviation, maritime or heavy-duty transportation, different alternative fuel types have been investigated, such as biomass-based fuels, biomethane, or hydrogen-based fuels (Gray et al., 2021). While heavy-duty transportation has fewer barriers to becoming fully electric, long distances can be problematic. There are more difficulties to face in aviation transport, and electric batteries may not even be possible, especially for long-distance flights due to their weight. More sustainable options need to consider their weight and volume. Research indicates that only biofuels or synthetic fuels will be an option in the future (Gray et al., 2021).

When discussing sustainable transportation, especially with a focus on passenger transportation, human behaviors and outside factors can have a significant impact, such

as COVID-19. While it might not be as prominent now as it was in 2020, it still impacted transportation in most places. It affected all three dimensions of sustainable transport, environmental, social, and economic. The impact it had on transportation was immense, with studies reporting a decrease in the activity of 50% and more which was also related to the loss of income for the transportation sector, as many people avoided public transportation (Nundy et al., 2021; Kanda & Kivimaa, 2020; Kamargianni et al., 2022). Furthermore, there was not only a reduction in travel overall, but many people started viewing private cars as more secure, especially people who were not vaccinated (Kanda et al., 2020). Thus, highlighting that the travel behavior of passengers changed because of the pandemic, as was seen with individuals more likely to drive private cars.

Other challenges the transportation sector faced due to COVID-19 included a significant decrease in the use of public transport, with many interviewees mentioning that the fear of contracting the virus was their main reason, which was found in India as well as Sicily (Bishnoi & Suraj, 2020; Campisi et al., 2022). As such, safety measures in public transportation are essential in the future (Bishnoi & Suraj, 2020). Although COVID-19 had many disadvantages, there was also a positive impact on the environment, as coal use and emissions were reduced due to the lockdowns and the lower use of transportation (Nundy et al., 2021). Additionally, it helped implement policies that supported businesses operating in the transportation sector by introducing policies that could improve the financial viability of the operators (Sunio & Mateo-Babiano, 2022). However, whether the measures implemented during and because of COVID-19 will last and for how long is uncertain.

When talking about sustainable passenger transportation, especially road or rail, it is often mentioned in the context of cities, more specifically connected to smart cities or sustainable cities (Zawieska & Pieriegud, 2018). Research shows that if business-as-usual continues, GHG emissions can significantly increase, with one case study on Warsaw showing a potential increase of 42% from transport-related emissions (Zawieska & Pieriegud, 2018). A study by Sharma and Agrawal (2017) investigated different cities across the globe and found that particulate matter (PM) contributes to transportation fatalities as it can affect mental awareness and concentration. While transportation might not be the major contributor to these emissions, it does have an impact. Similar effects were also seen in an OECD study, stating that an increase in PM can decrease labor

productivity (Dechezleprêtre et al., 2019). However, the smart city model has significantly reduced GHGs in the transporting sector. It describes a way for cities to become more sustainable and counteract the problems generated by population growth and industrialization. One aspect of it includes the transportation systems within a city (Sharma & Agrawal, 2017). This is done through the intelligent and efficient use of Information and Communication Technology (ICT) (Zawieska & Pieriegud, 2018). To transition to more sustainable transportation in cities, there is a need for collaboration between technological developments and policies. Thus, the government's support is needed for successful implementation (Goyal & Howlett, 2018).

As such, there is a theoretical and practical relevance. One concept to move transport towards more sustainability is the MaaS concept, also called Mobility as a Service, which can be defined as *“a mobility distribution model in which a customer's major transportation needs are met over one interface and are offered by a service provider”* (Hietanen, 2014, p. 2). MaaS relies heavily on cooperation and collaboration between stakeholders, which can often lead to problems (Karlsson et al., 2016; Maas, 2022) as it involves collaboration between public and private organizations. MaaS moves transportation from being just a physical system towards more digitalization. However, its implementation can be challenging as different business models have been introduced (Cruz & Sarmiento, 2020). To implement these, there are still challenges that must be overcome, with financial support and regulatory issues being part of it.

Additionally, it has been observed that one of the most significant challenges may not be the customers, as previously thought about, but rather various internal challenges within and between companies (Karlsson et al., 2016). With growing transportation and payment options, it is becoming increasingly essential to integrate the different mobility solutions that can help use other options without needing separate tickets, which is what the MaaS solution offers (Cruz & Sarmiento, 2020). However, this requires a high need for cooperation between different operators and industries and might take time to implement fully.

MaaS is a popular option for cities to move towards more sustainable transportation (Russo, 2022). Research on smart cities and MaaS is increasing, and one aspect mentioned often in this context is the prioritization of electrification in transportation (Anthony Jnr. et al., 2020). Another method used in the past to make cities and their

transport system more sustainable is low-emission zones, which offer an opportunity to reduce emissions in densely populated areas (Monforte et al., 2023; PROMOB-e, 2018).

An essential aspect of sustainable transportation and sustainable cities includes road transportation, such as buses, cars, bikes, or e-scooters. Regarding the transition to more sustainable transport in the road sector, the focus lies on electric vehicles, as their market shares are increasing and technology is advancing (Wahid et al., 2021). However, research shows three leading potential technologies becoming prominent in the next few years. The first is hydrogen fuel cell vehicles, likely to become more dominant after 2030, biofuel and electric hybrids, which will be the alternative for the next few years (Köhler et al., 2009; Rivera-González et al., 2020). Additionally, the paper by Köhler et al. (2009) highlights that technological transitions are more likely than lifestyle changes for an efficient and sustainable transition. Some of these vehicles include “*battery electric vehicles (BEVs), hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell hybrid electric vehicles (FCHEVs)*” (Wahid et al., 2021, p. 1). One of the most common options is battery-electric vehicles (BEVs) increasingly relevant as they produce lower carbon emissions than fuel-powered vehicles, especially in countries that use mainly renewable energy sources (Nilsson & Nykvist, 2016). BEVs are and will be, for the next few years, heavily dependent on governance measures to make them more cost-efficient and educate customers (Nilsson & Nykvist, 2016). Since 2021 there has been a drop in new car registration within the EU, except for Vans, Sport Utility Vehicles (SUVs), and BEVs (Monforte et al., 2023). When looking into sustainable transportation, battery-electric and hydrogen-powered vehicles are mainly used in road transportation, with the technology in aviation only being used for short flights of 200 to 800km (Monforte et al., 2023). There are also other options, such as biofuels or fuel cell vehicles, with the former having more political resistance, while the latter seems to become increasingly more essential (Nilsson & Nykvist, 2016; Grahn et al., 2009).

Regarding electric vehicles in Nordic countries, people tend to favor taxes over subsidies, and the policies need to weigh the short-term impact versus the long-term stability (Kester et al., 2022). Additionally, to counteract the problem of the increasing use of privately-owned cars, hydrogen-powered vehicles have been introduced as one option to significantly decrease emissions, which is a viable option for public transportation to become more sustainable (Franzitta et al., 2017).

While electric vehicles are at the forefront of many companies and governments to decrease GHG emissions, hydrogen fuel cell vehicles offer unique features when it comes to zero-emission vehicles, as they have a wider reach of up to 500km and have generally seemed to have a shorter refuel time (Isenstadt & Lutsey, 2017). Isenstadt and Lutsey (2017) showed that many governments globally plan to build more hydrogen infrastructure for road vehicles, including cars and buses, with the EU also introducing the Alternative Fuels Infrastructure Regulation to ensure new infrastructure deployments (European Commission, 2021). However, hydrogen has its downsides, especially regarding its economic aspects, as hydrogen fueling infrastructure is very limited and costly. Additionally, the life cycle of hydrogen production depends on the source of energy used, as the energy production process is where most of the emissions arise (Isenstadt & Lutsey, 2017). However, while the environmental benefits are significant, the economic aspect could be more beneficial, especially as the breakeven time is long for cities or countries that do not already have the needed power plants (Franzitta et al., 2017).

As the hydrogen implementation shows, one barrier sustainable transportation faces is infrastructure or the lack thereof. When switching to more zero-emission vehicles, such as electric vehicles, replacing older vehicles and building the necessary infrastructure is necessary. However, problems can often arise when there is a lack of strategy, struggles to attract investment from the private sector, missing infrastructure standards, insufficient local technical experts, or limited grid capacity due to a lack of early funding (Tankou et al., 2023). Consequently, Tankou et al. (2023) summarize some of the policies and practices that can support infrastructure deployment. First and foremost, they mentioned the importance of developing a detailed strategy that includes an action plan. Similarly, using incentive programs can help with the deployment at the initial stage and then slowly be phased out. These incentives can range from tax reductions to reductions of tariffs on these charging stations. Finally, standardizing the charging station is another important aspect, as it will help make it easier for customers (Tankou et al., 2023).

However, a lot is still needed to fully transition to more sustainable transportation, as studies show that the most dominant regime is still the auto-mobility regime, meaning there is a focus on using cars for transportation (Millard-Ball & Schipper, 2011; Lin & Sovacool, 2020). Moreover, as transportation impacts different aspects of life, it has

additional challenges to overcome. While moving towards more sustainable transport, reducing emissions is emphasized in many articles (Lin & Sovacool, 2020; Litman & Burwell, 2006; Miller et al., 2016a). The literature shows that there are still many obstacles to overcome, the main ones being a lack of consistent frameworks and planning and a shortage of funding (Hickman et al., 2013). These are not the only obstacles to overcome. They also included the environmental (air pollution, noise pollution, water pollution, climate change), social (equity, affordability, community cohesion, aesthetics), and economic dimensions (mobility barriers, consumer cost, traffic congestion, infrastructure costs) (Litman & Burwell, 2006; Miller et al., 2016a). However, there are also outside drivers, including public concern about climate change, new government regulations and policies, and innovations, including electric vehicles, to help move the transition to sustainable transportation along (Geels, 2012).

While there is some indication that the industry is moving towards alternative energy uses, whether the necessary emission cuts are to be fulfilled is still in question. Although different transportation alternatives are available, such as biking, walking, or using public transportation, governments need to implement car-restraining policies, change the behavior of the passengers, and implement better innovation strategies for the public transport sector (Geels, 2012). Whereas this was the case in 2012, there has been some change, especially regarding innovations in the public transport sector. However, there is still a need for change to fully transition to sustainable transportation and cut emissions as proposed and planned by the different governments (United Nations, 2015; Brdulak et al., 2020).

2.2. Public Transportation

Public transportation is generally seen as a public good (Agaton et al., 2020) and an essential factor in increasing sustainability in transportation (Miller et al., 2016a). The literature shows that promoting public transportation within the EU is a crucial contributor to reducing the environmental impact, noise levels, and reduction of traffic accidents (Minelgaité et al., 2020). However, as of now, the use of public transportation is relatively low, with many people still not using the available options, and research even indicates that within wealthier EU nations, people are less inclined to use public transportation, which may be related to the higher availability to private cars (Minelgaité

et al., 2020). According to the study, this goes for most wealthier EU nations, with the highest usage among those countries being in Austria. Additionally, the research by Minelgaitė et al. (2020) showed that people generally have lower satisfaction with ticket prices, making the public less interested in using them. Thus, lowering the costs may increase the attractiveness of public transportation.

Different factors are essential for efficient public transportation, especially collaboration between various organizations and stakeholders (Hrelja et al., 2016). Research on cooperation in public transport is limited but can be defined as *“the attempt to overcome problems by collective action and to change a situation in which the parties would otherwise act independently into a situation where they act together to achieve shared objective”* (Hrelja et al., 2016, p. 8). Thus, trust-building is essential to collaboration, as it can affect the organization and open discussions about the problems where they can be described and objectively shared (Hrelja et al., 2016). Other factors which are needed to have adequate public transportation are the effective use of government subsidies, improved quality of public transit, multimodal coordination, restrictive car policies discouraging the use of cars, advertising and encouraging incentives for busses or making structural changes to the systems (Buehler, 2009; Karlsson et al., 2016), all of which have been shown to increase the use of public transportation methods. Lastly, customer satisfaction is an essential aspect of user loyalty and should be considered and included by operating companies (Le et al., 2020).

Usually, in public transportation, there is a trade-off between operating costs and the service provided to the user (Ibarra-Rojas et al., 2015). While the passengers want to reach their destination as fast as possible, with little waiting time, the operator wants a profitable system (Ibarra-Rojas et al., 2015). The efficiency of the operation of transportation systems can influence the environmental aspect needed for sustainable transportation and increase interaction between individuals and connect communities (Ibarra-Rojas et al., 2015). Over the past years, there have been new developments in public transit, especially relating to the planning and operation, including some new systems such as *“fare-box and Automated Fare Collection Systems (AFC), Automatic Passenger Counter Systems (APC), [...] and Geographical Positioning Systems (GPS)”* (Ibarra-Rojas et al., 2015, p. 39), which have helped both the operators and passengers to make it more efficient.

Other technologies and new ideas to improve public transportation have been introduced recently, including the customized bus (CB) used in China. The bus system is more interactive by using the internet and sharing their travel-demand data (Liu & Ceder, 2015). While this might not be as widely available and developed yet, it does indicate the importance of customer feedback and interaction while also giving an attractive option to passengers to reduce their personal vehicle use. Furthermore, customized transportation methods such as CB have increased in recent years. With, for instance, the use of Uber, individuals can customize where they go. This can, as seen above, be used in public transportation, not just in CB but also with mass-customized buses (Xu et al., 2022). Mass-customized buses have three main features, with the first having less uncertainty, as there is a predetermined pattern that predicts passenger numbers. Second, the routes are designed around individuals' needs, and third, there is more interaction between bus companies and individuals (Xu et al., 2022). Thus, customization in public transportation can make transportation more attractive to customers. Another form of transportation is the bus rapid transit (BRT), which is mainly linked to the use of modern vehicles and increased flexibility (Deng & Nelson, 2013). Additionally, it has been shown that it is a cost-effective and flexible substitute for other public transportation systems.

In addition to new transport systems, there are new developments in the technology used, with the electrification of public transportation playing a vital role in reducing emissions from electric buses, railways, or electric scooters (Guno et al., 2021). Besides electricity, hydrogen has also been used in Chile with great potential, as the country is expected to be the leading producer and exporter of green hydrogen by 2030 (Pettigrew, 2022). This transition has been shown to provide many benefits, not just the reduction of emissions, but it can also positively impact the air quality and involves the energy sector (Dominković et al., 2018). However, there are still challenges that companies must overcome.

Funding is, for instance, integral to public transportation as it can lead to positive economic returns (Litman, 2014). A review by Litman (2014) showed that 18 different funding options are available, including various taxes, fees, tolls, rent, and advertisements. However, while the research discussed other funding options, they did not identify any new cost-effective funding options, instead, Litman (2014) suggested that various funding sources can be used. In many countries, the financing of public

transportation is often aided by governments and the implementation of subsidies, while others, such as in some Spanish cities, fall back on public funding (Jalon et al., 2019). Research also showed that public transportation does not necessarily lack financial resources but an insufficient distribution (Jalon et al., 2019). Additionally, the management of transport companies, whether it is public or privately owned, does not have a significant impact on the financing needs of the companies, instead, the most influential aspect is population density (Jalon et al., 2019).

2.3. Sustainability in Public Bus Transportation

While public transportation entails different modes, such as e-scooter, bicycles, trains, or buses (Oeschger et al., 2020), the thesis mainly focuses on road public transportation, specifically buses. The SDGs highlight the importance of equality and making cities more inclusive, safe, and sustainable, emphasizing the need to improve all these aspects (United Nations, 2015). Public transportation can support the three main sustainability dimensions, namely, social, economic, and environmental. While some of the research on sustainable public transit focuses on the environmental dimension, such as decreasing emissions, the social aspect is often overlooked but can easily be included by making transportation available to people with disabilities (Stjernborg, 2019; Velho et al., 2016).

Research on public transit in cities worldwide identified that while Western developed countries, including Western Europe, North America, and Oceania, have performed better regarding their environmental and social aspects, they still need to improve their system effectiveness and economic indicators. In contrast, Asian and Latin American countries rank lower (De Gruyter et al., 2016). Furthermore, while countries such as China have shown improvements in their environmental sustainability through the use of smart transportation since 2016, the literature indicates that there are still improvements to be made (Wen et al., 2023; Su et al., 2022; C. Zhao et al., 2022). Additionally, the study highlights that the energy performance of the public transportation varies by location, as colder or warmer places need to cool or heat more to make it suitable for humans. Furthermore, it showed a strong need for Western developed countries to improve their economic and system effectiveness (De Gruyter et al., 2016). Moreover, the sustainable public transport sector does not only depend on the country but involves different entities and stakeholders, such as national and local government incentives, customer

preferences, and competitiveness of companies in the transport sector (Sztangret, 2020), making it essential for transportation systems to be tailored to each country or city needs (López et al., 2019).

With the sales of electric vehicles increasing and electric buses having a high growth rate, it is essential to investigate the governmental action and policies that have been presented to help introduce more electric vehicles (PROMOB-e, 2018). A project in Brazil called Energy Efficient Propulsion Systems (PROMOB-e) evaluated public policies on electromobility in public transportation. It is mentioned that first and foremost, there has to be a clear motivation and electromobility introduced, with some of the other key drivers including the lower operating costs that offset, the higher prices to purchase the buses as the electric buses have lower fuel as well as maintenance costs (PROMOB-e, 2018). Additionally, citizens benefit from improved air quality by having lower reduced emissions and noise levels. Furthermore, to help overcome the financial barriers of the investments, the authors suggest using different incentives and financial schemes, with examples ranging from federal financing programs, which can help the operators to purchase electric vehicles, introducing discounted charging options, preferential lane access, exemption from annual fees or tax exemption and subsidies when buying the vehicles (PROMOB-e, 2018). However, policies can not only help limit the financial barrier but are important when incorporating more electric vehicles into the public transportation system. With the PROMOB-e (2018), authors mention the need to have long-term visions for electric vehicles, establishing short- and long-term procurement targets and action plans for different electric vehicles, which can range from buses, cars, trucks, or motorcycles, as well as organizing outreach programs to increase awareness and educate people on the different policies, plans, and technologies used.

Regarding sustainable public transportation, literature has identified different indicators to measure it (Miller et al., 2016b; De Gruyter et al., 2016; Reisi et al., 2014). A review by Miller et al. (2016a) identified four main aspects, including environment, economy, social and system effectiveness. Some of the mentioned sustainability considerations and their related objectives include decreasing energy use per passenger and minimizing the energy consumed per kilometer, increasing system economic efficiency by reducing operating cost, or increasing accessibility on different dimensions (Miller et al., 2016a). Karjalainen and Juhola (2019) proposed the Public Transportation

Sustainability Indicator List (PTSIL), which can be used to assess policies. This list includes indicators of different dimensions: environmental, social, economic, governance, and urban form. Karjalainen and Juhola (2019) showed, using PTSIL, that Canada and Finland already strongly focus on the environmental dimensions, while improvement is still needed in the social dimension. Additionally, it showed that while indicator scores can be high overall, the individual indicators had more variation and were context-specific, thus making it hard to generalize these findings to other cities and countries (Karjalainen & Juhola, 2019).

2.3.1. GESTLE Framework

Previous literature has mentioned some standard constituents of sustainable public transportation. For example, the Political, Economic, Social, Technology, Legal, and Environment framework (PESTEL) is widely used across disciplines. However, research on sustainable transportation proposed a similar framework, specifically when looking into transportation (Dubey & Gunasekaran, 2015). This framework includes similar aspects as PESTLE, namely government policy, economic and social dimensions, technology, legal structure, and environment (GESTLE) (Dubey & Gunasekaran, 2015). The following section investigates each of these aspects.

Government policy

Government policies are a critical aspect when considering sustainable transportation. Especially in public transit, it is not only the business executives that make the decisions, but different ministries are usually involved in the process (Dubey & Gunasekaran, 2015). Additionally, Agaton et al. (2020) mention various ways the government can and should be involved. These aspects include more substantial financial support, such as subsidies or tax benefits, and investing in public infrastructures, such as charging stations, which is becoming more critical. Governments should also include clearer implementations of their policies related to their vehicle fleets and transportation management while helping educate drivers and mechanics on how to handle electric vehicles (Agaton et al., 2020). Furthermore, governments should invest in developing electric vehicles that are locally made to advance the regional economy and increase their investments in mass transportation. Another critical aspect of better adoption of electric vehicles is a

transparent implementation of governmental policies and general governmental support (Agaton et al., 2020), as well as public behavior, as this is one of the critical challenges implementers of MaaS faced (Cruz & Sarmiento, 2020).

Economic

The economic aspect of sustainable public transportation is already seen above, as government investments are significant. However, previous research shows the economic advantages of investing in alternative fuels, with electric public transit at the forefront (Agaton et al., 2020). Even though the investment of changing the public transportation fleets towards more electric-powered buses is expensive, in addition to the costs of replacing batteries, the financial advantages added due to the lowering of operation costs and further environmental benefits due to the use of electric buses outweigh the previously mentioned expenses (Agaton et al., 2020). This reduction of operating costs is also evident in other studies on urban public transport vehicles, in addition to lowered energy consumption when replacing the bus fleet with newer models (Konečný et al., 2020). Furthermore, a life cycle cost analysis (LCC) shows that the economic aspects of diesel versus electric buses depend on the routes and how they are serviced. The authors also highlight that electric buses save the initial higher cost, which decreases with higher usage (Comello et al., 2021). However, the economic aspect is still a significant challenge to sustainable public transportation as financing and financial support are still needed (Agaton et al., 2020; Guno et al., 2021). Thus, finding different ways and options to fund the transition is important.

Currently, there are different financing options available. For one, finding a third party willing to purchase the vehicles and then leasing or renting them to the operators. Another option includes facilitating cheaper rates and better conditions at the banks if operators decide to buy the vehicles themselves (ZEBRA, 2019). Another option suggested by the Zero-Emission Bus Rapid-deployment Accelerator (ZEBRA) partnership (ZEBRA, 2019) is the Pay As You Save (PAYS) business model. This model means lower initial costs for the operators, as they purchase the buses without the batteries and pay them off as monthly utility service charges in addition to the electricity payments.

While the cost of purchasing a zero-emission vehicle (ZEV) is high, it is outweighed by its benefits. Different funding sources can be used to help limit the initial costs, which can

generally be separated into three primary sources. First are the private industry investments, where car manufacturers, electric utility companies, or infrastructure providers invest. Second is funding from the government through different actions and expenditures, such as introducing subsidies or tax benefits for purchasing zero-emission buses. Third is the collaboration between public and private entities, which may include a combination of funding from public institutions like municipalities and privately-owned firms (Slowik et al., 2019). While subsidies can be helpful at the beginning to initiate the change, however, to phase them out, different strategies can be used. Some examples involve limiting the number of vehicles included, making them dependent on customers' income, or making the incentive depending on the range of the vehicle.

Slowik et al. (2019) also mention different funding mechanisms, including a carbon tax, fuel taxes, emission-indexed vehicle taxation, or implanting awareness campaigns to support the industry. Some of these actions involve policies on national and local levels, as these two should align (Miller et al., 2017). Other ideas to finance more sustainable vehicles, such as buses, can include direct or loan payment from the operator, using a capital or operator lease or component lease, which entails the manufacturer owning parts of the vehicles, such as batteries, which is paid back over time (Miller et al., 2017). In general, leasing agreements are becoming more popular, similar to contracting. Contracting involves contracts with private bus operators to do public transportation for them. Often, these contracts involve different requirements the operators must comply with, especially bus specifications, such as stating what Euro standards the buses should have (Miller et al., 2017).

Social dimensions

The social dimensions of public transportation can include cultural aspects, demographics, and behavior (Dubey & Gunasekaran, 2015). Previous literature has seen changes in passenger behavior which can significantly impact the reduction of energy consumption and, with that, the reduction of GHG emissions (Konečný et al., 2020). It has also been shown that there are relations between the ownership of cars and the use of air transport in middle-income groups (Konečný et al., 2020), demonstrating that the social dimensions can significantly impact sustainable public transportation. Generally, there are a lot of benefits and drivers for implementing sustainable transport, with

research showing that electric vehicles in the public sector can decrease air pollution and GHG emission (Agaton et al., 2020), as well as having public and legal support (Guno et al., 2021). While many people still use their cars, primarily due to convenience, there is interest and support in the public sphere to have better structured and sustainable public transportation available.

Another critical aspect of the social dimensions includes accessibility. A case study in Stockholm showcased that there is still a need for improvements, as some of the major complaints surrounding the feeling of exclusion, which was often due to the behavior of the bus drivers, with data showing that some of the drivers tend not to use the accessibility functions (Stjernborg, 2019). Thus, at least in some cities, the social dimensions of sustainability in public transportation have been overlooked.

Technology

When it comes to reducing GHG emissions, not only the customer's behavior is essential, but also the technology behind it to limit GHG emissions (Dubey & Gunasekaran, 2015). For instance, electric vehicles are more profitable compared to internal combustion engine (ICE) vehicles (Agaton et al., 2020). Therefore, switching to other technological innovations is necessary, as it can increase environmental sustainability (López et al., 2019). Therefore, there needs to be a stronger focus on technological advances to decrease environmental impact and increase social sustainability, such as using accessible buses. However, while some new technological advances, such as hydrogen buses or quiet buses, may score high on their performance, the improvement in each of the sustainability dimensions is quite limited (López et al., 2019), thus the desire to upgrade and innovate bus fleets is still there (Corazza et al., 2016). In 2021, most buses operated used an ICE that is either fueled with diesel or compressed natural gas (CNG) (Dallmann et al., 2021). However, it has been shown that the electric buses had significant energy efficiency benefits, which energy consumption models exhibited. The use of BEVs is increasing, especially in China, which has the largest market (Basma & Rodríguez, 2021). However, fuel-cell technologies, such as hydrogen, lack behind in terms of model diversity (Basma & Rodríguez, 2021). Additionally, the technology of regional and inter-city buses lags behind, mainly due to the high driving range and the increased size of batteries needed (Basma & Rodríguez, 2021). Thus, one of the most significant barriers to battery

electric buses is their range, mainly as it depends on increased operation conditions, meaning that the more people are on the buses, the lower the range is (Dallmann et al., 2021).

Moreover, most research focuses on new innovations and technologies in bus types, showing a high need for midi and articulated buses (Corazza et al., 2016). The midi, or midsize buses, are shorter, with a general length of 9 – 11 meters, while the articulated buses are more extended with an added axle. In addition, bus stakeholders, such as local administrators or company representatives, have indicated a willingness to change propulsion systems to more electric-powered buses and hybrids or switch to biodiesel or compressed natural gas (CNG). However, governmental support is needed for these changes, especially regarding financing and policies (Corazza et al., 2016).

One potential energy option is natural gas. While natural gas has lower CO₂ emissions than diesel, its energy consumption by kilometer is higher (Mulholland & Rodríguez, 2022). Additionally, a life cycle assessment from well-to-wheel² showed that the potential environmental benefits of CNG are reduced through the fugitive methane emissions during unintended leakages (Mulholland & Rodríguez, 2022). Most of the emissions were produced in the operation phase, especially for hydrogen and battery electricity, as the use and processing of raw materials lead to higher emissions than natural gas or diesel. However, the emissions of the operation phase were significantly lower by 73% (Mulholland & Rodríguez, 2022). Also, it was shown that if the buses were solely powered by renewable electricity, there would be 90% less emissions of CO₂ than in the case of diesel usage.

While the use of CNG is promoted in India, the methane leakage during the production process is too high (Kelly & Zhou, 2022). Other energy options involve two types of hydrogen, including green hydrogen or renewable electrolysis hydrogen, which is generated through solar or wind, and blue hydrogen, which is produced from natural gas by carbon capture. Thus, blue hydrogen has a higher GHG emission compared to green hydrogen (Kelly & Zhou, 2022). Additionally, a study in India showed that while green

² Well-to-wheel is part of the life cycle assessment for the transportation sector, specifically for fuel, including aspects from the fuel production to vehicle operation (Stettler et al., 2023).

hydrogen will be more costly than compared to blue hydrogen until 2030, it will be cost-competitive in 2050 and can be considered an essential future renewable energy source as it can reduce GHG emissions significantly (Kelly & Zhou, 2022). Therefore, while this might not be an option for public transportation currently, it will be an option in the future.

Furthermore, previous literature has shown that newer and more developed technology can reduce pollution and encourage lowering the reliance on fossil fuels (Agaton et al., 2020). This was highlighted in an environmental impact assessment showing the benefits of using electric vehicles, namely by significantly decreasing air particulates and the use of fossil fuels (Agaton et al., 2020). As such, utilizing electric buses is important in many countries, and the switch to electrically powered vehicles influences the SDGs with direct influences on Goals 3, 7, 9, 11, 12 and indirect effects on 3, 11, and 13 (Guno et al., 2021).

The environmental benefits of electric buses have already been discussed, but a life-cycle assessment (LCA) of electric and diesel buses shows that the former has lower emissions of GHG and NO_x than diesel buses. In contrast, other emissions, such as PM10 or SO_x, were higher, mainly due to energy generation (Du & Kommalapati, 2021). By 2040 electric buses will have a positive environmental cost saving due to their reduction of life-cycle emissions, however, the authors also mention that the results are highly dependent on factors such as oil prices and inflation rates (Du & Kommalapati, 2021). However, how to make the transition to these options more accessible and efficient is still discussed, with one study in Korea highlighting the importance of customer experience (Kwon et al., 2020). Generally, passengers view safety as one of the essential attributes, while eco-friendliness and ride comfort come after (Kwon et al., 2020). This indicates that for the new buses to be socially accepted, they need to fulfill the passengers' needs, which in this case is safety. However, changing passengers' behavior to move away from cars usage is complex, with different programs put into place. In this case, a study conducted in Sweden showed that these behavior-changing programs can significantly affect travel behavior during their implementation (Friman et al., 2012). However, bus stakeholders seem less confident about switching to more sustainable fleets, which can affect passengers' perceptions (Corazza et al., 2016). All this highlights that the alternative fuels

used for sustainable public transportation are at varying stages of development (Baldino et al., 2019).

Besides zero-emission vehicles, soot-free buses are also operated. While the ZEV commonly has zero emissions, the engine technology of soot-free buses can reduce tailpipe black carbon emissions. For instance, engines that are Euro 6 certified are considered soot-free. These buses, however, are still using fossil fuel to power the engine, and while they limit parts of the emissions, they cannot be considered zero-emission (Miller et al., 2017).

Legal Structure

The legal country-specific structures are other crucial aspects of sustainable transportation. However, the study by Dubey and Gunasekaran (2015) did show that it is a significant aspect of sustainable transport, and there is still a need for changes in the legal structure in many countries. Especially for buses, there are specific standards that they must fulfill, with the Euro standards for buses being among the most significant requirements and standards being used (Williams & Minjares, 2016). The standards were first adopted in 2005 by the European Commission to limit air pollution in the transportation sector. Jin et al. (2022) showed that implementing Euro 6/ VI engines reduces NO_x emissions and black carbon. Furthermore, implementing the new generation, Euro 7, can avoid up to three million premature deaths in the G20 countries over the next decades. This was also supported by previous literature, where the data shows that Euro 6/ VI buses reduce NO_x, which is necessary to improve air quality (Williams & Minjares, 2016).

Environment

The environmental dimension is significant in the case of sustainable transportation. The use of fossil fuels has shown the need to utilize more energy-efficient vehicles when it comes to public transportation (Dalala et al., 2020), with studies showing that GHG emissions were significantly reduced when the bus fleet was upgraded to electric vehicles in addition to introducing photovoltaics systems to power the batteries (Dalala et al., 2020). Generally, GHG emissions can impact the ozone layer and affect the greenhouse effect, thus increasing global warming. Transportation is a significant GHG emitting

sector, making it increasingly necessary to find solutions (Konečný et al., 2020). The direct emissions from vehicle operation relate to their fossil fuel consumption. Still, there are also indirect emissions involved with diesel-powered buses emitting CO₂, CO, NO_x, and PM coming from diesel fuel production (Konečný et al., 2020). Previous literature showed that replacing the bus fleet with newer models can significantly influence direct and indirect emissions. While electric vehicles also produce emissions, this can be reduced when looking into the electricity production of the origin country of said energy (Konečný et al., 2020), which can be an essential aspect in Iceland mainly using renewable energies. When it comes to the Nordic countries, there are multiple challenges the region must face when it comes to public transportation, with researchers showing that across the Nordic countries, there are 44 challenges, including governmental support of fossil fuels, longer distances to rural areas, lack of public transport infrastructure, electrification of transport, and lower population density (Sovacool et al., 2018).

2.4. Transportation in Iceland

Building a sustainable public transport system is essential in Reykjavik and the surrounding capital area, as it is the most populated area in the country. The area contains more than a third of the population, as of 2022, the number is around 235.000 out of 375.000 inhabitants (Hagastofa Íslands, 2022). In recent years there has been a change in accessibility to the country by airplanes and cruise ships, primarily due to tourism (Keeling, 2020). With increased tourism in the country, transportation has become even more important, with studies highlighting the importance of available public transportation to decrease the use of rental cars (Remer & Liu, 2022). The country hosts annually more than six times the number of tourists compared to the island's population, which can impact the environment, resources, and transportation sector (Remer & Liu, 2022). With Iceland's unique geological location, there are a lot of different challenges and drivers the country faces, with fossil fuel intensity being mentioned as one of the more significant challenges to consider when moving towards more sustainability (Sovacool et al., 2018). Research suggests that infrastructure in the rural areas still needs to be improved, however, while the capital area is more developed, the usage of public transportation seems to be relatively low (Ottósson et al., 2019). Due to the increasing tourism, GHG emission in the country has significantly increased in the transportation

sector, however, to combat these changes, Iceland has amplified the use of electric vehicles, its development, and the use of low-carbon alternative fuels (Keeling, 2020; Shafiei et al., 2014; Lin & Sovacool, 2020). But there are still challenges, especially regarding financial concerns and the lack of charging stations.

Iceland has one of the highest rates of cars per capita, with a study showing that 70% of households have at least one car they use (Ottósson et al., 2019). This indicates that transportation is heavily dependent on private and rental cars, contributing to a big part of the emissions inside the country (Saviolidis et al., 2021). Research on Iceland shows that low-carbon transportation, especially road transportation, is possible to achieve after 2035, but it depends on the battery life and replacement cost (Shafiei et al., 2014). A study showed that there are different power options, with the most relevant being electricity, there is also biofuel and hydrogen (Shafiei et al., 2015). However, the research demonstrates that the transition to either option relies on the oil prices and carbon tax. The use of Hydrogen has also been included in the Icelandic Climate Action Plan (Aðgerðaáætlun í loftslagsmálum), where it was also mentioned that hydrogen-powered vehicles are included in tax subsidies (Umhverfis- og auðlindaráðuneytið, 2020).

Thus, when it comes to Iceland's sustainability, there are still improvement opportunities in the transportation sector, with research showing the need to reduce the emissions from engines and increase the use of low-emission vehicles (Olafsson et al., 2014). Some of the other drivers and barriers identified include the benefits of being environmentally friendly and energy security, while the barriers contain the lack of policy incentives, weather, and pricing (Lin & Sovacool, 2020). Additionally, cities are an essential part of decreasing emissions, especially considering transportation, due to their power and policies, and this is also the case for Reykjavik (Dillman et al., 2021). However, most of the research on Iceland was conducted on the transition towards electric vehicles and not specifically on public transportation, which is still an understudied area. A case study by Dillman et al. (2021) on Reykjavik shows the importance of including direct and indirect emissions in transportation studies. While electrifying passenger vehicles might decrease emissions, this might not be important if more people start owning and driving their cars. Moreover, the study highlighted that the zero-emissions policy the city has planned is unrealistic with their current plans and policies. Only a change in technologies, behavior, and the urban form is needed to be fulfilled this goal (Dillman et al., 2021).

When it comes specifically to the local public transportation system, the report by Skúladóttir et al. (2019) included buses, ferries, and domestic flights as the main modes of public transport, while closer to the capital area it can also include airport transfer, taxis, and bikes (Reykjavíkurborg, 2021). There are also specific laws that transportation companies need to follow, this includes a law on passenger transport and cargo transport on land from the Ministry of Infrastructure. This includes licensing to operate and register vehicles transporting more than nine passengers. Additionally, the transportation companies need a travel service license, a community license, and a driver's certificate (Þingskjal nr. 28/2017). This law also includes accessibility, such as not permitting to refuse passengers based on disabilities or mobility issues. As for the structure of public transportation, there are different entities involved. Strætó, the leading public transportation provider in the capital area, is owned by different municipalities (Strætó, n.d.-e), similar to the public transport system in other cities around the country, most of which is bus transportation.

A study conducted on the bus system in the capital area showed that about 20% of the residents use Strætó at least once a month, which was lower than in previous years (Ottósson et al., 2019). The study concluded that the travel time of Strætó was too long, with most users stating they would use the bus a lot more if the travel time would be faster than the car or only up to 5 to 10 minutes slower. They also indicated that the current route system should be adjusted and made a priority. Ottósson et al. (2019) suggested that public transportation by buses should increase in case of the frequency, thus shortening the travel time, which could be done with priority bus lanes. The route systems in the capital area could also be modified for nearby municipalities. Figure 1 shows that there are many different routes within the capital area, however, as was mentioned in the study of Ottósson et al. (2019) and later in a report for the Borgarlínan project (BRT Planning International, 2020), the routes are not planned as efficiently as possible as they are primarily aimed at connecting most of the population, rather than efficiency.



Figure 1. Current routes – Strætó.

Note. From Strætó (n.d.-g).

Making public transportation more sustainable in the capital area, including the new BRT line, is part of the Climate Action Plan of Iceland (Umhverfis- og auðlindaráðuneytið, 2020) but also part of the 2040 Master Plan (Aðalskipulag Reykjavíkur 2040) of the city of Reykjavik (Reykjavíkurborg, 2021). The city also introduced a Green Plan, where there is a focus on eco-friendly transportation, including projects such as the 15min neighborhoods and a new cycling plan (Reykjavíkurborg, n.d.). Additionally, some of these suggestions of Ottósson et al. (2019) have been included in the Borgarlínan project or also called the “city line project,” which plans to implement rapid transit by bus (Borgarlína, 2021). In 2020 a report was published to discuss the current system and what

changes must happen in the Borgarlínan project (BRT Planning International, 2020). It highlights the importance of a more frequent network and direct routes. It shows that currently, there are too many routes that terminate downtown, and as such, some of these routes should be restructured to have more straight, frequent routes that will pass through downtown Reykjavík. This will be based on the bus rapid transit (BRT) systems to provide residents with faster and more reliable travel options (BRT Planning International, 2020). The changes suggested in the 2020 report included dedicated bus lanes, off-board fare collection, level boarding, and priority intersection, to name a few. Additionally, the buses should be run on clean domestic fuels such as electricity.

However, Borgarlínan will not only focus on the bus system but generally improve sustainable transportation methods, such as biking, by building more bike lanes and bike parking close to the bus stations. These ideas are primarily included in the current Borgarlínan plan. However, the project is still in the initial implementation stage (Borgarlína, 2021). Also, the Borgarlínan report states that this will be the transport system for the entire capital area (Borgarlína, 2021), which will be an expensive project. The first phase will be a 14-kilometer-long route system which is expected to cost around 24.9 billion ISK (Borgarlína, 2021). The proposed route changes of Borgarlínan are displayed in Figure 2. As seen, the proposed Borgarlínan routes are straighter and more direct to hopefully combat some of the negative aspects, such as the long travel times, that the current routes system (Figure 1) displays. All this demonstrates that there is still more to be done, and identifying the drivers and barriers is essential for sustainable public transportation in the capital area.



Figure 2. Proposed routes – Borgarlínan.

Note. From Borgarlína (2021, p.25).

2.5. Green Practices in Public Transportation Companies

Regarding the drivers and barriers for businesses to become more sustainable, seven important categories must be considered: “*environmental, economic, social, institutional, technological and informational, supply chain, and organizational*” (Tura et al., 2019, p. 91). Research has shown that the significance of the drivers and barriers is context-specific, meaning that the strategies employed can vary significantly between companies, thus indicating that business should analyze their own internal and external environment to identify essential drivers and barriers (Tura et al., 2019). Other articles identified three essential aspects: economic, social, and environmental, with one study also suggesting the importance of institutions for developing countries (Daimi & Rebai, 2022). However, while the institutional aspect might not be as important in developed countries, the three

other elements are still essential for assessing the performance of public transportation companies. According to the researcher, the economic aspects influence profitability and capacity management, the social aspects include safety and service quality, while the environmental dimension includes air pollution and energy consumption. These indicators allow decision-makers to analyze the performance of public transportation companies while providing a good overview of the most critical aspects while tracking the progress in line with the SDGs (Daimi & Rebai, 2022). Additionally, the literature suggests that companies must include strategies that raise the perception of commitment to environmental sustainability, which can lead to customer satisfaction and build stronger relationships (Vicente et al., 2020). Research showed that small businesses tend to be oriented toward profitability, while larger companies focus on modernization and decreasing CO₂ emissions (Sofijanic et al., 2021).

An essential driver towards sustainable businesses and cooperations is sustainable business model innovations (SBMI) (Bocken & Geradts, 2020). SBMI not only includes economic factors but social and environmental ones as well. There are different drivers and barriers regarding how factors of organization impact SBMI initiatives. Generally, the drivers and barriers can be separated into three major levels institutional, strategic, and operational. Regarding institutional barriers, uncertainty avoidance was mentioned as it focuses on boosting shareholder value and focusing on short-term growth. At the same time, the drivers can include concentrating on shareholder and stakeholder value, embracing ambiguity, and appreciating the company's sustainability. On the strategic level, the barriers contain functional strategy and emphasize short-term growth. In contrast, collaborative innovation and having a deliberate focus on SBMI were defined as drivers. Lastly, the barriers on the operational level can include functional excellence, having fixed resource allocations, and an incentive system focused on short-term targets. In contrast, the drivers have people capability development, having dedicated resources for SBMI, and an incentive scheme for sustainability (Bocken & Geradts, 2020). The study highlights the importance of organization behind SBMI while drivers and barriers co-exist.

2.5.1. Five C Framework in Public Transport

When it comes to sustainability in companies, one important aspect is the company's strategy. One method to incorporate sustainability into a business is to analyze and

include a strategy following the Five C framework by Jóhannsdóttir and McInerney (2018), but it was initially developed for insurance companies. In addition to identifying internal and external drivers, the framework includes five different elements, namely Commitment, Configuration, Core business, Communication, and Continuous improvement. The framework itself is broad and can be used for other sectors and businesses besides insurance, with only the core business phase needing significant change according to the sector/business operations relevant for them to succeed and where most impacts are made. Although it was initially developed from an environmental sustainability perspective, it is also relevant in the broader context of sustainability. Figure 3 provides an overview of the different aspects and dimensions of the framework (Jóhannsdóttir & McInerney, 2018), adjusted for public transportation companies.

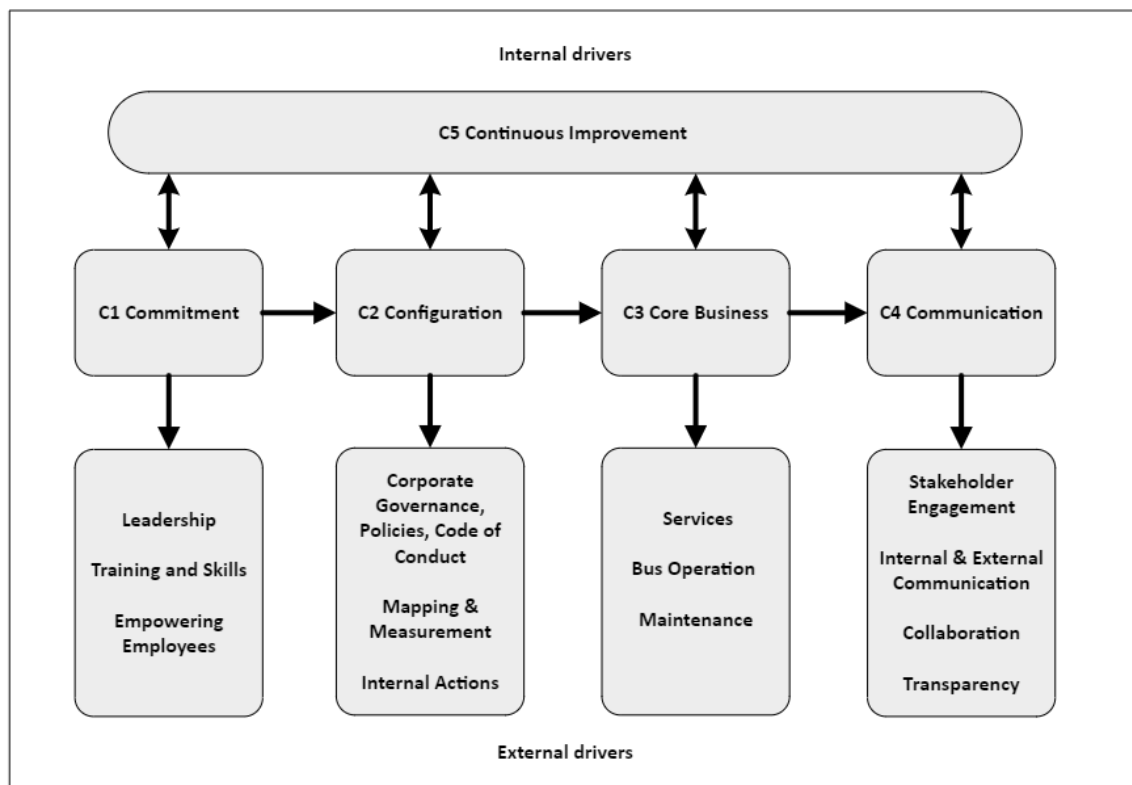


Figure 3. Five C framework for bus transportation companies.

Note. Adapted from Jóhannsdóttir and McInerney, 2018, p.1259.

2.5.1.1. Commitment

The first element of the Five C model, Commitment, includes three main aspects, namely Leadership, Training, and Empowering employees. The leader’s primary role is to establish a vision, mission, goals, and sustainability/environmental strategy for the

business. It is also mentioned that environmental risks and opportunities must be identified while defining success and allocating relevant business resources. Training is important in raising environmental issues and enhancing employees' skills. Thus, training plans, web seminars, and volunteer work can strengthen employee abilities. Furthermore, employees can be empowered to act by recruiting the right people, gathering ideas through meetings and workshops, and introducing reward systems and incentive plans (Jóhannsdóttir & McInerney, 2018).

Companies in the transportation sector must implement new management models into their systems (Susniene & Jurkauskas, 2008). Additionally, training drivers has always been important within the transportation sector, as a special license is needed in European countries to drive buses (Directive 2006/126/EC). However, research suggests that special eco-driving training can impact fuel consumption and GHG emissions reduction when simulator-based training is used, even more so when training is conducted over a period of six months (Sullman et al., 2015). This eco-driving simulator included five main aspects to anticipate traffic flow, maintain a steady speed, shift gears up early, frequently check tire pressure, and consider extra energy consumption when using air conditioning. This study was conducted in Helsinki, Finland, with external weather conditions, so it can also apply to Iceland (Sullman et al., 2015). Other types of training have also been implemented in different companies besides eco-driving. This can include providing safety training and training drivers on reading and interpreting the information specific to electric buses (Dhole & Gode, 2022). In addition, this training often includes teaching employees new skills or refreshing their skills, specifically on electric vehicles, and training against range anxiety (Dhole & Gode, 2022).

2.5.1.2. Configuration

The business configuration element of the Five C framework has been described as how companies formulate or organize their sustainability actions (Jóhannsdóttir & McInerney, 2018). Generally, there are four main aspects: corporate governance, company structure, mapping and measurements, and internal actions. Regarding corporate governance, it is essential to integrate environmental and social factors into the policies, principles, and code of conduct. As such, companies should add policies on climate change, and the natural environment needs to be included, especially when defining strategic projects.

Regarding the company structure, the paper by Jóhannsdóttir and McInerney (2018) suggests that insurance companies should establish environmental steering committees and have open communication between these committees and company executives.

Mapping and measurements are essential to identify the direct and indirect impact on the environment. As such, environmental measures must be included in the day-to-day decision-making, and relevant key performance indicators (KPIs) must be selected. Additionally, internal actions play an important role. These include identifying the key stakeholders, including the natural environment. As such, the company needs to analyze its products and evaluate its environmental risk, improve procurement and reusability of office supplies, and work on waste management and reduction (Jóhannsdóttir & McInerney, 2018). More specifically, in the transportation sector, research has shown that consumers are more likely to do business with companies perceived to be environmentally friendly/more sustainable. Vicente et al. (2020) found that commitment to environmental sustainability directly affects passenger loyalty and satisfaction. It was also found to have a positive correlation with service quality. This indicates that the commitment to sustainability the transportation companies can affect consumer behavior, as the passengers value sustainability.

As such, one major aspect of moving towards more sustainability in transportation involves the passenger and their behavior, however, the attempts to change these behaviors are often ineffective (Cruz & Katz-Gerro, 2016). In transportation companies, sustainability is often referred to as green technologies to reduce emissions and financial burden to increase profits, which is understood as changing how the vehicles are powered and monitoring their performance. Furthermore, the research found that the choice and strategies these companies have are limited by policies and financial resources, which often leads to the economic aspect limiting the strategy that can decrease the environmental impact (Cruz & Katz-Gerro, 2016). When it comes to strategies to change consumer behavior, some public transportation companies have used social networks to discuss innovations for mobility, collaborate with other transportation companies, combine public transport with other forms of transportation, use apps for tickets, improve customer service, or using a survey to measure customer satisfaction. However, the literature also highlights the importance of public policies, as

they are one of the most important aspects of promoting public transportation (Cruz & Katz-Gerro, 2016).

This highlights the importance of another aspect of environmental practices, which is the economic element, such as environmental purchasing, which is often seen as an effective way to increase the environmental performance of a business or an industry (Björklund, 2011). This also applies to the transportation sector. While there is no one definition of environmental purchasing, Björklund (2011) based it on Mulder (1998), stating that *“the practice of public authorities or private companies taking supplier environmental product and process performance into account when purchasing products and services”* (Mulder, 1998, p. 123). Furthermore, research has found that environmental purchasing of transportation is influenced by different factors, including environmental management, the company’s reputation, demand from customers, and regulations applied by the government (Björklund, 2011). Additionally, external factors seem to have a more substantial influence on environmental purchasing than compared to internal ones, not just by the number of external factors but also by their impact size. Interestingly, most factors were viewed differently, indicating that if a factor is seen, a driver or barrier can depend on the person (Björklund, 2011).

As Jóhannsdóttir and McInerney (2018) highlighted, another aspect of configuration includes monitoring and evaluation. In the transportation sector, this can be done by sharing the data from bus operations on energy efficiency, battery health, and the cost of maintenance (Dhole & Gode, 2022). This goes especially if operations are outsourced. Similarly, different certifications can be used to track and monitor the company, specifically for environmental management. ISO certification 14001 is essential (Díaz de Junguitu & Allur, 2019) as it includes different requirements that a company can use to increase its environmental performance. Previous literature shows that the most common ISO certifications companies use are ISO 9001, ISO 14001, and OHSAS 18001 (Arimany-Serrat et al., 2019).

2.5.1.3. Core business

As mentioned, the core business described by Jóhannsdóttir and McInerney (2018) focuses on the investment sector with four main aspects: products, risk management, loss prevention and claims, and investment. While some of these are partly relevant to

other industries, sector-specific aspects must be identified. In this case, a value chain of public transportation companies describes the activities of a company that is of importance for competence strategy and organization (Johnson et al., 1999), with the main activities for a public transportation company being the operations, maintenance, marketing, and after-sales service (De Fátima Teles & de Sousa, 2014). Additionally, the researchers found that for public transportation companies, resources and competitive advantage can act as mediators regarding a positive relationship between the economic results and the environmental benefits (De Fátima Teles & de Sousa, 2014). The maintenance, marketing, and after-sale services can be described as services they provide, such as transporting passengers where they need to go. Part of this includes the involvement of fares and tickets, and with increasing new technological innovations, the forgery and evasion of fares seem to be growing as well (Fürst & Herold, 2018). This evasion of fares can impact a company's economic or financial sustainability, as it involves a loss of income for the companies, especially free riding being the largest problem. Research suggests that increasing control and using electronic tickets can have a positive effect, and the latter is an attractive option for customers (Fürst & Herold, 2018).

Bus operations must consider and use the charging time efficiently (Dhole & Gode, 2022). Ideally, the best routes should be identified and prioritized to see which will be easiest to switch to electric buses. Additionally, part of the operations also schedules the routes and frequency and the charging solutions. When investing in new buses, the batteries' lifetime should be considered, and contracts accordingly aligned to it (Dhole & Gode, 2022). As mentioned in section 2.3.1. some other aspects that need to be considered when purchasing new buses involve different standards, including the Euro standards (Williams & Minjares, 2016). This is in addition to considerations of newer technologies, such as Battery-electric buses or hydrogen-powered buses (López et al., 2019).

2.5.1.4. Communication

Regarding communication, Jóhannsdóttir and McInerney (2018) mention four main aspects, that is stakeholder engagement, internal and external communication, partnership, and collaboration. Stakeholder engagement includes increasing environmental awareness within the company as well as for their external stakeholders.

Internal and external communication involves a spokesperson communicating these topics through magazines, conferences, or websites. Additionally, NGOs should be included in research and development, and there should be a partnership between private companies and public aspects such as municipalities or public authorities. Finally, transparency involves measuring tools and indicators and publishing reports for transparency (Jóhannsdóttir & McInerney, 2018).

Public transportation companies are influenced by different external factors, including demographic, political, economic, social, privatization, cooperation between companies, and factors that are influenced by the customers and suppliers (Susniene & Jurkauskas, 2008). Therefore, to give the passengers the best service, a collaboration between other stakeholders, including the municipality, road maintenance service, or other public transportation companies, is vital (Susniene & Jurkauskas, 2008). As public transportation systems are quite complex, they tend to involve multiple organizations, experts, and stakeholders. These different actors often cover aspects such as funding or infrastructure, for which open dialogs and developing trust is needed, as conflicts can arise due to every entity having different goals (Pettersson & Hrelja, 2020). As for transparency, researchers have suggested that companies' environmental practices should be made visible to the consumer, and importance is laid on communication, clearly communicating the sustainability strategies and policies (Vicente et al., 2020). Thus, it is recommended that transportation companies have a communication strategy, including publishing sustainability goals and achievements.

2.5.1.5. Continuous improvement

Regarding continuous improvement, Jóhannsdóttir and McInerney (2018) mention that addressing sustainability issues in the day-to-day business is essential. For example, companies must follow up with associations about what industry climate change actions are needed and monitor the outcomes of the environmental goals set beforehand. Additionally, they must review the strategies regularly and ideally share the best practices on their website and seminars. However, implementing environmental sustainability strategies is not done once and for all, rather, this process must be reviewed and improved regularly.

3. Research Methods

The research methods used for this thesis include three different methods, namely, a literature review, interviews, and an analysis utilizing the Five C framework using interview data and information available online (Jóhannsdóttir & McInerney, 2018).

3.1. Data collection: Literature review

The selection criteria, see Table 1, was used to find literature relevant to the study. Due to the extent of this thesis, the focus was mainly on peer-reviews articles and institutional reports from different companies and the Icelandic government, focusing on literature in English as these are in a language the author understands. Nonetheless, some exceptions were made, as some institutional reports were unavailable in English, consequently, some reports that were included are in Icelandic. Additionally, the period between 2008 and 2023 was chosen based on the Kyoto Protocol, as 2008 was the first commitment period for nations to address climate change through an international agreement (UNFCCC, 1997). However, some exceptions were made, allowing for a deeper dive into the history and evolution of sustainable transportation. To select the literature, websites were chosen that have known credibility of showing articles from published journals that can be tailored to the need of the selection criteria.

Table 1. Selection criteria.

Conditions	Inclusion Criteria	Exclusion Criteria
Publication Type	Peer-reviewed articles, institutional reports (government and companies)	Books, conference papers, other types of papers, thesis papers
Language	English, Icelandic when necessary (i.e., policies)	Other languages
Time Period	From 2008 to 2023	Everything before 2008
Research discipline	Business models and sustainable transportation	

Conditions	Inclusion Criteria	Exclusion Criteria
Sources	Google Scholar, Scopus, ICCT, Governmental Websites, Websites of Strætó, RE/FlyBus, and Gray Line	Newspapers, Magazines
Topics/Concepts	Sustainable Public Transportation; Public Transportation; Internal and external barrier/drivers; (Public) Transportation in Iceland; Transition of transportation; Massive Transportation	

Note. Created by the author.

While most references were found using the selection criteria, some have been added through further search using references from selected articles. The process of finding the literature is presented in Table 2. In total, 92 publications were selected after using different search engines and selection criteria and reading through the different abstracts. Regarding Google Scholar, only the results of the first five pages of article output were considered for abstract reading to decrease and limit the number of papers chosen significantly. Altogether, 85 of these articles were used for the thesis.

Table 2. Literature review – article selection.

Sources	Search Criteria	Outcome	After abstract reading	Final Selection
Google Scholar ^a	Sustainability OR sustainable; Public transportation	48.200	9	8
	Sustainable public transportation	23.500	11	10
	Drivers and barriers of sustainable public transportation	19.100	11	8
	Sustainable transportation in Iceland	16.200	11	11

Sources	Search Criteria	Outcome	After abstract reading	Final Selection
	Public transportation Companies AND sustainability	573	15	9
Scopus ^b	Title-abs-key: sustainab* and transport* Exact keyword: public transport	191	18	9
	Title-abs-key: transport* and bus company* and business	31	5	3
	Title-abs-key: sustainab* and transport* and business Keyword: public transport	105	12	11
ICCT	Sustainable public bus transportation; Only publications: after 1.1.2008	445	20	16

Note. Created by the author.

^aOnly the articles from the five pages were considered. Sources included: MDPI, Elsevier, researchgate.net, JASTOR; from 2008.

^bYear:2008 to present; Language English; Document type: Article; SRCTYPE (source type): Journal.

3.2. Data collection: Interviews

Semi-structured interviews were conducted with different representatives and experts in the public transportation field. As this study is exploratory, having interviews helps get a better overview of the drivers and barriers and gain some other important information about what is still needed to improve sustainable public transportation. Additionally, semi-structured interviews grant the interviewees the opportunity for more open responses (Petrescu et al., 2017). The sampling was mainly based on a non-probability sample, meaning that the probability of selecting the sample is unknown, with different sampling strategies such as purposive, quota, or snow-ball sampling (Acharya et al.,

2013). The primary method was purposive, also called convenience sampling, as individuals were selected based on their profession, which is most useful for the research. However, snowball sampling was also used to gather more interviewees by asking interviewees and people initially contacted if they knew of suitable interviewees (Parker et al., 2019). Potential interviewees were stakeholders involved in public transportation, including the bus companies, specialists (i.e., transport engineers), politicians/representatives from the government, Reykjavik City, and someone involved in public transportation, for instance, from Icelandic New Energy and Vegagerðin, the road and coastal administration. Following the report from Lin and Sovacool (2020), all interviewees were contacted through email or phone, and they came from Strætó, Gray Line, Reykjavik Excursion, Vegagerðin, Reykjavík City, Department of Transport and Infrastructure, and Iceland New Energy. They were all chosen based on their backgrounds and work experience.

In total, eight experts were interviewed. The interviewees were asked for permission to record the interviews and were asked to sign a consent form. Following the interviews, the audio recordings were transcribed for analysis. The semi-structured interview framework is in Appendix 1: Interview Framework. An overview of the length of the Interviews is in Table 3. It shows how long each interview lasted, with the shortest being 20:37 minutes and the longest 51:50 minutes.

Table 3. Interview length.

Interview	Interview Length
#1	51:50 min
#2	35:25 min
#3	45:02 min
#4	46:16 min
#5	32:25 min
#6	22:38 min
#7	39:08 min
#8	20:37 min

Note. Created by the author.

3.2.1. Interview framework

As mentioned above, a semi-structured interview framework was designed (Kallio et al., 2016). Following this, open-ended and neutral questions were chosen, with all the questions covering one topic each (Rosenthal, 2016). Two semi-structured interview frameworks were designed, one with general questions asked to the stakeholders of transportation companies and a second with questions relevant to the representatives of the public transportation companies. This was done to get a better understanding of the Five C framework (Jóhannsdóttir & McInerney, 2018) and how well sustainable strategies are developed and followed in each business. The interview framework can be found in Appendix 1: Interview Framework. Interviews were conducted in January and February of 2023. All interviews were conducted in the English language, however, this was neither the mother tongue of any of the interviewees nor the interviewer.

3.2.2. Transcription and Coding

The coding and data analysis followed most of the methods described by Castleberry and Nolen (2018), who categorize qualitative data analysis into five main steps, namely compiling, disassembling, reassembling, interpreting, and concluding.

Castleberry and Nolen (2018) mention that transcribing the data is an essential first step when *compiling* the data. Therefore, for this research, a written text based on audio recordings was developed (Rosenthal, 2016). For this, Microsoft Word Version 16.71 was used, with its transcription option, and each interview was cross-checked by the researcher. For *disassembling* the data from these interviews, codes were used to better convert the text into usable data (Castleberry & Nolen, 2018). A coding guide was developed following the transcription, making it *a priori* based on previous literature. This was based on the three main aspects of sustainability: Social, Environment, and Economic (Dobranskyte-Niskota et al., 2007; Miller et al., 2016b), as well as elements from the Five C framework (Jóhannsdóttir & McInerney, 2018), used as overall themes for the coding. Some of these codes were changed after coding the first two interviews to make them more cohesive. From the sustainability aspects, 23 codes were chosen (See Appendix 2: Codes), and for the Five C framework, 15 codes were chosen (See Appendix 2: Codes). The interview transcripts were then analyzed and coded based on these codes and extracted into Microsoft Excel Version 16.72 for further analysis.

In the *reassembling* step, the codes were grouped into two overarching themes, Sustainability, and the Five C framework (Jóhannsdóttir & McInerney, 2018), with the following subthemes: *environment, social, economic, commitment, configuration, core business, communication, and continuous improvement*. Following this, the coded text extracts were placed into multiple sub-themes. After the grouping of codes and themes, the extracts were further separated between *drivers and barriers*.

The *interpreting* step was partly covered in the compiling, disassembling, and reassembling steps (Castleberry & Nolen, 2018). Thus, the data was separated into the sub-themes that were mentioned above, the specific codes, and then finally into drivers and barriers. Based on the distinctions, each sub-theme and code were looked at in more detail to see the frequency and structure of the result section. Additionally, Microsoft Excel Version 16.72 was used for further analysis using pivot tables to understand better different aspects, such as how many drivers and barriers were mentioned, the different codes indicated in one interview, and across the various interviews. In the result section, the interviews are referred to as shown in Table 3. Additionally, the *concluding* step involved using the interpretations gathered in the previous step to answer the research questions (Castleberry & Nolen, 2018).

3.3. Data collection: Five C Framework Analysis

The third method involved analyzing the information available on three public transport companies according to the Five C framework (Jóhannsdóttir & McInerney, 2018). The three companies are Strætó, the company responsible for all the public transportation in the capital area and around the country, Reykjavík Excursion, and Gray Line (Strætó, n.d.-j; Reykjavik, n.d.-e; Gray Line, n.d.-e), who are both mainly tourist companies but also offer airport transfer to and from the international airport in Keflavik.

To analyze these three companies, the codes mentioned above for the Five C framework were used again (See Appendix 2: Codes), separated into the five main themes: commitment, configuration, core business, communication, and continuous improvement (Jóhannsdóttir & McInerney, 2018). The data was gathered from the companies' websites, based on what is available to the public. Thus, the conclusions drawn from this analysis are mainly to provide an overview of the general process in the public transportation sector.

4. Results

4.1. Sustainable public transportation in the capital area

The following section includes an analysis of the interviews separated by the drivers, barriers, and other aspects. Figure 4 provides an overview of the number of drivers and barriers mentioned in the interviews. It shows that barriers are more evident than drivers, especially the economic and social aspects which have a high number of barriers recognized. While some of the factors mentioned as drivers or barriers in the interviews are mentioned multiple times, as explained in section 4.1 and 4.2, Figure 4 shows how often each of the themes was mentioned in the interviews, indicating that there is a strong focus and recognition of the barriers compared to the drivers.

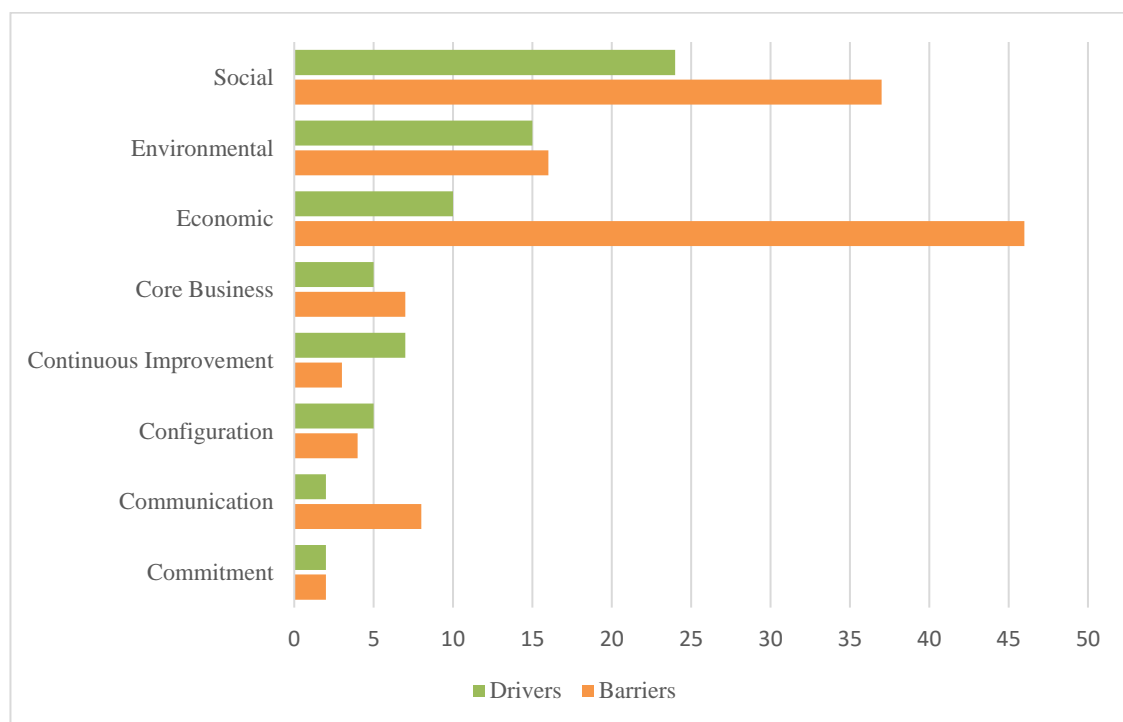


Figure 4. Drivers and barriers recognized by the interviewees.

Note. Created by Author.

Overall, the drivers were mentioned 49 times, and the barriers were mentioned 99 times, all related to the environmental, social, and economic aspects of sustainability. Most drivers were discussed in the context of social sustainability ($N=24$), while the economic aspect was most often addressed as a barrier ($N=46$), with more information

can be seen in Table 4. To present these findings, the chapter is structured so that the outcomes related to the drivers are discussed first, followed by the barriers.

Table 4. Drivers and barriers to sustainable public transportation.

Theme	Total # of Drivers	Total # of Barriers
Environmental	14	16
Social	24	37
Economic	10	46

Note. Created by the author. The number of drivers and barriers is the frequency of how often each theme was mentioned. Most themes were mentioned multiple times in each interview.

4.1.1. Drivers of sustainable public transportation

This section covers the drivers and separates them into three main themes, environmental, social, and economic. Although, within each section, the specific sub-themes are discussed, they can also be found in Table 5, Table 6, and Table 7 at the end of each section.

4.1.1.1. Environmental drivers

Five codes were mentioned regarding the environmental aspect, including efficiency, emissions, fuel types, standards and assessment, and technology, see Table 5. Standards and assessments were most often mentioned, especially Life Cycle Costing (LCC) analysis, meaning an analysis of all costs (Comello et al., 2021):

They already were getting offers for electric buses that were on Life Cycle Costing, they were cheaper than diesel. That is like 2017, so I would believe that they were getting better offers today and also better quality [...]
(Interview #7)

Another interviewee mentioned the importance of including life cycle assessments (LCA), meaning an analysis of the environmental impact (Du & Kommalapati, 2021), in the future to drive sustainability further along:

Is it polluting more if you go all the way from the well-to-wheel in electric buses and diesel buses? [...] But there are, you know, there are also discussions about this LCA [...], and I know that Denmark has, at least in one tender, made the option for the better [...].” (Interview #1)

This indicates that while electric buses might have a higher initial cost, they are cheaper in the long run and better for the environment, and other countries are already changing to other fuel types. Furthermore, another part of standards and assessments includes different environmental certifications, such as the ISO certifications. The interviewees revealed that different companies either already have an ISO certification (ISO14001) which they want to retain: *“We have a certification, and we have to meet the criteria to maintain that certificate,”* or they are aiming to get a certification, as another interviewee states: *“I like to have an ISO certification and that is why we are aiming for in the end at least [...].”* (Interview #8). Thus, the need to achieve and maintain a certification drives the companies to move toward more sustainability, as they inherently want to meet the necessary criteria.

Another important driver is related to the emissions emitted by the different vehicles and generally the negative impacts they can have on the environment, especially during colder and windless days, which is always a possibility in Iceland. Specifically, one interviewee mentions the air pollution Reykjavik must deal with during cold, windless days, which can be reduced by using electric buses and generally promoting public transportation during these days to limit the use of cars (Interview #1). Another interviewee mentions when talking about specific night buses, *“[...] if you would think it is as an environmental issue that you would reduce the use of taxis or shuttle service or whatever, it is far better that the people take the bus home.”* (Interview #3). However, buses also have emissions, so even if everyone switches to public transportation, there is still the need to decrease emissions and limit energy consumption as much as possible, with one interviewee stating that they push for more ecological driving, which can reduce energy consumption:

Not to have the buses idle to drive in an ecological manner because it can save fuel 20 to 30%. Estimate's goal that you can reduce consumption of oil by up to 30% with ecological driving. So, we push it. (Interview #5)

From a technological perspective, different drivers can and have moved this sector towards more sustainability. For instance, interviewees have mentioned that electric buses produce less noise for neighborhoods and make it easier to talk inside the bus *"You know, you can talk easily inside them. And there is less noise when you drive through your neighborhood"* (Interview #1). Additionally, there are many advances in building electric buses, as seen in Table 5, such as in the case of buses designed for lower temperatures, making them fully zero-emissions buses by also using electricity and batteries for heating. Interviewee #3 talked about the general technological advances by saying: *"[...] if you go only five years back, they weren't that many models on the market [...] And the range was far, far less than it is today"* (Interview #3).

Table 5 shows a more in-depth overview and summary of the environmental drivers mentioned in the interviews. The main drivers are four, but each one has specific aspects mentioned in the interviews. Additionally, the table provides an overview of how often and in which interviews the themes and elements were noted, with at least one additional example.

Table 5. Environmental drivers overview.

Environmental Drivers	Total Frequency	Individual Aspects	Interviews	Example
Standards & Assessments	6	Criteria from certifications (4)	#1, #5, #7, #8	<i>"We are using the lists from the certificate or the standards you know, so they know that they are obliged to keep good track of everything they use and try to use as little of it as they can."</i> (Interview #1)
		Life Cycle analysis		
		Life Cycle Cost analysis		
Emissions	3	Air pollution in Reykjavik (2)	#1, #3, #7	<i>"To improve sustainability, like I said, we need upgrades in the infrastructure. We need upgrades in the services. It also it is going to cost a lot of money but it is through</i>

		Night buses		<i>that, that we will get more people into the bus. [...] hopefully, but mainly reducing our environmental impact [when] travelling between A and B [...]" (Interview #7)</i>
Technology	3	Improvements in range	#1, #3	<i>"One company [...] was building zero emission buses for Russia [...]. Now they are offering the buses to other Nordic locations because they are specifically designed for low temperature operations." (Interview #3)</i>
		New zero emission buses		
		No noise		
Efficiency	3	Ecological driving	#5	<i>"We know that going into the electric buses will also help us a lot with maintenance [...]. There are some very positive elements of reduced maintenance with electric buses." (Interview #5)</i>
		Easier maintenance		
		Tracking system		

Note. Created by the Author.

4.1.1.2. Social drivers

Table 6 highlights that the social drivers discussed in the different interviews are mostly related to motivation, accessibility, politics, the Borgarlínan project, and health impacts. Motivation was the driver most often mentioned by interviewees. However, the types of motivation varied between the responses from the interviewees. In some cases, they discussed their personal beliefs in influencing sustainability positively, with one interviewee mentioning: *"I strongly believe that we have to, have to think about the future generation [...]"* (Interview #1) or interviewee #5, who mentioned that they personally want to provide more sustainable options, as seen in the example of Table 6.

Most of this stems from either the belief in making changes for future generations or making societal changes, as there seems to be societal demand to become more sustainable. For instance, one interviewee stated that *"It is just that the population is growing. We are getting older. We want to move; we have strong demands of greater mobility within our society. And you have to work together to achieve it"* (Interview #4). Additionally, motivation also stems from the business side, making sustainable options

and transition more attractive give a positive impact on businesses. One interviewee stated that the reason for companies motivation: *"[...] is just obviously responsibility for the company to do that. There's no other reason. Of course, it [is] just healthy for the business to think about this and yeah, try to be best of it"* (Interview #8). This was also seen by the stakeholders interviewed, e.g., interviewee #2, see Table 6, where the person states that they see companies being motivated and positive to change towards more sustainability.

Another driver mentioned by the interviewees is increasing accessibility, primarily through city projects and policies such as so-called 15-minute neighborhoods, which is part of Reykjavik's city green plan to make the city more sustainable. Politics also play an important role in driving sustainability in the public transportation sector, with interviewee #7 stating that the main motivation comes from policies and the owners, which are mostly consistent with the different municipalities of the capital area.

The other drivers mentioned mostly relate to the Borgarlínan project and how it can drive the sector's sustainability forward. One interviewee #2 believes there is hope that the Borgarlínan project will influence and change customers' behaviors, which currently like to own their cars and have done so for most of their lives. Another interviewee said: *"It will be a better system than what we have today. It definitely will. And getting buses off the gridlock in the peak hours will increase the reliability by a whole lot."* (Interview #6) This, therefore, highlights the potential Borgarlínan has for the future of sustainable public transportation in the capital area and drives the sector forward.

Table 6 summarizes the social drivers mentioned in the interviews. They are separated into five main drivers, namely motivation, accessibility, politics, Borgarlínan, and health impacts. The table includes the frequency of these drivers and aspects mentioned, and an additional example for each theme is provided in Table 6.

Table 6. Social drivers overview.

Social Driver	Total Frequency	Individual Aspects	Interviews	Example
Motivation	15	Personal believe (4)	#1, #5, #8	<i>"I think we, most of us at least, want to be able to provide more environmentally friendly options, both you know for us personally, and as a member of society."</i> (Interview #5)

Social Driver	Total Frequency	Individual Aspects	Interviews	Example
		Business motivation (9)	#1, #5, #8, #6, #2	"All these companies I have been talking to, they are positive about being more sustainable [...]" (Interview #2)
		Societal demand (2)	#5, #4	"So, we are not just meeting our own personal goals, but the requirements of the public today. If you do not have a product that the consumer wants, that is a big driving force too as it goes hand in hand with the way our society and the opinions of the public are developing." (Interview #5)
Accessibility	3	Closeness	#2	"This relates to one of the key policies, which is to develop this 15-minute neighborhood. It is also part of a part of the green plan, and of course it is also related to how convenient you can get from point A to point B, and it's also related to how [...] to make the city more livable." (Interview #2)
		Reliability (2)	#6, #7	
Politics	1	Policies	#7	"The motivators, they are the policy that they are operating under and the will of the owners." (Interview #7)
Borgarlínan	5	Changing customers behavior (2)	#2, #3, #6, #7	"[...] that is also when the opportunities come, like we are trying to encourage people to use multiple low transportation [...] for example, Borgarlínan is a key project." (Interview #2)
		More reliability (2)		
		Use low transportation		
Health Impacts	1	Health issues	#6	"When we have tight streets that lead up to those main points of interest, and right next to healthcare [...]. And having buses running up to Hallgrímskirkja, does create friction between the inhabitants going with the small child's to the kindergarten, which might even close, the outdoors for the kids because of the buses, because of the CO2 [...]" (Interview #6)

Note. Created by the Author.

4.1.1.3. Economic drivers

The last category in this section covers the economic drivers. In five interviews, costs, incentives, investments, and ticketing came up. An overview of all the economic drivers is found in Table 7. Cost was mentioned in three interviews and can be separated into two main aspects: reduced costs for the operation and maintenance of electric buses and increasing fuel prices. The first aspect seems to be especially of importance for the

companies, with one interviewee mentioning, *“maintenance or the operational expense on electric buses is much, much lower than it is diesel bus”* (Interview #1), and interviewee #7 stating that the cost of operation lowers when switching to electric buses. As for the increasing fuel prices, in an interview with a company representative, asking what drives the company towards more sustainability, the person replied that fuel prices play a big factor (Interview #5). This was also seen in other interviews, with another interviewee mentioning: *“Other companies are also dealing with increased costs, you know they are still so dependent on diesel fuel, and that has been rising”* (Interview #7).

Incentives were only mentioned in one interview, where the person went into the benefits and potential drivers of using incentives, as seen in other countries, such as Norway. The example in Table 7 shows that VAT deductions for zero-emission vehicles are a valuable government incentive and can potentially positively stimulate the economic market. In addition, the person stated that recalculating the value per kilogram of CO₂ can make a big difference, especially for heavy-duty vehicles such as trucks:

If you calculate the incentive per kilo CO₂ for both units, then you end up with a ridiculously high amount of incentive that the truck should get [...]. We are talking about a figure somewhere around €200.000 [...], and even €200.000 would be less than the incentive they give to a car today per kilo CO₂ in the lifetime of the vehicle. (Interview #3)

These incentives have only partially been implemented in Iceland. However, the quote shows that these incentives can drive and stimulate the market, as shown in other countries. Therefore, if Iceland focuses on incentivizing private electric vehicles, recalculating the prices of CO₂, or adding some VAT reduction for electric buses or trucks, it can positively impact sustainability in public transportation. Regarding investments and financial aid, it was mentioned that investing in more sustainable options is essential *“it just healthy for the business to think about this and try to be best of it”* (Interview #8). Additionally, interviewee #7 also stated the possibility of applying for a specific grant from the Ministry of Environment, Energy and Climate to drive the investment further.

Bus ticket issues were also highly discussed, especially with Strætó new ticket system. Some mentioned, for instance, how it can drive sustainability in the public transportation

sector. Introducing a new ticket system will, for example, reduce paper waste by reducing the use of paper tickets by switching to contactless payments, the use of cards, or an app: *“There was a lot of waste there, so we start to think how we can make this paper waste, paperless and we introduced an app in 2014”*. This can also be seen in the example provided in Table 7.

Table 7 provides an overview of the economic drivers mentioned in the interviews. Four main themes were noted, including costs, incentives, investment, and bus tickets. Table 7 shows the frequency of how often each theme came up and in which interviews this was the case, finishing by giving additional examples for each theme.

Table 7. Economic drivers overview.

Economic Drivers	Total Frequency	Individual Aspects	Interviews	Example
Costs	5	Higher fuel prices (2)	#1, #5, #7	<i>"I think for their operations in the long run. They will actually reduce cost if they switched to electric buses."</i> (Interview #7)
		Reduced operation cost (3)		
Incentives	1	VAT reduction	#3	<i>"[...] mentioned the VAT deduction of zero-emission vehicles [...], and I think that was the best incentive which has been made for this implementation and did exactly what it was supposed to do. So, it showed that with some contribution from the government, you can actually stimulate the market quite a lot."</i> (Interview #3)
Investment	2	Applying for grant	#7, #8	<i>"There is also a budget, they can also apply for a grant from the Ministry of the Environment, Energy and Climate to even get some money to help with the investment."</i> (Interview #7)
		Healthy for business		

Economic Drivers	Total Frequency	Individual Aspects	Interviews	Example
Bus Tickets	2	Less paper use Contactless payments	#1	"Then probably soon we are introducing the EMV, [...] it is contactless payments." (Interview #1)

Note. Created by the Author.

4.1.2. Barriers of sustainable public transportation

This section covers the different barriers mentioned in the interviews, separated according to environmental, social, and economic themes and relevant sub-themes.

4.1.2.1. Environmental barriers

The environmental sustainability barriers are seen in Table 8. Technology, different fuel types, and efficiency were most often mentioned. Regarding technology, most barriers mentioned relate to electric buses and batteries. The range of the batteries needs to be longer, specifically for longer distances, which might not necessarily be a problem for transportation within the city, but for outside trips such as airport transfer. Interviewee #3 mentioned explicitly that regional buses to Akureyri must be operated differently if switched to battery electric. They will need to plan more frequent and more prolonged stops to recharge. On the other side, interviewee #3 states: *"The short-distance buses inside Reykjavik should be able to do it on batteries because that is a more efficient way to do it."* The range problem also arose in other interviews where the efficiency of battery-electric vehicles was discussed, highlighting that until the batteries can last for longer distances and get lighter, it will not be an option for the bus operation companies, specifically in the case of coach buses:

So at least for now, we have to get battery that is lighter, you know to get some luggage also in the buses and also more range. You know it has until it will be around 500 kilometers, 400 kilometers. At least 400 real kilometers. [Until] then, I don't see it as an option. (Interview #8)

Similar to interviewee #8, the size of the batteries was mentioned as a barrier in other interviews. This is mainly a problem for the private companies operating coaches, as the technology needs to be developed to match the needs of these companies given the sizes

of their coach vehicles, requiring a reduction in other necessary space such as seating or storage spaces. Interviewee #5 stated they are concerned with the current size of batteries in coach buses, especially in terms of their effect on the usability of the buses. With the current standards, the usability of battery-electric coach buses is lowered by either a reduced number of seats or reduced storage level due to the battery, which can directly impact a company's productivity. The interviewee mentioned that companies operating coach buses mainly wait for new developments, such as smaller batteries with additional range.

The problem with current battery-powered buses in the capital area is that they are not entirely zero emission. While they use the electric battery to power the bus while driving, they still need diesel fuel to heat them, which is especially important for colder countries like Iceland. This was also discussed by one interviewee, who stated: *"There is also, of course, one disadvantage about being in Iceland. That is, it is not a hot country, it is a cold country. And we have to have a preheater on the buses, and we are using diesel today."* (Interview #1). The usage of diesel for pre-heating the buses often relates to the fact that the range of the batteries is sufficient for covering a full driving day and heating the bus as well, as driving a whole day takes away much energy and extra stops to charge have to be considered. Interviewee #3 even stated that the current electric buses are not able to cover a full shift without recharging: *"So even though we install a heater like a diesel heater, as it is in the current battery buses, you still have to stop for two or three hours in the middle of the day to charge them."*

This also draws the attention to other barriers, as stated by Interviewee #5, who mentioned that having more electric-powered buses also means that there is a need for more charging stations, either on location or even implementing intermediate charging stations during longer stops. While other energy options, such as hydrogen or methane, have been used and discussed in the past, it seems as if the focus is on battery electric vehicles, as mentioned by one interviewee:

Policymakers do not want to [change], so they emphasize things where they do not have to change as much for themselves. So, it is obvious that they will always choose the battery electric vehicle. Or even those hybrid vehicles, even if it is actually worse for the environment than battery electric. (Interview #6)

While the last two environmental barriers were only mentioned once, they are still important aspects to consider. For example, as recycling is an essential aspect of sustainability, some barriers regarding recycling of batteries still need to be discussed. Table 8 highlights the problem related to scooter batteries, but there was no mention in any other interview of what happens to the bus batteries after their use phase and what effects this can have on the environment. In addition, weather can be unpredictable in Iceland and impact the transportation system. While the example stated in Table 8 primarily focused on the Westfjords, it does show that some aspects of the transportation system are vulnerable to weather.

Table 8 offers an overview of the environmental barriers, with five main sub-themes, which include technology, fuel types, efficiency, waste, and weather. As in the previous tables, it shows the frequency of how often the themes were mentioned and in which interviews while providing additional examples for a better understanding of the environmental barriers.

Table 8. Environmental barriers overview.

Environmental Barriers	Total Frequency	Individual Aspects	Interviews	Example
Technology	7	Battery range (2)	#1, #3, #4, #5	<i>"So, the last bus show he went to he, they were saying that it would be a few years until they developed batteries that meet those requirements. So, we are not seeing drastic change in the next few years." (Interview #5)</i>
		Battery size in coaches (2)		
		COVID impact		
		Electric buses heated with diesel		
		No new developments		
Fuel Types	4	Charging station (2)	#3, #5, #6, #8	<i>"It is not easy to handle methane because they are only, I think it is one or two gas stations to filled up with the methane. And so that is maybe not the option for the whole fleet [...]." (Interview #8)</i>
		Focus on BEV or hybrid		
		No full zero-emission buses		
Efficiency	3	Light & smaller batteries needed	#8	<i>"If you are going to electricity, you know the range of the battery, now everyone tells you 300, 330km but we are facing 200 kilometres." (Interview #8)</i>
		Range of battery (2)		

Environmental Barriers	Total Frequency	Individual Aspects	Interviews	Example
Waste	1	Recycling batteries	#2	"You know it is very difficult to recycle the batteries." (Interview #2 - when talking about scooters)
Weather	1	Vulnerable for weather	#7	"It also has been important for the West Fjords, because the road system there is very vulnerable for weather." (Interview #7)

Note. Created by the Author.

4.1.2.2. Social barriers

Regarding social barriers, the most important ones seemed to be politics, motivation, accessibility, and public transportation usage. The specific barriers, with some examples, are presented at the end of this section. In the interviews, politics was mentioned by most of the interviewees. Some interviewees, for instance, do not believe that politicians want to change or are not forward enough with their actions and thinking. For example, one interviewee claimed that *"[...] the politicians in Iceland, they are very [much] behind the politicians in Europe in thinking about environment. I have never actually got this question [about LCA] from an Icelandic politician"*. Another interviewee stated that while there is an energy transition plan, the politicians do not want to change their own behaviors:

So, we have a plan, you know they, they call it like a transition plan or energy transition plan. [...] And those policymakers that are emphasizing on this transition, they do not want to change their own habits. [...] those policymakers they don't want to, and so they emphasize on things where they do not have to change as much for themselves. So, it is obvious that they will always choose battery electric vehicles. (Interview #6).

Another barrier that the public transportation in the capital area and the Borgarlínan project must face is the multiple stakeholders involved in the project. This makes communication difficult and can delay the decisions making process. This was especially shown with the election in each municipality, as newly elected representatives will have to understand and lead the project. For example, one interviewee mentioned that these

new people were a part of the Borgarlínan project after the last municipal elections and had to deal with the required high investments, which seemed to worry some of them (Interview #7). Regarding the different stakeholder's involvement, interviewee #2 mentioned that even decisions related to bus stops involve many stakeholders. While the cities own the bus stops, a private company often owns the advertisement screens. The hardware of the displays that show how far away the buses are is owned by the city, but the data belongs to Strætó. Additionally, the routes that Strætó drives are often co-owned, which makes communication and changes very difficult as it must move through many different entities before decisions are reached.

Political barriers are not only national, but also outside influences have impacted sustainable public transportation in the capital area, with two prominent examples being COVID-19 and the war in Ukraine: *"Yeah, the main challenges transportation companies here have to face when it comes to sustainability, and I mean COVID is a big part of that. COVID [...] and now the war in Ukraine. Higher prices on everything"* (Interview #4).

While the financial barriers are discussed under the economic theme, one interviewee mentioned that the government needs to increase financing. Interviewee #7 stated that during COVID-19, the revenues dropped while the costs increased. Additionally, some of the funds provided by the government to Strætó have not followed the interest rates as discussed initially: *"The amount [funded by the government] was supposed to follow an index stipulated in the original contract. But actually, the state has never followed the interest, just paid the same number."* (Interview #7). The interviewee also highlighted that the current payments are lower as initially defined.

While motivation is a primary driver, it can also act as a barrier or a hindrance, especially when the mindset of politicians and customers expresses no motivation to change and prefer using their cars over public transportation. In terms of the public, there seems to be much resistance, as stated by interviewee #3, as many residents own their cars and are used to driving everywhere. The resistance also influences the Borgarlínan project, with many people not believing in the new bus rapid transit system plans in the capital area and its potential. Consequently, Iceland is missing the ambition and mindset to change. One interviewee stated that more ambition is needed in the cities, and Borgarlínan plans to benefit the future and have a more city-like society (Interview #6).

Later, the person goes into the need for a change in mindset: *“We don’t have good public transportation. We don’t have all these things that make other cities attractive. So, the mindset in Reykjavik, at least, has to change in such a way that we emphasize on getting people back from other countries.”* (Interview #6). This is also related to brain drain³, which was mentioned in the interviews and was noted as a downside of the current public transportation system, or lack thereof:

[...] So, it is basically a leakage of knowledge. We have really educated people or population in Iceland. But the thing is, those who are most educated, they move abroad [...]. And the problem is that when people move abroad, they usually move to a city which has a much higher standard of living and much higher quality of life. And so, they do not turn back. (Interview #6)

Another barrier has to do with the current accessibility. It seems like the existing public transport has certain areas which are connected and accessible. In contrast, other areas appear to be more left out, with some regions having specific public transportation methods for employees but not the general public or visitors (Interview #4). However, the interviewees did not specify which area this applies to. In one interview, it was also mentioned that the current routes are intertwined and complex, so while most places in the capital area have bus stations, they are not always planned for the convenience of the people living there *“[...] instead the bus routes, they are really twisted. And yeah, they do not make any sense if you look at it from the point of view of a person going to work, for instance.”* (Interview #6). Additionally, the accessibility and affordability are also limited for people working from home, with one interviewee mentioning that there is no possible ticket option for people going to their workplace once or twice a week, making the month or yearly pass too expensive. This highlights that the current system is not functioning according to people's lifestyles (Interview #4).

In addition, usage and demand are significant barriers to sustainable public transportation which was mentioned in different interviews. One interviewee stated that

³ Brain drain is defined as the loss of skilled and educated personally from a country, sector or institution (Vega-Muñoz et al., 2021).

Iceland is “[...] a private car society” (Interview #4), and another interviewee said that “we have a low usage of public transport in general.” (Interview #7). Even for private companies’ demand can be a barrier, as stated in Interview #8:

[...] I don't get any more prices for each seat for each passenger if their car cost me 100 million or 40 million. [...] I will not get any more for each seat in the bus that will cost me €600.000, you know? Even if it is electricity, and I market it like that? [...] People they talk about the environment and everything like that, but they don't like to pay for it. (Interview #8)

Table 9 summarizes the different social barriers that came up in the interviews. Six barriers were mentioned, including politics, motivation, accessibility, population density, laws, and regulations, as well as usage and demand. Table 9 states the frequency and in which interviews they were mentioned. The table also offers additional examples on each barrier.

Table 9. Social barriers overview.

Social Barriers	Total Frequency	Individual Aspects	Interviews	Example
Politics	13	Elections (3)	#1, #2, #3, #4, #6, #7	"Because again, it is a little bit of our politics. The city is run by taxpayers' money. Usually, a lot of the resources are dedicated to education. There are not many resources [...]. And if we have resources on mobility, then it will be dedicated to Borgarlínan." (Interview #2)
		Financial resources (2)		
		Limited actions (4)		
		Stakeholders (2)		
		Outside influences (2)		
Motivation	9	Brain drain	#3, #6, #7, #8	"It is always question about the last krona. People talk environmentally and everything but they don't like to pay for it." (Interview #8)
		Friction between public and private		
		Lack of ambition (4)		
		Negative opinions (2)		
		Opposition to Borgarlínan		
Accessibility	6	Complex route system	#3, #4, #6, #7	"But then the next hurdle was how to get out of the out of those places, because so many of them
		Lack of accessibility (3)		

Social Barriers	Total Frequency	Individual Aspects	Interviews	Example
		Long travel time		<i>just stop in some gas station and there is no place where people in the wheelchair to get from there. We have a long way to go." Interview #7</i>
		Not fit for every lifestyle		
Population Density	2	City lacks density	#2, #6	<i>"And densification of the city, even though a lot of like older generation don't agree with that. It is very difficult to convince them to give up their cars." (Interview #2)</i>
		Need for densification		
Laws & Regulation	1	No rush	#7	<i>"There's a bit of a tendency, I think, in the developer market in Iceland. They are never in a rush. They just have some law and then they wait for the right time to build up." (Interview #7)</i>
Usage & Demand	6	Low usage (4)	#2, #4, #6, #7, #8	<i>"We do view public transportation or what have been viewing public transportation for the last decades more as a service for people who don't have driver's license. And the aim was, basically written in the master plan for Reykjavik in 1962. Where it says: until every adult has their own vehicle, public transportation has to be provided for those who don't have driver's licence. Or something like that." (Interview #6)</i>
		Master plan		
		Private car society		

Note. Created by the Author.

4.1.2.3. Economic barriers

Table 10 includes economic sustainability barriers. The cost was the most mentioned barrier in the interviews, mentioned 18 times in six different interviews. This was followed by infrastructure, funding, affordability, investment, and tickets/revenue. Regarding cost, it most often came up concerning the prices of electric buses. While some interviewees want the change from diesel to electric buses, the cost of these buses does

overshadow it. Generally, it was mentioned by multiple interviewees that there is a high initial cost of electric buses, with one explicitly stating: *“It is more expensive to buy, to invest in the electricity infrastructure and the buses. And when you are heavily affected financially, it is a temptation to go to the fossil bus because it is half the price of the electric bus.”* (Interview #1) and another interviewee declaring that: *“You can get two Euro 6/VI [standard] buses for one electricity city bus”* (Interview #8). It is not just the higher costs of the electric buses that are hindering the move towards sustainability within the sector, but also the higher prices of other materials that are needed for the necessary infrastructure. There specifically, COVID-19 and the war in Ukraine were noted as reasons for the increased prices of material and oil (Interview #4).

It is not just the general increase in the costs of the technology and materials, but other costs were mentioned as well. For example, recycling and other aspects of environmental sustainability were mentioned, including tracking air pollution, doing LCA's, etc. This is costly for the companies as they potentially must hire new personnel to monitor and keep track of these aspects, and thus the companies will have increased salary spending. Specifically, the interviewee said: *“If I have to be 100% in that [sustainability], it will cost me at least one or two guys, people just to monitor it and everything like that”* (Interview #8).

To have more buses driven with alternative fuel, there is not only the need and cost of buying these buses but also to invest and build the necessary infrastructure to refuel and recharge. A lack of infrastructure was another significant barrier mentioned in the case of moving towards more sustainability: *“I think mostly it is infrastructure. [...] You know the groundwork that you have to do before you can actually do this effectively, profitably, and efficiently. So that the customer will not feel that the service is lacking [...]”* (Interview #5). The lack of infrastructure is also a significant factor why other fuel types are not as prominent right now and will be challenging to implement for bus companies: *“If the bus company was offered cheap hydrogen buses today, they would not be able to buy them except somebody would build the infrastructure. The same with the battery electric buses, the same, actually, with methane dispensing.”* (Interview #3).

The barrier of infrastructure does not just involve the lack of charging infrastructure but also the road infrastructure, for instance, related to the Borgarlínan project, to

accommodate the separate bus lanes planned, which was mentioned in Interview #6. Furthermore, the interviewee also noted that the effects the electric vehicles have on the roads, compared to diesel fuel, are greater due to the increased weight of the vehicles: *“Electric vehicles are heavier, and they have more impact on the infrastructure. So, the wear and tear are worse from electric vehicles because they are heavier”* (Interview #6). This should be considered when planning on switching most, if not all, buses to electrically powered vehicles.

While everyone needs more funds, the question arises of how the transition will be financed, especially since five out of the eight interviewees mentioned a lack of funding or a need for more funding in the sector. This was especially highlighted in the interviews with the different company representatives, with one stating: *“If COVID hadn't affected us, we probably had invested in emission-free buses for 1 1/2 billion or something like that. But we had to use the funds for just keeping the company going.”*

When talking about public transportation companies, there are budget constraints, primarily due to COVID-19 affecting revenue, making companies unable to renew or invest in new fleets for the past years (Interview #7). Generally, this shows that more funding is needed for the companies to make a sustainability-related investment, such as for the Borgarlínan project. The examples shown in Table 10 suggest the need for a lot of investment, which overwhelms the newly elected representatives. They are tasked with a great deal of investment without seeing an immediate return in funds, as an investment is needed in new infrastructure, such as bridges and bus stops.

The last barriers mentioned were affordability and tickets, which are often related. While the ticket prices are high and everything is getting more expensive, there seems to be a lack of willingness to pay. The lack of willingness to pay was mainly mentioned in the context of customers: *“Everyone is thinking about the environment and everything like that, but like I said, no one wants to pay for it”* (Interview #8). This indicates that while the prices and costs of the companies are increasing, the demand and willingness of the customer to pay higher prices for an electric vehicle are not there. This was mentioned in interview #8: *“Even though I bring up luxury buses, people don't want to pay anymore for that instead of just packed in a big bus with a lot of other people.”* The buses will therefore double the cost amount, but the seat prices cannot increase by the same

amount. This highlights that the increase in costs would potentially be carried out by the companies, which is not always possible.

This brings up the question of affordability for the customers. Some might not be able to afford increased ticket prices. Furthermore, one interviewee mentioned the lack of ticket options and stated that having more options and generally affordable ticket options can help make public transportation more attractive (Interview #4). This highlights the importance of offering more ticket options to different lifestyles than currently available. In Table 10, six different themes of economic barriers can be found, namely costs, infrastructure, funding, affordability, investments, and tickets. In addition to the example mentioned in the section above, the table includes some quotes related to the themes mentioned.

Table 10. Economic barriers overview.

Economic Barriers	Total Frequency	Individual Aspects	Interviews	Example
Costs	18	Cost of infrastructure (2)	#1, #3, #4, #5, #7, #8	<i>"It is more expensive to buy, to invest in the electricity infrastructure and the buses. And when you are heavily affected financially, it is a temptation to go to the fossil bus because it is half the price of the electric bus. But you know, the operational cost of an electricity bus is 1/5 of the operational cost of the diesel bus." (Interview #1)</i>
		Cost of recycling		
		Higher cost for electric (9)		
		Higher prices		
		Higher costs & lower revenue		
		Increased interest rate		
		No willingness to pay (2)		
		Public transport not profitable		
Infrastructure	10	Borgarlínan need new roads/intersections	#1, #3, #4, #5, #6, #8	<i>"We want to because not all of our routes can have these buses with other than fossil fuels because of lack of infrastructure." (Interview #4)</i>
		Heavier buses		
		High cost of infrastructure (2)		
		Lack of infrastructure (4)		
		Need infrastructure investment (2)		
Funding	9	Difficulties with funding	#1, #2, #3, #4, #7	<i>"[The thing] about the bus fleet in Iceland is due to lack of funding. It is a very old fleet. Most of the buses that the bus company owns</i>
		Lack of funding (7)		
		Used funding for COVID		

Economic Barriers	Total Frequency	Individual Aspects	Interviews	Example
				<i>are very, very old.</i> (Interview #3)
Affordability	3	Need more ticket selections Not cheap No willingness to pay	#3, #4, #8	<i>"I will not get anymore for each seat in the bus that will cost me €600,000, you know?"</i> (Interview #8)
Investment	3	Afraid of investment Budget constraints Expensive investment	#1, #7	<i>"There are new faces in the mayor offices [...] and these people they are new to the project, they are scared of it. They just see a big Money Mountain moving closer and they are afraid of the investment."</i> (Interview #7)
Tickets	3	Lower revenue (2) No willingness to pay more	#7, #8	<i>"So basically, it is increased cost and a huge drop in fair box revenue due to COVID."</i> (Interview #7)

Note. Created by the Author.

4.1.3. Other aspects of sustainable public transportation

This section includes some codes and topics discussed during the interviews, which do not fit under barriers or drivers but are relevant to this thesis. These codes are separated into environmental, social, economic, and other. The codes are explained in more detail under each aspect, with an overview in Table 11.

4.1.3.1. Environmental aspects

Few interviewees talked about the different types of fuel used. While there seems to be a focus on electric-powered vehicles, there are also discussions on hydrogen or methane use. Table 11 highlights that hydrogen can have advantages compared to electric-driven buses, especially regarding the coaches. As the barriers showed, battery-powered coach buses are at a disadvantage because the battery takes away valuable space and has limited range. According to interviewee #3, hydrogen would fix some of these issues. Hydrogen is already used in other countries: *"Some are using hydrogen, [...] some in Germany. In Cologne, I think, they have 20 or 30 hydrogen buses"* (Interview #3). In Iceland, there is already development for producing hydrogen, and two buses already run on hydrogen: *"Reykjavik Energy is developing hydrogen production and, I think, we have two buses that run on hydrogen right now"* (Interview #2). Although this might not be a

current option, it is important to consider alternative fuels to find better and more sustainable options. So, there seems to be some interest in hydrogen infrastructure and vehicles: *“But if you have enough electricity, then hydrogen is a really clever solution because you can store it.”* (Interview #1). Bus solutions exist for many alternative fuels, with methane being directly produced in landfills in Iceland. Additionally, there has been a new development in bus technology, also to have articulated buses on electric power, however, Iceland lacks behind:

If there is one category in large vehicles which you could convert, it would be buses. So therefore, we are far behind, and I think it is mainly because of the lack of resources for the bus company, not that the bus company doesn't want to do it. It is a question of resources because still, this technology is more expensive than the conventional one (Interview #3)

4.1.3.2. Social aspects

One question raised in the interviews was who public transportation is for. One example is seen in Table 11, discussing whether public transport should be for everyone, even if that means the quality will be reduced. Then comes the question of which part of sustainability the focus should be on. For example, regional or rural public transportation in Iceland is very limited, as there is limited usage in these areas: *“Nobody was asking for it. [...] nobody was using it.”* (Interview #7). This limited use raises the question of whether the social aspect of giving accessibility to everyone outweighs the economic and environmental aspects of no one using the transportation mode. Another aspect was the potential changes needed, such as increased frequency of Strætó trips. In addition, Interviewee #2 mentioned that customers should get some education on sustainable transportation and micro-mobility, such as use of scooters. These scooters are gaining popularity, now being one of the most used transportation methods: *“This is not official, but most people get around by car, and the second one is by scooter.”* (Interview #2). This already indicated a gap in the market that the scooter covered.

The last aspect has to do with Borgarlínan, where the plan is to fix some of the issues of the current public transportation system, such as lack of frequency, by focusing on ridership with quick connections: *“Having excellent connections at some routes and*

hoping it can create a more sustainable public transportation system.” (Interview #7). The same interviewee then goes on to state that the end goal of Borgarlínan is increased walking and cycling, with fewer use of cars.

4.1.3.3. Economic aspects

There were a lot of economic barriers mentioned, however, some interviewees also gave ideas of what changes are needed. One, presented by interviewee #3, was that Strætó should contract with all their buses, and consequently, the switch to total zero-emission vehicles would happen faster than if the company takes care of the investments itself. Additionally, buying buses from different manufacturers is not something the bus companies are used to do but is something they should consider. Moreover, when talking about the Borgarlínan project, it is said that the improvement will help the buses and other aspects of public transportation: *“All this infrastructure development is not only about Borgarlínan and the buses. It is also about walking and cycling, and I gradually believe we are getting to a place where we have better cycling infrastructure”* (Interview #7).

4.1.3.4. Other aspects

Other important transportation methods were mentioned. As shown Table 11, Iceland has domestic flights and ferries, with the latter being a meaningful connection within and to the Westfjords and to different islands around Iceland. One ferry has already started using electric batteries, but the other ferries seem old. However, there are many possibilities for them to change to battery-powered ships, as they usually have long waiting times: *“That could easily be done on batteries. Ferries do not run that frequently that you can’t stop for a while and usually the batter capacity is quite high because the ferries need to have weight.”* (Interview #3). So, while the weight of the batteries can be a significant barrier to road transportation, it might benefit water transportation.

Another type of transportation mentioned during an interview was using a train to cover the airport transfer to and from Keflavik. A few years ago, there was a discussion about building a train to connect the capital area to the airport, especially with all the tourists coming to the island. However, it does not seem to be economically viable: *“We have 2 million people coming into the airport, so I would think it is possible. Calculations indicate that still, you would lose money on it.”* (Interview #3).

Table 11 gives an overview of other aspects, which are separated into four main aspects of environmental, social, economic, and other. Each of these aspects has specific themes that did not fit into section 4.1.1. or 4.1.2. The table includes the frequency of mentions in the interviews and an example.

Table 11. Interview overview – other aspects.

Other aspects	Total Frequency	Individual Themes	Interviews	Example
Environmental	11	Fuel types	#1, #2, #3, #6	<i>"A lot of people say that coaches should rather be on hydrogen, because then you need less space for storage and less weight, and you have more weight and storage room for the luggage" (Interview #3)</i>
		Resources		
		Technology		
Social	14	Borgarlínan	#2, #3, #5, #7, #8	<i>"You know who should we serve with public transport? Do we serve absolutely everybody? And I think even in the capital are they can't do that and that will reduce the quality of the system if you try to do that so. The second option is then, are you going to be selective and choose good routes and try to get people that good routes?" (Interview #7)</i>
		Changes needed		
		Other transportation		
Economic	8	Borgarlínan	#3, #4, #7	<i>"When I looked at this I saw a golden opportunity for Strætó to buy a fleet of buses that would use this entire stream of methane. For some reason this was never an option because I think there was something that even though Sopra and Strætó are more or less owned by the same municipalities, the methane couldn't go to Strætó for free. They had to be pay some payments and suddenly it didn't make financial sense for Strætó to buy this methane. Basically, from the same pocket." (Interview #7)</i>

Other aspects	Total Frequency	Individual Themes	Interviews	Example
Other	9	Other transport	#3, #7	"In Iceland we define the domestic air and the ferries as part of the public transport system, since we don't have trains. We have one ferry running on electricity, the rest is all on the fuel." (Interview #7)

Note. Created by the Author.

4.2. Sustainability of public transportation companies

Overall, 21 drivers were mentioned, and 22 barriers in relation to the sustainability of the public transportation companies. The main themes, according to the Five C framework (Jóhannsdóttir & McInerney, 2018), include commitment, configuration, core business, communication, and continuous improvement. The most mentioned barrier was communication ($N=8$), with continued improvement being the most mentioned driver ($N=7$).

4.2.1. Drivers relevant to the Five C framework

This section covers the drivers mentioned in the interviews, according to the Five C framework, but more details on the drivers can be found in Table 12.

4.2.1.1. Commitment as a driving force

When it comes to the drivers of a company's commitment, leadership was the only aspect mentioned in the interviews. More specifically, the strategy and vision relevant to leadership can drive a company's sustainability forward. For example, one interviewee talked about how they themselves find the strategy and vision important for the company to move forward, especially as part of a strategy for making the company more sustainable:

COVID has affected us as many other companies. So, it had a great impact on the strategy of making, for example, the bus emission-free. [...] So, we are working on that strategy, which is part of the leadership. But of course, the vision of the top management is clearly very important for the strategy. (Interview #1)

In another interview, leadership was mentioned as driving the company forward by being open to changes toward more sustainable solutions, as seen in Table 12. Again, this highlights the importance of leadership not just within a company but also in making the company more sustainable.

4.2.1.2. Configuration as a driving force

One crucial aspect mentioned multiple times in the interviews was the company policies. The policies seem to be an essential step towards sustainability, as they help set the target and actions the company wants to achieve, as seen in Table 12. This was supported in another interview, with interviewee #5 stating: *“We are very proud of having such a new fleet. It is both good for us as a company and also something that our employees value. [...] So I mean that is a policy we are actively following, in terms of fleet renewal”*. So, these policies can drive a company towards more sustainability and make it more tangible for others to understand what it is doing. Additionally, some of the internal actions of a company can be considered drivers, such as having certifications, including ISO certifications, but it can push a company to continue its path of becoming more sustainable, as they are internally motivated to keep these certifications: *“We have a certification, and we have to meet the criteria to maintain that certificate”*.

4.2.1.3. Core business as a driving force

Two main aspects were mentioned regarding the core business of public transportation companies. These are the different services offered and then the buses. One of the services for the privately-owned companies is operating the airport transfer to and from Keflavík airport. One interviewee mentioned that this will be the first route to become electric because of the contract they have with the airport but also because it is always the same distance, thus easier to prepare for in terms of charging the vehicles: *“We have a contract with Keflavik Airport. We are running, back and forth to Keflavik Airport and probably there will be our first electric buses because that is always the same route.”* (Interview #8). Additionally, the reduced maintenance of the electric buses seems to drive some companies towards this option: *“Can also have other benefits, for example on maintenance which again goes into how we sustain our operations”* (Interview #5). Furthermore, the same person specified: *“We know that going into the electric buses will also help us a lot with maintenance. There are some very positive elements for reduced*

maintenance with electric buses.” As shown in Table 12, companies seem to focus on acquiring eclectic buses to reduce maintenance and because of energy efficiency. This indicates that there is pressure within the sector to move towards more sustainable options. This is strengthened by outside drivers, such as the customer's satisfaction with less noisy buses: *“But of course, we also find that the people who have actually experienced the usage of electric buses, they are really happy with them. You can talk easily inside them, and there is less noise when you drive through your neighborhood”* (Interview #1).

4.2.1.4. Communication as a driving force

The drivers mentioned concerning communication were external communication and stakeholder engagement, highlighting a push from the outside to move to more sustainability. The examples in Table 12 show that there is mainly a driving factor from the companies' stakeholders as sustainability becomes increasingly important. In another interview, it was also stated that their customers have requirements for them to have more environmentally friendly vehicles options:

But certainly, our marketing and sales department advertises and informs our clients of what type of buses we are using, and some of our bigger clients have some requirements that they need specific things. So, they require certain things in the buses, so obviously, that is communicated upwards to them.
(Interview #5)

Additionally, issuing a sustainability report can act as a driver for a company. This provides employees and other stakeholders a good overview of what is happening within the company, and it is easy to understand what still needs to change and where more action is necessary: *“It is beginning to be a major part of our reporting. Now the old days, it was the financial report, statement, etc., and now it is just part of the sustainable report. So, we are putting more and more visible signs to the employees [showing] that we really mean what we want.”*

4.2.1.5. Continuous improvement as a driving force

Most of the factors discussed in relation to continuous improvement have to do with certification, more specifically ISO certifications, that push the companies towards more

sustainability, either because they want to keep their certificate, see Table 12, or because they want to achieve the certification. For example, with interviewee stated: *“We like to have an ISO certification, and that is why we are aiming for in the end at least”* (Interview #8). Thus, having these types of certifications is important in sustainability. In general, the companies seem to move towards more alternative fuels, such as electricity, and are focusing on acquiring new buses within the next few years:

We will always move towards getting the best possible fleet, having the best fleet possible at each given time. [...] At one point in the next 10-15 years, I would expect that the majority of the fleet would be electric. But definitely, in the city buses, we will see the whole fleet moving quicker in that part than on the coaches' side, and at the end of this decade or early next decade, we will probably have only electric buses in public transportation. (Interview #1)

An overview of the drivers related to the Five C framework can be seen in Table 12. It can be separated into the five C's, each mentioning different aspects and an additional example of what has been stated above.

Table 12. Five C framework analysis of drivers.

Five C Drivers	Total Frequency	Individual Aspects	Interviews	Example
Commitment	2	Leadership	#1, #5	<i>"Leadership in this company is very positive towards changes into this direction and they are very active in finding more environmentally friendly solutions [...]." (Interview #5)</i>
		Strategy & Vision		
Configuration	5	Certification	#1, #5, #8	<i>"[...] and of course we have set this Policy around making the fleet mission free." (Interview #1)</i>
		Green bookkeeping		
		Policies (3)		
Core Business	5	Airport transfer	#1, #5, #8	<i>"I know, I know, and today it's really expensive. But although the electricity is expensive, you are seeing more or less all the bus company asking for electricity bus. [...] So you get 90% energy out of the diesel, you get 75-80% out of the electricity and you get 30 or 40% out of the hydrogen. [...] So yeah, I don't know if you</i>
		Electric buses (2)		
		Fossil fuel buses		

Five C Drivers	Total Frequency	Individual Aspects	Interviews	Example
		Services		<i>understood me. But we think that electricity will be the future energy, at least for the next 10-15 years."</i> (Interview #1)
Communication	2	External communication Stakeholder engagement	#5, #8	<i>"But I think everyone, stakeholders and everything, is thinking about the same. But how we will do it?"</i> (Interview #8)
Continuous Improvement	7	Better buses Certification (4) Electric buses (2)	#1, #5, #8	<i>"We have a certification, and we have to, you know we have to meet the criteria to maintain that certificate"</i>

Note. Created by the Author.

4.2.2. Barriers relevant to the Five C framework

This section covers the barriers, separated into five main themes: commitment, configuration, core business, communication, and continuous improvement. The subthemes and underlying barriers are found in Table 13.

4.2.2.1. Commitment as a barrier

Leadership can both be a driving force and a barrier, such as in the case of outside influences that can impact leadership effectiveness and budget allocation. One of the major aspects that impacted the companies was COVID-19, see Table 13. In this case, it was thought to have affected the company strategy, mainly related to the use of funds. Instead of investing funds in realizing the strategy, it was used to cover the revenue loss. Similarly, limits of funding can also be a barrier to the vision: *"There is one side effect of this strict vision that is, for example, we haven't got any more funding for investing in buses. So, from the time we set this vision, we have only been able to buy fewer buses [...]"* (Interview #1). While the vision and strategies can drive the company forward, they are limited to the available resources that must be considered when making and finalizing the strategy.

4.2.2.2. Configuration as a barrier

The limit of funds and resources is relevant to the theme of configuration. For example, here it was mentioned that while the company might have a strict policy for investing in electric buses, fewer buses were purchased due to the higher prices: *"We have been really strict in this policy because of the investments we had. So, before we set this policy,*

we could buy 10-12 buses each year for this investment, but when we started to buy electric buses, we could only buy five buses” (Interview #1). This is an especially relevant barrier when the company depends on other types of funding besides revenues. This funding often comes from the municipalities or the government, which is the case for publicly owned companies, as they need the approval of their budget on many different levels from the executives, company board, and municipalities. A topic brought up was the need for governmental support, especially after COVID-19, but as of now, the government is negotiating a contract that will increase the use of public transport in the capital area. Additionally, other barriers can arise when the company has not set a policy, see Table 13.

4.2.2.3. Core business as a barrier

Funding plays a big role in the case of the core business, especially since buses are a crucial component of the core business of public transportation companies in Iceland. Switching to electric buses is significantly more expensive than the ones running on fossil fuels. This was also stated in an example used in Table 13. However, the barrier of dealing with more expenses while recovering from COVID-19 is seen in other interviews: *“Right now it is just surviving and dealing with after COVID and trying to make some profit, then we have to think about the rest”* (Interview #8). Additionally, there seems to be no incentive for privately-owned companies to switch to the more expensive electric buses:

The size of the batteries does take away from the usability and the economic part of buying new buses, and so basically, those who are in the coach business, we are waiting more for the development of smaller batteries. So, we can get the same value and same usability for the buses that we buy. Because, of course, the number of seats and the length of the bus directly affect the service level and the productivity of the bus. (Interview #5)

Interviewee #8 also mentioned that while the companies must cover the higher prices for the buses, they will not be able gain higher revenues as people are unwilling to pay the higher costs, even if the buses are marked as being electric and environmentally friendly. These higher prices are in addition to the other barriers, specifically related to the batteries, which have limited range, heavier vehicles, and less space within the bus.

4.2.2.4. Communication as a barrier

Communication seems to be the most significant barrier, given how often it was mentioned in the interviews. Two underlying factors were barriers to internal and external communication and partnership and collaboration. For external communication, one interviewee talked about the company not being good enough at communicating externally. Many people seem unaware of the efforts to buy more electric vehicles. Additionally, the same interviewee mentioned that limited funding is also a barrier to communication, such as in the case of advertisements and image campaigns: *“We have talked about some kind of image advertisement. But we will just have to find some funds for it. That is the main problem or the main threshold for it.”*

Partnership and collaboration are significant barriers in the case of public transportation. Often, many different actors are involved in public transport, especially on a political level, by having different municipalities involved in the capital area, which can lead to a clash of interests: *“We do sometimes have a clashing of interest, where we don't agree on things”* (Interview #6). Thus, collaboration can often be complex: *“How to collaborate vertically and horizontally is also a thing because it involves a lot of different divisions. It is not only about the bus [...]”* (Interview #2). Some of the friction relates to the Borgarlínan project, but it does show that collaboration between different political actors and entities can slow down the process, especially if public transportation companies need funds, they are reliant on the collaboration between the municipalities and the government.

4.2.2.5. Continuous improvement as a barrier

There are some current barriers companies face when it comes to continuous improvement, for instance, in the case of infrastructure. While some companies seem to have a strategy and policies to upgrade their buses, they also need the necessary infrastructure to support their change of fleets. Most often, this involves some expensive changes, such as changing building sites that are better supported by the grid, given the need to charge multiple electric buses simultaneously, see Table 13. Other barriers relate to increased costs and limited resources. For example, one interviewee mentioned that they still need to develop a policy or strategy to implement changes. As a result, they will need to consider increased costs, not just for purchasing the vehicles but also for hiring

new personnel to cover things such as monitoring the company's sustainability. So, while the company's motivation might be to move towards more sustainability, they can be limited by the available resources and more imminent challenges rather than looking into plans.

Table 13 provides an overview of the barriers related to the Five C framework, providing examples of the overall themes. Additionally, the table shows how often barriers were mentioned in each of the C's and in which interviews they came up.

Table 13. Five C framework analysis – barrier overview.

Five C Barriers	Total Frequency	Individual Aspects	Interviews	Example
Commitment	2	Strategy	#1	<i>"COVID has affected us, as many other companies. So, it had a great impact on the strategy of making, for example, the bus emission free." (Interview #1)</i>
		Vision		
Configuration	4	Company structure	#1, #8	<i>"I don't know. But, I think everyone, stakeholders and everything, is thinking about the same. But how we will do it? We haven't sat down and make one policy about that." (Interview #8, when asked about future plan on sustainability)</i>
		Corporate governance		
		Policies (2)		
Core Business	7	Battery size	#1, #5, #8	<i>"It is more expensive to buy, to invest in the electricity infrastructure and the buses. And when you are heavily affected financially, it is a temptation to go to the fossil bus because it is half the price of the electric bus." (Interview #1)</i>
		Electric buses (4)		
		Services: ticketing (2)		
Communication	8	Campaigns	#1, #2, #6, #7	<i>"I think maybe we were a bit underestimating the preparation time needed for all this to move into implementation states. It is incredibly. It increases the level of confusion and difficulty incredibly much when you have so many municipalities in between." (Interview #7)</i>
		Clashing of interest		
		External communication		
		Partnership & collaboration (5)		
Continuous Improvement	3	Charging stations	#5, #8	<i>"Going into the future, we will probably have to build new grounds just from the scratch that basically is designed around charging stations. In our current</i>
		Cost		
		Policy		

Five C Barriers	Total Frequency	Individual Aspects	Interviews	Example
				<i>headquarters we basically don't have the capability of building the necessary infrastructure. So, we will probably see us moving into building it from the ground up so it is going to be [needing] funding." (Interview #5)</i>

Note. Created by the Author.

4.3. Five C framework business analysis

The following section includes the analysis of information from three different companies. First, the information gathered during the interviews will be analyzed, followed by an analysis of the information relevant to each company based on information found on their websites. This is done using the Five C framework (Jóhannsdóttir & McInerney, 2018).

4.3.1. Five C framework analysis

While the first two sections focused on the drivers and barriers of the companies, separated by the five C's, this section focuses more on the companies' current status to get a deeper insight into what they are currently doing regarding their sustainable strategy.

4.3.1.1. Commitment

Regarding leadership, two different aspects came up, namely, vision and training. the vision, with one company noting that they have a vision established in the company. Then all interviewees from the three public transportation companies agreed that leadership influences their companies and if they are moving towards more sustainability. In all cases, the leaders of the companies seem to be very open and positive about making these changes which also affects their employees: *"Going into the future, our leaders in this company are very open-minded when it comes to that, and we feel it, it trickles down. So, they are able to affect other employees in the company with that mindset, which is important going forward"* (Interview #5).

Additionally, most companies have training in place for their employees. This includes learning about the environmental impact, handling certain materials, reducing and reusing new employee courses, and establishing a mentor system for new employees. It

was also mentioned that most often, employees are trained on the buses and made aware of specific certifications, so they can familiarize themselves with them and the environmental policy:

When it comes to training employees, all our employees go through basic training and are trained on all our buses. They are also made aware that we have an ISO certification, so they need to familiarize themselves with our environmental policies. We have put quite an emphasis in the past few years on ecological driving.

However, only some companies have training in place, with one interviewee mentioning that COVID-19 impacted what kind of training they offered to their employees, which is very limited. Next to the training, it was mentioned that one company has installed charging stations for their employees at their headquarters to use for free while at work. This was done to incentivize them to use less fossil fuel-driven vehicles and instead be able to use electric vehicles. Additionally, another company representative specifically mentioned that they have policies that focus on equality within the company to ensure that everyone is treated fairly and with respect, which can be seen in Table 14.

4.3.1.2. Configuration

Three main aspects mentioned concerning configuration were policies, the company structure, and some of the internal actions carried out. All company representatives said that their companies have policies in place. For example, one stated: *“We have set this policy around making the fleet emission-free”* (Interview #1), and another interviewee said that they have an environmental policy, which is also communicated to their employees. When asked about their environmental policy, the third company interviewee mentioned that they are trying to stick to it. However, later, it was noted that there is a need for new policies and strategies to be put into place, which is not a current focus.

When talking about the company structure, this was mostly related to the publicly owned company, as the interviews highlighted the importance of municipalities for funding. Additionally, interviewee #3 mentioned that Strætó has contractors that are

servicing about 50% of the routes. With one interviewee discussing that Strætó should consider having contractors for all their routes, which can also help with the financial aspect of purchasing electric buses, as this will then fall onto the contractors. The structure of privately-owned companies is simpler. While Strætó has a board and municipalities to report to, a privately-owned company mainly has its board and some key stakeholders. As such, some private transportation companies are contracted by Strætó and Keflavik airport and need to fulfill specific requirements based on these contracts, meaning that the stakeholders can require, for instance, the latest Euro standards or electric buses.

The last aspect of configuration involves the internal actions the companies have implemented, see Table 14. For example, an interviewee mentioned recycling waste, energy saving, and less water consumption. The same interviewee mentioned green accounting for the past years and the publication of an annual sustainability report. Part of the internal actions also includes implementing different tracking systems. For example, one company representative explained a use of a systems on buses to track their usage, idling, and tracking whether the drivers follow driving protocols. This can, in turn, result in internal disciplinary actions according to the company's internal policies. Monitoring employees to see if specific procedures can be improved was also discussed, as well as using certification criteria to keep track of progress, such as using different ISO certification standards.

4.3.1.3. Core business

The two aspects of the core business are the buses and the services they provide. As the buses relate to the core operation of bus transportation companies, interviewees often mentioned them in the case of sustainability. Most often, companies want to purchase emission-free vehicles, mostly electric-powered ones. However, while this seems to be the focus, many companies also report problems, primarily related to the financial aspect of it, as electric buses cost almost double than diesel-powered buses with the highest Euro standard. However, there are 16 electric buses currently in Iceland, with 15 being operated in the capital area, and many companies planning on purchasing even more electric buses in the next few years.

Another company representative mentioned that they have the newest fleet and put a strong focus on renewing it, always going for the highest Euro standards at any given time. This also has other benefits for the company, as employees prefer the new vehicles due to their easy drivability and increased safety. Additionally, the privately-owned companies already have plans to introduce electric vehicles for their airport transfer, and the pick-up services run in the capital area. As for the services, the ticket system is a focal point, see Table 14, highlighting that implementing more digital ticketing systems or having the ability to pay electronically can and has reduced the paper waste of the tickets. Additionally, interviewee #5 mentioned that they had increased the utilization of their buses, ensuring that they do not leave half empty, and have seen great results since implementing this policy.

4.3.1.4. Communication

Communication was frequently mentioned, also from interviewees not working in transportation companies. In terms of internal communication, the interviewees stated the relevance of the intranet for communication and making the sustainability reports available to their employees internally. However, two interviewees stated that there is no or limited external communication: *“We could do a better job externally, that is for sure”* (Interview #1).

For stakeholder engagement, one interviewee mentioned the involvement of their customers in categorizing the waste and making the ticket system easier to use. Additionally, there are specific outside pressures from stakeholders to become more sustainable because of societal requirements (Interview #5). As for the publicly owned company, the stakeholders are a lot more involved in the business, for one, as the municipalities are part of the decision-making process, but also customers through public outreach, especially now with Strætó’s involvement in the Borgarlínan project: *“Each neighborhood has to be informed of the change, and we are trying to be as democratic as possible, but then is also with public engagement programs [...]”* (Interview #2). Related to stakeholder engagement is also how transparent the companies are. For example, it was only mentioned once by interviewee #5 that their customers have different requirements for what type of buses they should drive, and their sales and marketing team are communicating this to their customers.

Partnership and collaboration were frequently discussed. This has to do with how public transportation is structured, with many different stakeholders being involved at different levels, thus, collaboration is a major feature. It seems that most transportation companies, but specifically Strætó, have close ties and meetings with different organizations and entities, with one interviewee stating: *“We have regular meetings with Strætó, and I think it is monthly, where we discuss different topics like a priority at intersections, timetables, and routes.”* (Interview #6). The privately-owned companies also attend some of these meetings: *“They come here for meetings, every now and then, but I would say that we have much, much close dialogue and cooperation with Strætó and the road administration then privately-owned bus companies”* (Interview #7).

Much of the cooperation is also done through contracting, see Table 14. Strætó specifically is involved with different organizations and companies, where either Strætó provides the service or where another company offers service for Strætó. Thus, communication is a crucial aspect of public transportation. These contracts can also set certain requirements, such as making sure that the buses that are contracted from other companies fulfill the latest Euro standards (Interview #4).

4.3.1.5. Continuous improvement

In the case of continuous improvement, some interviewees talked about changes in their fleet to make them electric: *“So we are hoping that in 2028 there will be, 80% of the fleet have electricity as an energy source.”* (Interview #1). Another aspect discussed was the use of certification to keep track of improvements, similar to the use of sustainability reports or, as shown in Table 14, using the newest Euro standards for their buses. In general, most companies mentioned different aspects they plan to implement in the future, such as investing in more infrastructure and making the requirement for their contractors that newer and electric buses will be needed when the contracts run out.

An overview of the general aspects are found in Table 14. In addition to specifying which aspects have been mentioned related to the specific C’s, it also provides an overview of the frequency mentioned and extra examples besides the ones provided in the text above.

Table 14. Five C analysis of the interviews – overview.

Five C Analysis	Total Frequency	Individual Aspects	Interviews	Example
Commitment	13	Empowering employees	#1, #5, #8	<p>"[We have] policies involved with equality and that people are treated fairly, with respect and that we treat people the same. We have a very diverse employee base, coming from a lot of different cultures, so we put a lot of emphasis in treating your coworkers with respect and valuing each other's [...]." (Interview #5)</p>
		Leadership		
		Training & skills		
Configuration	16	Company structure	#1, #3, #4, #5, #8	<p>"So, we have for many years been taking care of the garbage, the usage of the electricity, usage of water and of course you have set this Policy around making the fleet mission free." (Interview #1)</p>
		Internal actions		
		Policies		
Core Business	18	Buses	#1, #5, #6, #8	<p>"We introduced a new ticketing system and there we are more or less trying to get rid of the paper ticket we still have. [...] But we have decreased the usage of paper here in dramatically by changing." (Interview #1)</p>
		Services		
		Transporting passengers		
Communication	40	Internal & external communication	#1, #2, #3, #4, #5, #6, #7, #8	<p>"We have contract with Strætó that they provide the service to. So we do the contract with the workers who drive the buses. [...] It is because they have a special contract, so they also give us service to make the timetables, organize the trip of every bus. They run this system for us." (Interview #4)</p>
		Partnership & collaboration		
		Stakeholder engagement		
		Transparency		
Continuous Improvement	9	Euro standards	#1, #5, #8	<p>"But at least we have our all our buses with the highest Euro standard for the engine. We have all the buses with Euro 6/VI and that is the highest today." (Interview #5)</p>
		Investment		
		ISO certification		

Note. Created by the Author.

4.3.2. Strætó

Strætó is specialized in public transportation in the capital area of Iceland and has around 300 employees, including drivers, employees at the garage, washing station, warehouse, customer service, and their office (Strætó, n.d.-c).

4.3.2.1. The commitment of Strætó

Regarding the leadership of Strætó, the company has published a strategy for 2020 and a vision. The strategy mentions the importance of the company in being an essential link in terms of public transportation, offering a more sustainable way of transport to the residents of the capital area. Strætó clarifies their role and values as a service company, which includes cooperation, reliability, and driving force (Strætó, n.d.-c). In the strategy, their vision is described, which is separated into four different aspects. First is the first choice for the residents to move around the city to work and go to school by having direct routes, special lanes, and priority at intersections. Second, to have their fleet carbon-free by 2030 by following the government climate policy and investing in environmentally friendly vehicles, including electric, hydrogen, or methane. Additionally, it is mentioned that they will follow and try to include SDGs 11, 12, and 13. Third, include dynamic knowledge by using information technology to improve their customer service and education of their employees. Fourth, having a desirable place to work by enhancing the work environment and image of the company (Strætó, n.d.-i). Additionally, Strætó mentions that the customers and service will be the most important to ensure the vision is achieved (Strætó, n.d.-i).

Strætó offers four different parts of training. One of which is Competence+, a European educational project for public transportation. This training is divided into four categories: environmental awareness, awareness of disagreements, civic courage, and stress management (Strætó, n.d.-d). In addition, this training includes different innovative training methods, such as virtual reality scenarios, online self-learning, and different workshops (Competence+, n.d.). A second training offered is Icelandic language courses. Employees with another mother tongue can take a placement test and get sorted accordingly into a language course, but most employees have completed at least one level (Strætó, n.d.-d). The third training involves re-education for professional drivers. Accordingly, commercial passenger drivers holding a driver's license of D and D1

must attend 35h of retraining every five years according to the law. Strætó has an operating permit to retrain and hold courses for their drivers. Lastly, the company offers a mentoring system for new drivers, where employees can guide new members. In addition, they also have an education system called Eloomi, with instruction videos and educational material (Strætó, n.d.-d).

To empower its employees, the company mentions different aspects, such as enhancing its employees' knowledge and skills by emphasizing education and lifelong learning in the work environment. They also focus on improving the work environment and image of the company, which impacts employees' well-being in the company (Strætó, n.d.-i). Another thing Strætó mentions is having an equal pay system, which they have gotten a Versa certificate for 2022-2025, meaning that the company is complying with the requirements of equal pay standards according to the Icelandic law ÍST 85:2012 (Strætó, n.d.-d). The equal pay certificate aims to work against the gender pay gap and promote equality in the labor market. Finally, the sustainability report shows that the company has employed charging stations for their employees to charge for free when parking their cars at the Strætó building (Strætó, n.d.-b).

4.3.2.2. Configuration of Strætó

Strætó has issued 14 different policies, including an education policy, procurement policy, equal pay policy, equality policy, human resource policy, privacy policy, processing of personal information, policy against bullying, the scope of control, environmental policy, information security policy, presence policy, service policy and security policy (Strætó, n.d.-f). With these varieties of policies, the company seems to focus not only on the environmental aspects but especially the social aspects. For example, many policies target employees' well-being by emphasizing their mental and physical well-being, equality, safety, and generally a better work environment.

The equality policy of Strætó ensures equality between all employees following the laws of nr. 150/2020 and 86/2018 (Strætó, n.d.-b). In the 2020 strategy, Strætó focuses on the service policy, providing exemplary service to their customers in a safe, fast, and environmentally friendly way (Strætó, n.d.-h). They need intensive training and education for their employees and managers to fulfill this (Strætó, n.d.-i). Furthermore, the environmental policy entails the company's commitment to reducing the negative impact

they have on the environment. This is done by continuously improving the company operation and preventing pollution, by using energy technologies, looking after the natural resources, increasing the share of recycling, considering the environmental impact of new products, training and educating the employees to work more environmentally friendly, inform the public on benefits of public transportation and fulfill the requirements of the laws and regulations (Strætó, n.d.-a).

When it comes to the structure of the company, it is different from a privately-owned company, as part of Strætó is owned by the municipalities of the capital area, specifically Reykjavík, Kópavogur, Seltjarnarnes, Hafnarförður, Garðabær, and Mosfellsbær. Together with one representative of each municipality, a board is formed every two years. The board and the internal auditor are ahead of the executives, which include the CEO, the Human Resource director, and the head of operations. Then follow five different areas of the company, which are the Operations, Customer service, Finance, Human Resources, and Planning/routing system (Strætó, n.d.-e). In the company strategy, the importance of creating a positive and constructive workplace culture is mentioned, which is done through retraining and attracting talented employees that have useful education and knowledge (Strætó, n.d.-i).

As for the company's governance, the sustainability report of Strætó does mention what good governance should entail, including professionalism, direction, transparency, and responsibility. Additionally, the board acts in a supervisory role, setting the overall strategy and vision for the future, which aligns with the owner's policies. Therefore, it should also include the statement of governance (Strætó, n.d.-l). Strætó emphasizes the code of conduct for the board on the website, aiming to define the representatives' behavior and attitude. This mainly entails the main rules that should be followed, including laws, not accepting bribes, and respecting the role of the employees (Strætó, 2012). Another aspect of governance involves the laws and regulations Strætó must follow, with the main laws being nr. 138/2011, which is the basis of the local government act, and the laws on passenger transport and cargo transport on land nr. 28/2017 (Strætó, n.d.-l).

When it comes to the internal actions of the company, it published an annual sustainability report to the public that shows different aspects of the company, including

some environmental aspects. One part of the report mentions the emissions that the company produces. There it is stated that while the direct emissions are decreasing, their indirect emissions are increasing. Strætó also reports on waste management, showing that it has reduced over the year leading up to 2021 (Strætó, n.d.-I). Additionally, the company wanted to focus on three different SDGs, including 11, 12, and 13 (Strætó, n.d.-I). An environmental monitoring system is in place to understand the environmental information better. In the report, Strætó claims to follow the government climate policy to improve the quality of life. To do so, the company strives to invest in an environmentally friendly fleet and be involved in different climate-related projects, including the Green Plan of Reykjavík, connecting air quality monitoring stations, and encouraging the use of eco-friendly transport during the grey days (Strætó, n.d.-I).

4.3.2.3. Core business of Strætó

Strætó mentions that as a service company, the focus is on their customers' needs by shortening the travel time, increasing the frequency of their trips, and using information technology to improve customer service (Strætó, n.d.-i). Part of moving towards more sustainability within the company is to switch to more environmentally friendly vehicles, such as electric (Strætó, n.d.-i), to do so, a charging infrastructure is needed. Additionally, Strætó published a report in 2021 about different charging options and possibilities for installing the charging infrastructure at different bus stations (Strætó, 2021).

A second core business aspect involves the fleet, aiming to have a carbon-free fleet by 2030, using either electric, hydrogen, or methane vehicles (Strætó, n.d.-i). The sustainability report states that Strætó owns 77 vehicles, of which 57 are diesel, five are methane, and 15 are electric. Contractors provide the other part of the fleet. Kynnisferðir provides 52 buses and Hagvagnar 25, all powered by diesel, making the total fleet that Strætó operated or owned 154 vehicles in 2021 (Strætó, n.d.-I). Regarding energy consumption, Strætó sustainability report shows that the total use of diesel has decreased over the years, while the use of methane and electricity has increased. Additionally, eco-friendly driving has risen from 20% to 34%, while the GHG emission of CO₂ has decreased.

4.3.2.4. Communication of Strætó

One part of communication is stakeholder engagement. For example, in the sustainability report of Strætó, the company mentioned that it emphasizes its role in society as a service company, and one way for stakeholders, specifically the customers, to get more involved in the new tariff and payment systems as the implementation of the Klapp payments system has a direct effect on them (Strætó, n.d.-l). Additionally, the company offers public engagement by having direct feedback sections for customers to use (Strætó, n.d.-k).

Strætó has different stakeholders, including the customers, owner, government, suppliers, the community, associations, and employees. Regarding external communication, the company offers direct contact to customers through social media and emails, conducts surveys on public attitudes, regularly holds open meetings and consultations, and has a formal suggestions section (Strætó, n.d.-l). Furthermore, Strætó emphasizes good relationships and cooperation with its suppliers and additionally publishes much information about the company on its website, which is accessible to everyone. The company publishes an annual community report for internal communication and is in constant contact with the owners (Strætó, n.d.-l). As for the employees, the company measures annually whether the employees recommend Strætó as an employer and measure their job satisfaction.

As for transparency, the company is very open in publishing its policies, meeting minutes, financial information, reports, and other documents. Especially the sustainability report offers detailed information on the company's environmental aspects and the effect of implementing policies.

4.3.2.5. Continuous improvement of Strætó

There are different aspects that Strætó does for continuous improvement of its sustainability strategy. One is the 2020 strategy and vision published, detailing future plans (Strætó, n.d.-i). Additionally, the sustainability report, published annually, acts as a guide to see where the company can change and what is still needed to be done in terms of waste management, reduction of diesel fuel, or increasing safety at the workplace (Strætó, n.d.-l).

4.3.3. Reykjavik Excursions

Reykjavik Excursions is a tourist company that operates tours. It has been a travel agent since 1968 in Iceland. Additionally, the company offers airport transfers to and from Keflavík (Reykjavik Excursions, n.d.-a).

4.3.3.1. The commitment of Reykjavik Excursions

Regarding leadership, the company presents a vision on its website and explains the company profile. The vision is separated into four main goals, environment, safety and services, people, and society. The environmental goals are to decrease GHG emissions by the kilometers driven and increase the proportion of recyclable waste. For the second goal, safety and services, the company wants to reduce the number of absences due to accidents and initiate a service and quality policy. The third goal, people, involves increasing employee satisfaction, implementing certified payroll systems, and having an equal salary for equally valued jobs. Forth, the goals of society involve the purchasing policy and evaluation of suppliers (Reykjavik Excursions, n.d.-a; 2022). The vision highlights some aspects of empowering employees by increasing employee satisfaction and having an equal salary.

Regarding training and skills, Reykjavik Excursion does not explicitly mention what training is offer for employees. However, it is noted that employees are trained to increase their environmental awareness, eco-driving lessons are provided to their drivers, and employees are taught how to handle hazardous materials (Reykjavik Excursions, n.d.-a; n.d.-b).

4.3.3.2. Configuration of Reykjavik Excursions

While the company's structure is not specially mentioned or shown on the website, different management roles are explained, including the chief executive officer, chief financial officer, chief technology officer, chief operating officer for various services, and the head of human resource management. Reykjavik Excursion is part of Icelandia, connecting different tour operators (Icelandia, n.d.).

The company's policies include a privacy policy, where customers are informed about protecting personal information (Reykjavik Excursions, n.d.-d), and the environmental policy. The environmental policy aims to improve on different environmental issues and reduce negative impacts, which is done in compliance with the Environmental

Management Standard ISO 14001:2015. Another part of the policy defines critical environmental factors to manage and monitor. The managing and monitoring are especially focused on the responsible use of resources, reducing waste, and recycling. In addition, the plan is to renew the bus fleet, apply the best techniques, and offer eco-driving lessons to the drivers. Additionally, customers are informed about environmental protection, how to respect nature, and that suppliers and service providers with a certified environmental management system are mainly used. Lastly, it is stated that the company wants to issue an annual report that informs employees and other interested parties about their environmental issues (Reykjavik Excursions, n.d.-b).

It is worth noting that Reykjavik Excursion has mentioned two specific certifications they have received. One is the ISO 14001 certification for environmental management, which they received from the British Standards Institute (BSI) (Reykjavik Excursions, n.d.-a). In addition, the company also has two Vakinn certifications for the quality of the system and environmental system, with the environmental certificate being of Gold Class (Reykjavik Excursions, n.d.-a).

4.3.3.3. Core business of Reykjavik Excursions

As the company is mainly a tourist company, some of the services that are part of the core business are not as relevant for a typical public transportation company, such as the ones offering day tours and activities, car rental, group travel, or operating the highland bus. However, the company operates the Flybus, which is an airport transfer to and from Keflavík, and the Hop-on & Hop-off bus driving in the capital area relevant to the study. To make these parts of the core business more sustainable, the aim is to minimize the negative impacts on the environment and monitor the critical environmental factors (Reykjavik Excursions, n.d.-a; 2022). However, it does not mention how the company wants and has improved sustainability in these services.

Buses are a major part of the company's core business, as it is the primary transportation method. Reykjavik Excursion mentions that 100 vehicles of different variant sizes are operated, making it the largest and newest coach fleet in Iceland, with all the buses conforming to the highest safety standards (Reykjavik Excursions, n.d.-c). Additionally, as mentioned in the environmental policy, vehicle emissions are reduced by applying the best available techniques (Reykjavik Excursions, n.d.-b), but the company

received the sustainable bus of the year award in 2020. A big part of making the core business and the buses more sustainable is receiving different certifications, indicating that they have achieved and are keeping specific standards (Reykjavik Excursions, n.d.-a).

4.3.3.4. Communication of Reykjavik Excursions

Most aspects of communication are related to environmental policy, such as what aspects of internal communication are in place or what the company wants to include, namely, informing the employees about the environmental impact of the company and sharing an annual report on environmental issues internally. The aim is also to educate customers about the importance of protecting the environment and respecting nature, which involves external communication (Reykjavik Excursions, n.d.-b).

In terms of transparency, it is not explained what assessment is used to monitor progress, such as using LCAs for their buses' use phase. While it is mentioned that they share the environmental reports with employees, there is no mention of other stakeholders getting access to the reports. Additionally, the website does not mention if improvements have been made since the environmental policy's implementation.

4.3.3.5. Continuous improvement of Reykjavik Excursions

Regarding continuous improvement, Reykjavík Excursion does not mention plans besides their environmental policy and keeping to the ISO and Vakinn criteria to keep their certification (Reykjavik Excursions, n.d.-a; n.d.-b).

4.3.4. Gray Line

Gray Line Iceland is a licensed travel agency operating different tours around the country, including airport transfers between Keflavik and Reykjavik (Gray Line, n.d.-e).

4.3.4.1. The commitment of Gray Line

On their website, Gray Line mentions its beliefs, which are related to traveling and why it is so essential: *“Travel is opening the mind and soul to different cultures and traditions. It’s breathing new air, building self-confidence through experience and breaking bread with friends, old and new.”* (Gray Line, n.d.-a). While this might not be stated as a vision, it does give a good idea of why the company is doing what it is doing. However, there is limited information available online when it comes to a clear strategy or vision for the company and future plans.

The second aspect of commitment includes training and skills. Gray Line mentions hiring trained tour guides who know their fields. However, there is no specific mention of what kind of training is required or what type of training is offered to them within the company (Gray Line, n.d.-f). Additionally, in the environmental policy, there is also the mention of training employees and educating them on environmental awareness without further explanation (Gray Line, n.d.-c).

In terms of empowering employees, Gray Line mentions that diversity is important, and the aim is to have a diversified team (Gray Line, n.d.-b), but the information on what else is done to empower the employees is limited.

4.3.4.2. Configuration of Gray Line

Gray Line mentions two different policies. One is a privacy policy, this is primarily for the customers, indicating that the company is committed to protecting customers data. The policy details how and what type of information is collected (Gray Line, n.d.-b). Gray Line also has an environmental policy. The policy covers different aspects, such as training employees and educating customers and employees on environmental matters. The claim is that the company is working on reducing its environmental impact, including sorting and reducing garbage and promoting sustainable development by reducing the use of raw materials. If possible, the company wants to choose its suppliers based on their performance regarding environmental issues. Furthermore, the aim is to reduce emissions and air pollution when maintaining and renewing equipment. Lastly, it is stated that the business is conducted in line with national laws and regulations (Gray Line, n.d.-c). The environmental policy mentions that the company consistently monitors its operations to save energy and reduce garbage and water consumption (Gray Line, n.d.-c). However, the website does not list any specific measuring tools or actions the company is undertaking.

While the website also misses some information on the corporate governance and structure of the company, some internal actions are primarily mentioned concerning the environmental policy (Gray Line, n.d.-c). Additionally, Gray Line mentioned that the company is part of the Clean & Safe project, which was set up during COVID-19 and launched in 2021 and was approved by the Inspection Authorities in Iceland and World

Travel (Gray Line, n.d.-c). This project is based on a model which can help tourist companies to become more responsible (Ferðamálastofa, n.d.).

4.3.4.3. Core business of Gray Line

The core business of public transportation companies in Iceland can vary, as there is one main company responsible for the capital area, while Gray Line is one of the companies that offer airport transfers and is mainly a tourist company. Thus, their core business can be different from the one from Strætó. Some core services and activities the company is responsible including helping customers discover the country, offering different tours, having coach rentals, offering tour packages, and offering airport transfer (Gray Line, n.d.-g). However, the website has no information about what is being done for each of these services to make it more sustainable.

Another critical aspect of the core business is the buses, as these are the main transportation method for the company, especially the coaches. According to their website, Gray Line has a modern fleet of 70 coaches from Mercedes, Sania, and Volvo. Additionally, the company employs in-house mechanics and technicians to work on the vehicles (Gray Line, n.d.-d). In terms of practices to make this part of the core business more sustainable, Gray Line has in its environmental policy that all the vehicles either already have the highest EU standard, or when new vehicles are purchased, they will align with the highest EU standards (Gray Line, n.d.-c).

4.3.4.4. Communication of Gray Line

The environmental policy mentions that employees and customers can learn about the company's environmental policy (Gray Line, n.d.-c) as part of internal and external communication. However, other aspects of communication, such as stakeholder engagement, partnership, and collaboration, are not discussed. This shows there is limited transparency on the website in the case of the core operation. Especially there is no specific information about what type of standards are used or what is used to review the environmental policy, when it was reviewed last, or what changes have happened since the implementation.

4.3.4.5. Continuous improvement of Gray Line

Lastly, in terms of continuous improvement in the environmental policy, it is mentioned that Gray Line wants to review its environmental policies regularly while working on upgrading and improving its performance (Gray Line, n.d.-c).

5. Discussion

The main aim of the thesis was to explore the current public transportation system in Iceland's capital area and investigate the main drivers and barriers to sustainability in this area. A specific focus was on different public transportation companies exploring what they are currently doing for sustainability and what could be improved using the Five C framework for analysis (Jóhannsdóttir & McInerney, 2018). Overall, the results show that there are more barriers that sustainable public transportation faces compared to the drivers. Additionally, most barriers were mentioned under the economic theme, which often involves external aspects, such as increased costs, the lack of infrastructure, or the need for funding (Lin & Sovacool, 2020; Agaton et al., 2020; Guno et al., 2021). At the same time, the most mentioned drivers were the social drivers, often underlying internal factors that might not be as visible, such as motivation and social demands (Reyes-Carrasco et al., 2020; Saeed & Kersten, 2019).

Regarding the drivers and barriers to companies' sustainability, communication was often mentioned as a barrier. This aligns with previous research, like Pettersson and Hrelja (2020), that stated that communication, especially for public transportation companies, is difficult, as there are often different stakeholders involved in the decision-making process, and there is a high need for collaborations between various entities. As for the specific Five C analysis (Jóhannsdóttir & McInerney, 2018), there are differences between companies regarding what they are doing and reporting on their websites. Therefore, the following section will answer the five research questions proposed.

Drivers of sustainable public transportation in the capital area of Iceland

The results focus strongly on the social drivers, followed by environmental and economic drivers. The literature emphasizes positive environmental effects when upgrading to electric buses (Grijalva & López Martínez, 2019; Ellingsen et al., 2022). The LCAs of previous studies suggest that during the production phase of battery electric buses, the GHG emissions can be higher than for diesel buses (E. Zhao et al., 2022), but they make up for it during the use phase, which has significantly lower GHG emissions (Ellingsen et al., 2022). Moreover, the electric buses' environmental benefits increase the longer they stay in use (Ellingsen et al., 2022), which was also mentioned in the results. The results

also suggest other advantages of electric vehicles, such as noise reduction. This is especially important in residential areas as it can be disturbing to have loud buses drive around. This was also seen in previous literature, where Laib et al. (2019) found that while there was no noise reduction from electric buses on high-traffic roads, a noise reduction was recognized in more quiet residential areas when using an electric bus compared to diesel buses. Therefore, highlighting the importance of electric battery-driven buses, which are at the forefront as a solution for the sector.

As for the social aspect, the most significant driver was motivation. The results show the importance of personal belief in creating more sustainable changes in the sector and the need to see progress. In contrast, other interviewees are more motivated from a business perspective, indicating that while they might not see the need for more emission-free buses, they want to see change as it benefits their companies. Furthermore, with an increasing interest in the environmental aspect, through new policies (European Commission, 2022) and environmental groups and initiatives such as “Fridays for Future” emerging, the public has become more aware of the need for changes and is pressuring politicians and companies to make the necessary changes (Reyes-Carrasco et al., 2020; Saeed & Kersten, 2019).

Additionally, the public transportation sector relies on different projects and policies. While some might hinder the move towards sustainability, others can drive the progress forwards, such as the green city plan of Reykjavik. As mobility is an essential factor in this plan, it is necessary to make changes, such as increasing accessibility and generally motivating citizens to change their behavior to switch from their cars to other, more sustainable transportation modes, such as biking, e-scooters, or using public transportation (Reykjavíkurborgar, 2022). Past research has highlighted the importance of using incentives to change people's travel behavior, especially for people that are not reliant on cars, while for predominate car users, the use of advertisements and education to change people's attitudes was more effective (W. Chen et al., 2019).

Another driver mentioned was the Borgarlínan project. It aims to fix some of the problems and barriers the current public transportation system has. In addition, the results highlighted that Borgarlínan could shift customers' behaviors towards different, low-emission transportation modes and increase reliability due to special bus lanes and

priority at intersections. However, as mentioned in Chapter 2.4, the Borgarlínan project is still in its beginning phase, and it will take years to complete. Additionally, the results indicated that it is highly affected by political changes (Sajjad & Javed, 2022; Arias & Bachmann, 2022). Thus, it is difficult to predict what changes will happen and if the project can fix the identified barriers.

In terms of economic drivers, one aspect mentioned is the VAT reduction for zero-emission vehicles, specifically for buses in Iceland. As the literature shows, the government and municipalities can play a significant role in helping to make zero-emission vehicles more affordable (ZEBRA, 2019; Slowik et al., 2019; Miller et al., 2017). The literature does discuss different methods, such as offering incentives to help companies pay for these vehicles and using VAT reductions. However, other options, such as a carbon or fuel tax, can also be used. These incentives can help stimulate the market, engage companies to increase the number of zero-emission buses they can purchase, and help move public transportation toward more sustainability (ZEBRA, 2019; Slowik et al., 2019; Miller et al., 2017).

Barriers to sustainable public transportation in the capital area of Iceland

Most of the barriers mentioned concern the technology, the infrastructure, and the costs. One thing that emerged from the results is that Iceland's public transportation sector focuses mainly on battery electric-powered vehicles. However, as the results and the literature state, the technology behind it still has some problems. For example, batteries might be efficient for city buses that can recharge during their longer stops, however, for the coaches driving longer distances, the range of the batteries is insufficient and additionally take away valuable space for luggage due to the battery's size (Basma & Rodríguez, 2021; Dallmann et al., 2021). This is especially a problem for airport transfer buses, as they rely on luggage space for people arriving in the country.

While the end of life of battery-driven vehicles was not particularly discussed, it is an important barrier to consider. As the results showed that e-scooter owners seem to have problems recycling their batteries, the bus companies and other stakeholders need to consider what will happen at the end-of-life of these batteries. Especially as research shows that there is still no perfect solution for the end-of-life treatment of lithium

batteries, as potential recycling methods are still being investigated (M. Chen et al., 2019). This, and the increased weight of the batteries and, in turn, the increased weight of the vehicles, can cause problems in the future, such as in the case of the road infrastructure and increased vibration impacting its endurance (Gray et al., 2021; Low et al., 2022).

Charging stations, specifically the lack thereof, was another issue brought up in the results. Even if all bus operators switched to more battery electric-powered buses, there are not enough charging stations to recharge them, especially not for longer distances such as the airport transfer to the international airport in Keflavik. The need for more charging stations in Iceland was already mentioned in a study by Lin and Sovacool (2020). However, to include these changes, different costs are involved. These costs can consist of increased infrastructure costs and investment in electric buses, especially as the battery-powered buses have a higher price than diesel alternatives, with the results showing that it is almost double the amount. The increased costs can result in a need for more funding. This need for funding was revealed in the results and the literature (Agaton et al., 2020; Guno et al., 2021). Previous literature has emphasized different suggestions on how companies can finance the transition to a more sustainable fleet. The literature highlighted the possibility of government incentives and funding methods that can help the companies fund new buses (Slowik et al., 2019; Miller et al., 2017), with the results also mentioning the possibility for companies in Iceland to apply for a grant.

Regarding the social aspect, motivation was also seen as a barrier. While own beliefs and motivation can drive the sector towards more sustainability, this motivation seems to be lacking, and it appears that people do not believe in the changes or the public transportation system. This can be seen as a barrier, especially if customers and politicians lack motivation and belief. Iceland is a private car society, and the capital area is planned around the use of cars. As such, people are less inclined to use public transportation, as most already own cars, and using them is in their habit (W. Chen et al., 2019). This is also reflected in the results, with different stakeholders mentioning limited demand for public transportation. Additionally, the results showed that the current system is not equipped to meet the needs of everyone. While some areas do not have the same access to public transportation as others, the system lacks structure, with the

existing bus routes being complex, indicating that it takes longer to move around the area (Ottósson et al., 2019). As for political motivation, there is a need for politicians to act (Willis, 2018), as the results show that the policymakers in Iceland are quite behind in their actions on sustainability. Some believe that the actions that have been put forth only require minimal behavioral changes from the politicians. While previous literature on the topic is limited, it does indicate that, generally, more action and participation toward sustainability is required from politicians (Kuzemko et al., 2020).

Other politic-related barriers have to do with the structure of public transportation in the capital area, more specifically, the Borgarlínan project. There are different municipalities in the capital area involved in the project, and with new elections, newly elected representatives are responsible and involved. However, with such constant changes, the progress is slow as new people need to learn about the project and are less inclined to make high investments immediately due to less profitability in the near future. This aligns with previous literature, stating that institutional changes during the development of a bus rapid transit (BRT) line can impact its implementation (Sajjad & Javed, 2022; Arias & Bachmann, 2022). More specifically, the literature shows that the start of implementation matters in political cycles, indicating that construction should ideally start before the political cycle ends before new people are elected and take over the project (Arias & Bachmann, 2022).

Another barrier includes the ticket system. Previous research has shown that the system can impact people's perception and desire to take public transportation (Ramos et al., 2019; Fürst & Herold, 2018). In addition, with more people working from home, there is a need for more flexibility in ticket options, which is currently not the case, as it does not allow for much flexibility. However, more flexibility in the ticket options has shown to be popular during the pandemic due to the increased uncertainty of taking public transportation due to lockdowns or quarantining (Pozo et al., 2022).

Additionally, some outside influences, such as weather, might not be as big of a barrier in Iceland's capital area, but it can impact public transportation in other areas. As such, there is the need for more variability in the system to not only focus on one method of transportation, such as ferries but also offer transportation modes that might be less susceptible to sudden weather changes, with one interviewee mentioning offering midi

buses. A previous study conducted in Iceland on battery electric vehicles showed that weather was a barrier in Iceland, especially due to the cold winters, which can impact the battery charging life (Lin & Sovacool, 2020). Specifically for buses, the literature indicated that higher wind speed and lower temperatures are associated with increased energy consumption in the buses and must therefore be considered by operators (Corbet et al., 2023).

Drivers that motivate public transportation companies in the capital area of Iceland to become more sustainable

The drivers that can motivate public transportation companies were categorized into the Five C framework (Jóhannsdóttir & McInerney, 2018). One driver mentioned in relation to commitment was leadership. As the results show, the leaders of the companies seem to be driving their company toward more sustainability or at least putting a focus on it. As described in the literature by Jóhannsdóttir and McInerney (2018), leaders can affect the company's vision and strategy, thus building a pathway for the company to become more sustainable, but they can affect their employee's behavior as well. Again, this aligns with the literature, which showed that a leader's motivation for more sustainability might impact a company's strategy and the effort to integrate sustainability into the core business (Eide et al., 2020).

As for configuration, the results indicate that policies and internal actions can drive a company's sustainability forward, especially internal actions such as sustainability reporting or having different measurements and certifications. The literature shows that companies should include measures of their environmental performance, with an environmental strategy significantly improving this performance (Kraus et al., 2020). In addition, analysis such as LCAs can drive a company forward in its sustainability efforts as they can learn about which aspects and phases should be improved (Salvador et al., 2021), and in the specific case of transportation companies, which buses are the most sustainable (Machado & Andrade, 2023).

As for the core business, the biggest drivers are related to using electric buses. While they have some barriers, certain aspects can drive companies to purchase more electric buses as they will reduce maintenance and have lower operating costs than diesel buses.

This was also shown in the literature. While it was not explicitly mentioned as a company driver, it has economic benefits in the long run (Agaton et al., 2020).

The driving forces in a company's communication mainly involve the company's stakeholders. The results show that companies experience pressure from the outside that drives them towards more sustainability. This could be primary stakeholders, including, in this case, customers and the municipalities or contractors, as they can set requirements for more sustainable buses. Regarding continuous improvement, the results highlight the importance of using certifications and the need to maintain or achieve them (Arimany-Serrat et al., 2019).

As this shows, different aspects are essential drivers for sustainability in public transportation companies. While drivers can affect the various aspects of a business, they all interact with each other. The main aspects can be seen in Figure 5. It shows that most of the drivers of public transportation companies, including companies' leadership, costs, new technologies, different measurement tools, and the pressure from their stakeholders to change.

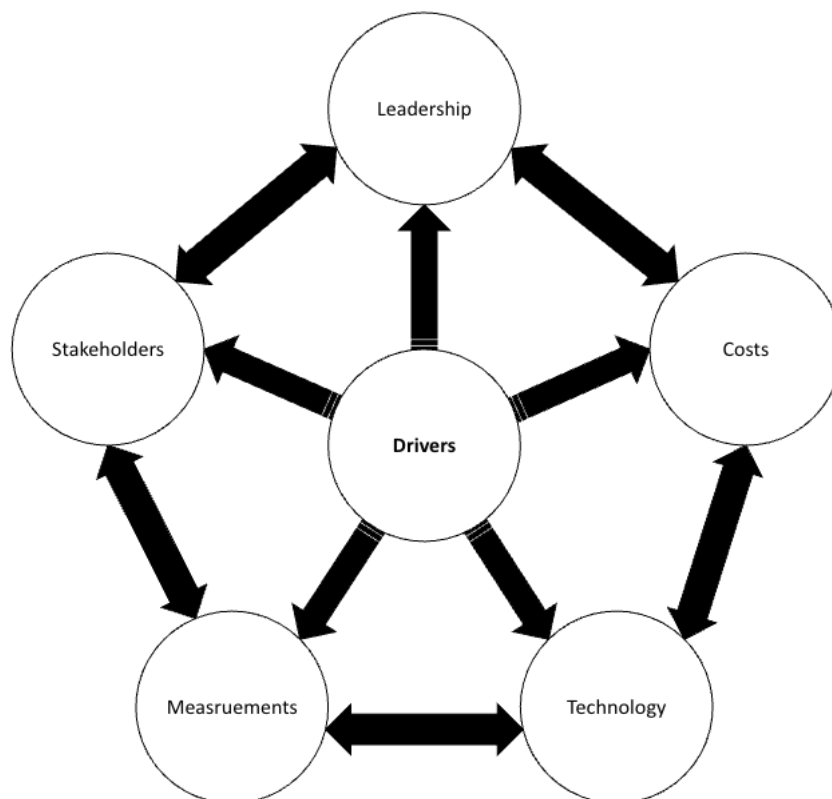


Figure 5. Drivers to motivate public transportation companies.

Note. Created by the author.

Main barriers faced by public transportation companies in the capital area of Iceland for adopting sustainability frameworks

The barriers of public transportation companies surround five main aspects, which are cost, technology, lack of infrastructure, partnership, and external variables, see Figure 6. While a motivated leader can drive a company towards more sustainability, leadership and their vision and strategies can be affected by external variables. Especially in the past years, COVID-19 had a major impact, with companies focusing on budgeting and surviving rather than setting environmental goals and policies. This was also seen in the literature, as many companies in other countries laid off employees, and the unemployment rate in the transportation sector increased during COVID-19 (Mack et al., 2021). In addition, the financial impact has been shown in the literature, where Kar et al. (2022) reported that due to COVID-19, the public transportation sector faced budget cuts and revenue losses.

In terms of the companies' configuration, most of the barriers highlighted were funding issues, and issues related to policies, as only one companies measured and published progress, according to their policies. This, therefore, can be a barrier for the companies to become more sustainable, as there are no clear plans. Instead, the literature indicates that having an environmental strategy can positively affect a company's environmental performance and should be considered to be implemented (Kraus et al., 2020).

The most significant barriers to core business were economic, mainly related to the lack of infrastructure and increased costs (Nundy et al., 2021; Kanda & Kivimaa, 2020; Kamargianni et al., 2022). External variables seemed to have a significant impact on their operations and financials. The companies cost increased due to the war in Ukraine and the higher costs of electric buses, which was intensified by the companies' lower revenue during COVID-19 and a lack of customers to pay. Again, this applies specifically to private companies where increased costs of purchasing electric buses (Agaton et al., 2020) do not lead to customers' willingness to pay higher prices for a seat in an electric bus to compensate for higher purchasing prices. Additionally, the lack of available technology, especially for coach buses (Baldino et al., 2019; Dallmann et al., 2021; Basma & Rodríguez, 2021), was an important barrier for the private companies as well as the lack of infrastructure available.

The biggest barriers in communication involve partnership and collaboration. As many different actors and entities are involved, the decision-making process is complicated, especially for funding for a public company (Pettersson & Hrelja, 2020). Additionally, as many companies were or are struggling during COVID-19, there is a high need for political and financial support or incentives (Nundy et al., 2021; Kanda & Kivimaa, 2020; Kamargianni et al., 2022). Lastly, the biggest barrier mentioned in the results related to continuous improvement is that some companies do not have any specific plans or policies to guide them toward more sustainability and are missing KPIs to track their progress.

The five main barriers for public transportation companies in the capital area can be seen in Figure 6. While there might be some other barriers these companies face when moving towards more sustainability, the results show that the main aspects include external variables, such as stakeholders, costs such as for new buses, the limited technology, lack of infrastructure, and the importance of collaboration between companies and their stakeholders.

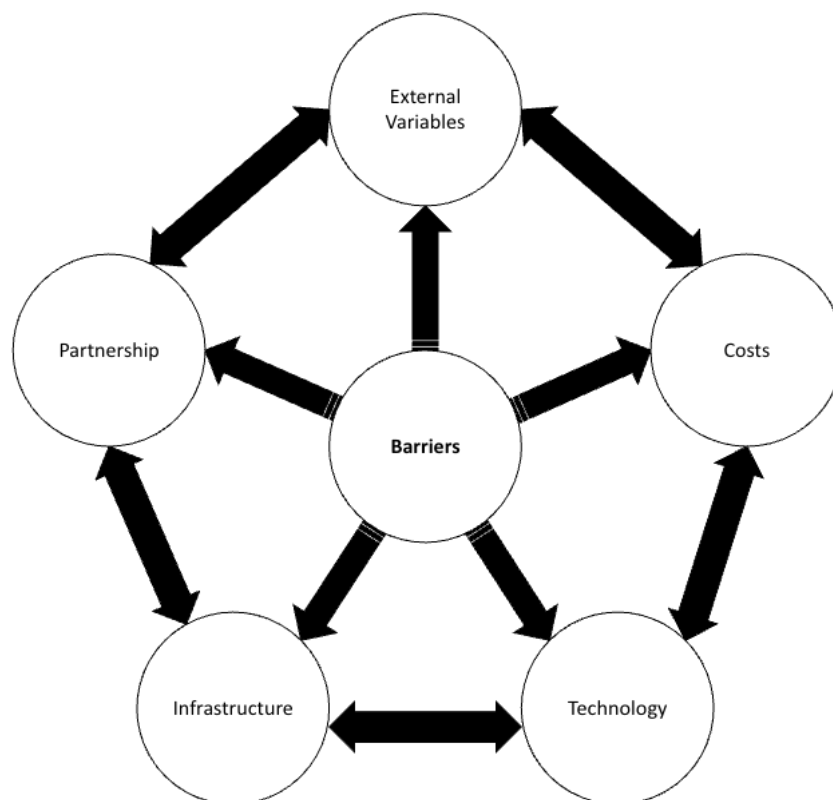


Figure 6. Barriers faced by public transportation companies.

Note. Created by the author.

As previous sections show, there are often overlaps in the drivers and barriers mainly focused on five key aspects, including external variables, costs, technology, internal actions, and leadership, see Figure 7. The external variables include stakeholders of the companies, the government, and the COVID-19 pandemic. While stakeholders can push a company towards more sustainability, factors such as COVID-19 placed significant constraints on the public transportation companies in the capital area. The costs have been identified both as drivers and barriers. For example, while electric buses have higher initial costs, the results and the literature demonstrate that operating cost is lower (Agaton et al., 2020; Comello et al., 2021). In terms of technology drivers, electric buses have the benefit of having lower GHG emissions during the use phase (Ellingsen et al., 2022) however, there are still certain barriers the companies face, including limited space due to the size of the battery.

As for the internal actions, measurements and sustainability reporting can drive a company towards more sustainability, while not emphasizing these actions can act as a barrier. Lastly, leadership and their actions can impact the company's sustainability from within. While the results show that there is motivation from the leaders to move towards more sustainability, the literature showed that if this is not the case, it can act as a barrier (Eide et al., 2020). All this can be seen in Figure 7.

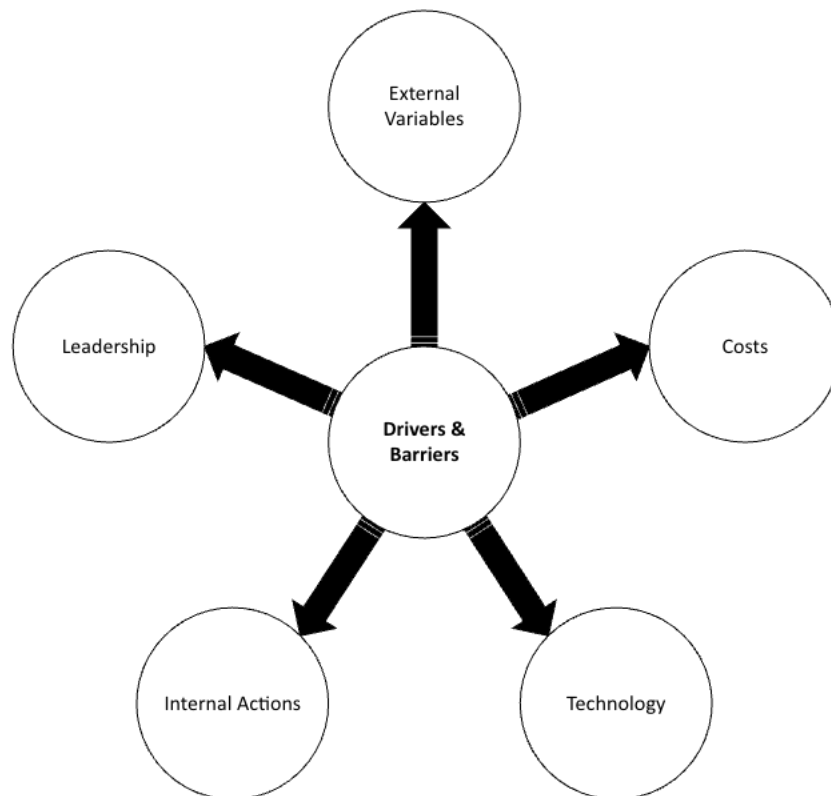


Figure 7. Drivers and barriers of public transportation companies.

Note. Created by the Author.

Inclusion of sustainability strategies of public transportation companies in the capital area of Iceland

This section centers around the Five C framework findings but is based on the empirical data from the company's publicly available sources and interviews, with a summary of the key findings can be found in Table 15. Regarding commitment, one crucial part is leadership, especially the leaders' willingness to drive sustainability forward, as this can trickle down to their employees (Eide et al., 2020). In addition, the results showed that the leaders in Icelandic transport companies are open to making sustainable changes. Furthermore, while having a strategy is an important aspect of the environmental performance of companies (Kraus et al., 2020), only Strætó presented an environmental strategy (Strætó, n.d.-i). In terms of empowering employees, Table 15 shows that there is an emphasis on equality, with only Strætó mentioning that they offer free charging stations to encourage their employees to use electric vehicles, with previous literature

showing that this can lead to benefits both for the employers and employees, including the promotion of low-emission transportation (Gong et al., 2021).

Another aspect of commitment involves training, with different training methods being discussed, as seen in Table 15. The importance of training, especially eco-driving, has also been highlighted in previous literature (Sullman et al., 2015). However, while Strætó mentioned some specific training they offered (Strætó, n.d.-l). Most information on training from Gray Line and Reykjavik Excursion stems from their environmental policies (Reykjavik Excursions, n.d.-b; Gray Line, n.d.-c), with limited information available. Additionally, one interviewee even said that there is currently almost no training in place. However, as Jóhannsdóttir and McInerney (2018) have stated, commitment to a company is an essential aspect of a sustainable strategy. As such, private companies should include more information and inform their employees that it is their priority. Additionally, the authors mentioned introducing reward systems and incentive plans to engage leaders and employees, which did not come up in the results and should be something the companies need to investigate.

For configuration, the main aspects brought up were policies and internal actions. All companies included an environmental policy with general sustainability statements (Reykjavik Excursions, n.d.-b; Gray Line, n.d.-c.; Strætó, n.d.-a). The importance of environmental policies has also been seen in previous literature, highlighting that it could positively affect customer satisfaction (Vicente et al., 2020). However, while they often mention that they want to monitor environmental factors and continuously review the policies, the companies do not mention any specific action or assessment on how they plan to do so, as specific KPIs were missing.

The lack of specificity also affects internal actions. While Strætó published a sustainability report and stated specific actions the company takes part in, such as reducing waste (Strætó, n.d.-l), the other two companies have vague information available, with only Reykjavik Excursion stating that they have an ISO 14001 certification (Reykjavik Excursions, n.d.-b). More specific actions were missing from their websites, and only some were mentioned in their environmental policies (Reykjavik Excursions, n.d.-b; Gray Line, n.d.-c). As only information from the websites was used for the analysis, it is questionable if the companies might carry out some more specific actions and

reporting methods within the company. Either way, including more specific actions and assessments, can help them improve the company's sustainability strategies. For instance, using ELASTIC could be a first step for the companies to identify the most critical indicators they need and want to report on (Castillo & Pitfield, 2010). This is especially important for smaller companies, as using too many different indicators may be overpowering. Similarly, the use of PTSIL can be helpful for companies to assess their policies and track their processes (Karjalainen & Juhola, 2019).

The core business of the transportation companies centers around two aspects, the buses they operate and the services they offer. As for the service aspect, the results revealed that the ticket systems are moving to more digital and paperless payments, with the importance of more electronic ticket options also being seen in the literature (Fürst & Herold, 2018). Furthermore, previous research showed that identifying and using the charging time more efficiently is essential (Dhole & Gode, 2022), which Strætó has incorporated with their charging station assessment (Strætó, n.d.-I).

As for the buses, Table 15 shows that the two private companies focused on maintaining and upgrading their buses with the highest Euro standards, with no specific plans for switching to battery-powered coaches. This is primarily connected to the barriers to using battery-powered coach buses. Thus, it does not make economic sense for the companies to switch their fleet to electric (Agaton et al., 2020; Guno et al., 2021), with previous research showing that smaller businesses tend to be more oriented toward profitability rather than decreasing their emissions (Sofijanic et al., 2021). While there are plans for the city buses to switch to more electric vehicles, the costs are currently too high. However, the results and literature suggest that a third party could purchase the vehicles and rent them out to public transportation operators, like Strætó (ZEBRA, 2019).

One of the most mentioned aspects in the interviews was communication which is a crucial aspect of public transportation as many different stakeholders are involved, thus, requiring much dialogue between the companies and their stakeholders (Hrelja et al., 2016). The results show that companies inform and educate their employees through their intranet. However, external communication needs improvements, which can also be seen as all three companies do not state specifically what type of communication they carry out.

Moreover, external transparency is lacking in private companies. While Strætó is very transparent, as seen in Table 15, the information from the other two companies is vague. Previous literature has shown that stating a company’s commitment to sustainability affects customers' behavior (Vicente et al., 2016), as such, it would be beneficial for companies to communicate more openly with the public and clearly state their current sustainability contributions. Likewise, publishing sustainability goals and achievements, and making them visible to consumers should be prioritized (Vicente et al., 2016). Lastly, Continuous improvement was mainly mentioned regarding the bus fleets, with most companies having plans for future changes, i.e., moving to more electric buses or purchasing new buses with the highest Euro standards. Additionally, all companies mentioned wanting to achieve an ISO certification or trying to maintain their certification, which is generally an essential aspect for companies (Arimany-Serrat et al., 2019).

Table 15 summarizes and compares the key findings from all three companies and the interviews, separated by the five different C’s. Most results have been shortened, with Table 15 only highlighting the presented aspects. For instance, while Reykjavik Excursion states their vision in detail, Table 15 only shows that it exists. If no text is in the table, the company or interviews did not mention this aspect. Overall, it shows that the private companies, Gray Line and Reykjavik Excursion, seem behind in their sustainability strategies, especially concerning their communication and configuration, but all five C’s can be improved upon.

Table 15. Five C comparison of the three companies and interviews.

		Strætó	Reykjavik Excursions	Gray Line	Interviews
Commitment	Leadership	Vision & mission	Vision		Leaders
	Training & Skills	Competence+, driving lessons, language courses	Eco-driving, environmental awareness	Environmental awareness for employees	Different training options
	Empowering Employees	Educating employees, equal pay, charging stations	Equal pay	Importance on diversity	Charging stations & equality

		Strætó	Reykjavik Excursions	Gray Line	Interviews
Configuration	Policies	14 policies, including environmental policy	Privacy and environmental policy	Privacy and environmental policy	Different policies
	Code of Conduct	Code of conduct for board			
	Companies Structure	Owned by municipalities			Contracts with Strætó to operate routes; Strætó relies on municipalities for funding
	Corporate Governance	Mentioned in sustainability report			
	Internal Actions	Sustainability report (report emissions & environmental monitoring system)	ISO certification & Vakinn, monitoring environmental factors, recycling and reducing waste	Reducing environmental impact (reduce use of raw materials, emissions, waste)	Recycling, reduce (energy & water usage), monitor driving style
Core Business	Services	Focus on consumers, assessment on charging stations			New ticket system (electronic)
	Buses	Electric buses, strategy to be carbon free	Buses with higher Euro standard, new technologies	New buses with highest Euro standards	Purchase electric buses or new Euro standard
Communication	Stakeholder Engagement	Customers can be involved	Educate their customers on protecting environment		Involving customers (waste management & ticket system)
	Internal & External Communication	Regular open meetings	Annual environmental report for employees		Share sustainability report internally
	Transparency	Publish information (reports, policies, assessment etc.)	Unclear on assessment/monitoring & no sustainability report published	No sustainability report published, limited information available	

		Strætó	Reykjavik Excursions	Gray Line	Interviews
	Partnership & Collaboration				Meeting and contracting with municipalities & companies
	Continuous Improvement	Strategy set for future improvements	Maintain certifications	Renew environmental policy (no specifics)	Use of Euro standard, future investments, ISO certification

Note. Created by the Author.

6. Conclusion

The conclusion is divided into three main sections, namely the theoretical and practical implications, the study's limitations, and suggestions for further research.

6.1. Theoretical and practical implications

This study gives a unique insight into Iceland's public transportation sector, using mixed methods of interviews and the Five C Framework to analyze the information available from the different transportation companies. It gives an in-depth overview of what is currently happening within the public transportation sector in the capital area of Iceland, as there is limited literature on the topic. Additionally, semi-structured interviews allowed a deeper dive into the topic and covered aspects the researcher had not considered beforehand. The results build on the existing knowledge of the Five C Framework, showing that it can be transferred into other sectors, such as public transportation. Moreover, new models were synthesized to highlight the essential drivers and barriers that public transportation companies face when transitioning toward more sustainability.

As for the practical implications, the results, in line with previous literature, suggest an increasing need for politicians to push for more ambitious goals and increase financial incentives available to public transportation companies, including VAT reductions or carbon emissions taxes. As for the private companies, the findings suggest that while the motivation demonstrated by the leaders should continue, there are still aspects the companies need to improve upon. For one, private and public transportation companies seem to lack some incentive programs or reward systems for their employees to engage them more in the companies' sustainability actions. Other improvements include mainly the companies' transparency by introducing specific KPIs and SDGs into their strategies and environmental policies and introducing sustainability reporting, such as using LCAs or other types of environmental analysis of their products.

6.2. Limitations of the study

There are a couple of limitations of the study that must be noted. First, in addition to the interview data, other information came mainly from the companies' websites and publicly available data, thus, the transparency of information, or lack thereof, influences the findings. Second, this exploratory study gives an overview and explores the topic but does not necessarily provide solutions to the barriers. Third, is relevant to the research methods. Due to the use of interviews, the thesis results can be subjective, especially as one person coded the data. However, this can also be seen as a strength, as internal consistency of the coding is provided. Additionally, even though people signed an informed consent which included that their answers would be anonymous, there is always the possibility that interviewees did not respond honestly. Also, with a limited number of companies doing public bus transportation in the capital area, it is challenging to ensure the anonymity of the interviewees.

6.3. Suggestions for further research

Different suggestions for future research have emerged throughout the study. Given that only publicly available information about the companies was used, in addition to interview data, future research could focus on collaborating with transportation companies. This could help to get access to information not available otherwise, to make a detailed analysis on their environmental actions, such as by analyzing internally shared reports and more in-depth interviews with not only the companies' leaders but also employees working on all levels of the businesses. Furthermore, gaining information from the public is also relevant. This would help better understand why or why not people use public transportation and what changes they recommend.

Further research could focus on companies' comparison between different countries to understand sustainable public transportation in other contexts better and to see the strategies employed. Another research topic consists of the Borgarlínan project. As this is still in the beginning phase of implementation, it is relevant to know if it will change and fix some of the barriers identified in this study.

Iceland also has other public transportation methods besides buses. Thus, future research should investigate using and including other transportation modes, such as ferries, e-scooter, or airplanes. Furthermore, different transportation modes came up

multiple times in the interviews. For example, it was mentioned that ferries could have the potential to be more battery-powered. This is something to investigate to see if there might be other options and use for ferries. Lastly, while accessibility was discussed in the context of some regions being better contacted, such as Reykjavík, while others are harder to reach, there was no mention of how accessible the currently operated buses are. Thus, future research could examine how accessible the transportation system is for people with disabilities.

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Appendix 1: Interview Framework

Interview Framework: Companies

Format: Semi-structured interview
 In-person/online
 Recorded on the mobile phone/Zoom

- Give informed consent, explicitly asking for Permission for recording.

Before we start: How do you define sustainability?

Leadership/Commitment:

1. How do you think leadership affects your company's sustainability?
2. What training do you offer for employees?

Configuration:

3. How do your company's internal actions affect the sustainability of your business?

Core Business:

4. How has the core business been made more sustainable in the past years?

Communication:

5. How are your stakeholders involved in the sustainability of your business?
6. How is sustainability communicated internally and externally, and to whom?

Continuous Improvement:

7. How do you think the company will move forward regarding its sustainability?

Background Question:

8. What are the main drivers that motivate Strætó to become more sustainable?
9. What are the main barriers faced by Strætó for adopting sustainability frameworks?

Ending:

10. Is there any additional information that would be relevant to this research?

Finishing the interview:

- Thank them for their time

Interview Framework: Stakeholders

Format: Semi-structured interview
 In-person/online
 Recorded on the mobile phone/Zoom

- Give informed consent, explicitly asking for Permission for recording.

Before we start: How do you define sustainability?

General questions:

1. How do you view sustainable public transportation in Iceland?
2. How does your work/organization collaborate with or affect the public transportation companies (i.e., Stræto, RE, or Grayline)?
3. In your opinion, what are the main drivers that motivate public transportation companies in the capital area to become more sustainable?
4. What are the main barriers that public transportation companies in the capital area have to face when they want to become more sustainable?
5. How do you think the public transportation companies will/should move forward in the future regarding their sustainability?
6. What technological advances do you think will happen in the following years in the sector?
7. What is still needed to improve the sustainability in the public transportation sector here in the capital area?

Ending:

8. Is there anything else you would like to add to the topic?

Finishing the interview:

- Thank them for their time.
- Ask if they know anyone I could interview for this project/Thesis.

Appendix 2: Codes

Themes		Codes	Explanation
Sustainability	Social	Accessibility	journey time, accessibility to people with disabilities, journey length/distance, distance to bus station
		Usage	How often is public transportation used
		Population Density	concentration of people in a certain area
		Political Motivation	interest of the government/municipalities
		Laws & Regulation	any laws, regulations or standards
		Health Impacts	Noise pollution, health issues
		Risk & Safety	Injuries, death
		Personal Motivation	motivation from internal desire, also outside pressure, reason to keep working towards goal
		Politics	policies (set of plans on what to do) from government, municipalities or companies, political structure
	Environmental	Emissions	polluting emissions
		Technology	weight, age, standards, size, type of vehicles, load factor
		Fuel Types	electrification (electric), hydrogen, methane, diesel, CNG
		Weather	weather effects: colder/warmer climate, snow, rain
		Efficiency	energy efficiency, travel distance, efficiency of transportation method, speed?
		Standards & Assessments	Environmental standards, other standards that are used to check environmental aspect (i.e.: LCA)
		Resources	Use of resources: water, energy, land etc.
		Waste	recycling, garbage
	Economic	Funding	money given by organization or government/municipalities
		Investment	putting money/effort/time into it - to make profit or gain advantage
		Incentives	tax/money incentives to make people more likely to purchase/change behavior

Themes		Codes	Explanation	
		Costs	money spent on buses/technologies/infrastructure, cost the company generally has - prices of new buses	
		Ticketing	ticketing system (Klapp app), prices of tickets	
		Affordability	being cheap enough for people to buy	
		Infrastructure	fuel infrastructure, road infrastructure	
Five C- Framework	Commitment	Leadership	person in charge of organization, behaviors to align vision, mission and strategy of company	
		Training & Skills	Training and skills the company offers or requests from their employees	
		Empowering Employees	engaging the employees, offer special things to help them	
	Configuration	Policies	policies (set of plan on what to do) from government, municipalities or companies	
		Code of Conduct	rule people in a job have to follow	
		Companies Structure	the way the company is organized/structured	
		Corporate Governance	how company is managed on the top level	
		Internal Actions	any actions that are happening within in order to contribute to environmental sustainability	
	Core Business	Services	customer service, other things they do (tours etc.), maybe the standards/awards they got for sustainability?	
		Transporting Passengers	transport of passengers	
		Buses	technology used, standards to follow, type of buses	
	Communication	Stakeholder Engagement	what is done to engage stakeholders, get to know them	
		Internal & External Communication	communication within the company and outside	
		Transparency	openness of communication - how transparent are they	
		Partnership & Collaboration	partnership and collaboration with the stakeholder of the company	
	Continuous Improvement			future steps to be take, what is done on a day to day basis to ensure sustainability is maintained- Standards/assessments that will keep it
	Barriers			something that prevent something else from happening/is challenges it
Drivers			activities that drives/pushes/motivates the sustainability of the sector	