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User acceptance and mental models – an exploration of citizens perceptions of autonomous buses in the Arctic region

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Preface

This master thesis symbolizes the end of my two years in Master of Science in Global Management at Nord University. During this study, I have acquired knowledge about sustainable blue and green value creation. Furthermore, I have acquired in-depth knowledge about perspectives in management, entrepreneurship and technological development on business, community and institutional levels in a framework of social, economic and ecological sustainability.

Last semester I had an internship at Nordland County Municipality, which led to the writing of this master thesis. While working with their project Smarter Transport Bodø and Autonomous buses, I encountered various citizen feedback in social media. I saw a potential to write my master thesis about these autonomous buses and illustrate citizen perceptions. Working on this thesis has been both challenging and deeply rewarding. I have enjoyed working with the subject of smart transport, citizen perception and the sustainable aspect of it.

I would like to thank all the informants for their contributions during the interviews and for their reflections and openness. I would also like to thank Siri Vasshaug, my supervisor during the internship for an including and great internship. I want to thank to Nordland County Municipality and the EduSmart project of Nord University for the collaboration on this master thesis. And finally, I am grateful for my supervisor Evgenii Aleksandrov, Associate Professor at Nord University Business School. Thank you for inspiring conversations and constructive feedbacks. Your contributions have been of significant importance.

This experience has been rewarding and I look forward to a new chapter in my academic and professional career.

Hanna Lisa Borkamo

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Abstract

Autonomous vehicles for transportation can be considered an important step in the development of modern smart cities. The research regarding autonomous buses in the arctic region have been minimal and this Master thesis aims to cover a part of this gap, with emphasis on user acceptance and mental models.

The purpose of this study is to examine citizens' responsiveness and acceptance of autonomous buses with a focus on social, cognitive and behavioural factors in a single city context in the arctic region. The research question for this study is *How do citizens perceive autonomous buses in the arctic region?* In order to address this research question, the theoretical framework applies combination of the unified theory of acceptance and use of technology (UTAUT2), perceived value theory and mental model theory. Such combination gave possibility to analyse (1) factors that are most important regarding citizens user acceptance of autonomous buses and (2) the main cognitive aspects of the shift towards autonomous buses.

The study uses a qualitative research method with a case-study approach, in which ten interviews were conducted with citizens in Bodø under Smart Transport project. The choice of interviews was natural because of its ability to capture rich information about a phenomenon and to obtain diverse citizen opinions. The interviews were conducted in Bodø and was based on a local initiative and a local bus route, in which autonomous buses are meant to be tested.

This study's findings emphasise the importance of different determinants in achieving user acceptance among the study's informants and that mental models have great influence on user acceptance. Awareness around these factors can contribute to and enhance the project of implementing autonomous buses in Bodø or other arctic regions. In addition, the study emphasises the complexity of user acceptance.

Sammendrag

Selvkjørende kjøretøy kan bli ansett som et viktig ledd i utviklingen av moderne, smarte byer. Forskningen rundt selvkjørende busser i de arktiske områdene har vært minimal og denne masteroppgaven etterstreber å fylle noen av disse hullene i forskningen, med et omfattende fokus på brukeraksept og mentale modeller.

Målet med studien er å undersøke hvorvidt innbyggere er mottakelig ovenfor endringer og akseptere autonome busser med fokus på sosiale, kognitive og atferdsmessige faktorer i en bysammenheng i de arktiske områder. Studien utforsker denne problemstillingen *Hvordan oppfatter innbyggere selvkjørende busser i de arktiske områder?* For å besvare forskningsspørsmålet brukes det teorier knyttet til brukeraksept og hvordan mentale modeller påvirker potensielle brukere av et tilbud. Kombinasjonen ga mulighet til å analysere (1) faktorer som er viktigst for innbyggernes brukeraksept og (2) de kognitive aspektene ved overgangen til autonome busser.

Jeg har benyttet en kvalitativ forskningsmetode med case-studie tilnærming, hvor jeg har gjennomført ti intervjuer med informanter i Bodø under Smartere Transport prosjektet. Metoden ble brukt for å fremme varierte, mangfoldige og nyanserte refleksjoner hos informantene. Intervjuene ble avholdt i Bodø og tok utgangspunkt i et lokalt prosjekt, hvor selvkjørende busser er tenkt å bli testet.

Studiens hovedfunn vektlegger betydningen av ulike faktorer for å oppnå brukeraksept hos studiens informanter og hvordan mentale modeller påvirker brukeraksept. Oppmerksomhet og bevissthet rundt disse faktorene kan bidra til og styrke prosjektet med å implementere selvkjørende busser i Bodø eller andre arktiske regioner. I tillegg legger studien vekt på kompleksiteten i brukeraksept.

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1. Introduction

Autonomous vehicles for transportation can be considered an important step in the development of modern smart cities (Munhoz et al., 2020). Previous research has focused on different factors that can influence user acceptance of autonomous vehicles. This includes factors such as safety, perceived usefulness and other determinants (Bernhard et al., 2020; Nastjuk et al., 2020). However, less attention has been given to the in-depth analysis of citizen perceptions of implementing autonomous buses and citizens' perspectives on such a change, with particular attention on the micro and behavioural level in the context of a specific city. This is a topic which is still much lacking in theory in conducted research (Wolf, 2016). By these means and in order to cover some of this gap, this master thesis will explore the existing social, cognitive and behavioural aspects of citizens regarding the change towards autonomous buses.

The purpose of this study is to examine citizens' responsiveness and acceptance of autonomous buses with a focus on social, cognitive and behavioural factors in a single city context in the arctic region. Bodø in the north of Norway. This study will investigate if the arctic context has an influence on citizens perception and user acceptance of autonomous buses. My goal is to present prominent factors which may influence user acceptance and that may determine whether a project, such as the implementation of autonomous buses, gains trust and user acceptance or not. Awareness around such factors can enhance and support the implementation of such project in for instance other arctic regions.

The main research question for this paper is *How do citizen perceive autonomous buses in the Arctic region?* In order to address this research question, the theoretical framework applies combination of the unified theory of acceptance and use of technology (UTAUT2), perceived value theory and mental model theory. Such combination gave possibility to analyse (1) factors that are most important regarding citizens user acceptance of autonomous buses and (2) the main cognitive aspects of the shift towards autonomous buses.

The theoretical framework applies a combination of three different theories. These are the unified theory of acceptance and use of technology (UTAUT2) (Venkatesh et al., 2012) the perceived value theory (Zeithaml, 1988) and the mental model theory (Norman, 1983). These theories provide fundamental support in the analysis of cognitive, social and behavioural factors that can influence citizen perception in times of change, for instance in the implementation of new autonomous buses.

Empirically, I conducted a case-study of the Smart Transport Bodø project, which is related to autonomous buses. Implementing autonomous buses in Bodø is a part of the Nordland County Municipality project Smarter Transport Bodø and is the first long-term autonomous transport service north of the arctic circle (Sensible 4, n.d.). Overall, the autonomous buses will be running in an urban area with mixed traffic that involves a lot of activity from soft road users, micro-mobility and other hard road users. This entails a mixed traffic picture that consists of many fellow road users.

The research is based on a documentary analysis and ten interviews with local citizens who live in the city. The choice of interviews was natural because of its ability to capture rich information about a phenomenon and to obtain diverse citizen opinions. Interviews were used to collect the primary data and the secondary data is the theoretical framework that has provided with insights of the phenomenon to be studied. The documentary analysis is presented under the theoretical framework and shows different articles and studies on the subject of smart mobility and user acceptance. The interviews were conducted in Bodø and was based on a local initiative and a local bus route, in which autonomous buses are meant to be tested. This study may serve as a research supplement to the previously conducted quantitative data in the research field.

The rest of thesis is structured as follows. The second chapter provides the literature review and background about smart cities for sustainability and smart mobility and how citizen user acceptance affects changes in society. The third chapter describes the theoretical lenses used in this study and chapter four presents the research methodology and illustrates the methodological choices on which this master's thesis is constructed, as well as the methodological tools that have been used during the research. This arctic context will be further described in this chapter. The fifth chapter introduces the empirical findings, while chapter six provides an analysis and discussion of the findings in relation to literature review and theoretical framework. Lastly the conclusion in chapter seven gives theoretical and practical contributions, in addition to suggestions for further research.

2. Literature review

2.1 Smart Mobility and Smart City for Sustainability

The concept of smart city has grown enormously and is a new way of imagining cities and how citizens can live. Smart city initiatives offer citizens infrastructure and services that improves citizen life (Vanolo, 2014). The concept focuses on how cities and communities can

develop into being sustainable and forward-looking within the aspects of economy, social and environment. Benevolo et al. (2016, p. 13) defines a smart city as a “complex, long-term vision of a better urban area, aiming at reducing its environmental footprint and creating better quality of life for citizens”. Smart cities integrate information and communication technologies, and aim to optimize efficiency in city operations, services and communication with citizens. According to Grossi et al. (2020, p. 633) smart cities can “be viewed as a system of information and flows, that can be controlled, modified and optimized to reach efficiency goals in many areas”.

The smart city concept integrates new responsibilities for a city concerning environmental protection, technological upgrade and quality of life (Vanolo, 2014). Smart city initiatives are therefore often used for coping with severe urban problems. This includes economic, environmental, social and human aspects (Brorström et al., 2018). According to Giffinger et al. (2010) a smart city has six conceptually distinct characteristics. These cities typically have a smart economy, smart mobility, smart governance, smart environment, smart living and smart people. A well performing city in a forward-looking way in these six characteristics of urban smartness is according to Giffinger et al. (2007) defined as a smart city, built on the ‘smart’ combination of endowments and activities of self-decisive, independent and aware citizens.

In a smart city context, smart mobility is a connection between various elements of infrastructure, technology and mobility used in daily life and business. According to Munhoz et al. (2020) smart mobility is a “mobility that uses digital technologies to integrate systems and means of transport that interacts with users, aiming at a sustainable, safe, accessible environment that meets citizens’ mobility needs”. Giffinger et al. (2007) describes smart mobility as the local accessibility, international accessibility, availability of information and communication systems, infrastructure and sustainable and safe transport systems.

Smart mobility is considered essential if you want to increase the intelligence of cities (Munhoz et al., 2020). By implementing intelligent mobility solutions citizens can gain several transportation options and more adaptable and affordable travel while reducing the reliance on private vehicles and promoting energy-efficient mobility (Flügge, 2017). According to Munhoz et al. (2020) it is a multimodal integration that is aimed at optimizing the transport of people and goods, a key factor for smart mobility. This development is associated with the increasing replacement of vehicle ownership by vehicle usership.

Furthermore, it is associated with equity in citizen access to public transport. Such development focuses on reducing car dependency and increasing sharing systems or other alternative transportation modes to improve traffic conditions and increase sustainability. According to Munhoz et al. (2020) information and communication technologies are crucial for successful implementing of smart city mobility services. Information and communication technologies are essential in order to control, manage and integrate services both for transport operators and users. In addition, they are important for improving vehicles and people's movement and the integration of intelligence and increasing sustainability.

The sustainable aspects of smart mobility has become an important theme among many researchers. Transportation systems have a huge impact on climate, emissions, land occupation and citizen satisfaction. Smart mobility has the potential to reduce travel time, greenhouse gas emissions, air pollution and noise (Munhoz et al., 2020). For public policies, environmental protection is an essential aspect for policymaking, where urban mobility manifests a transition to a low-carbon circular economy and reduction in emissions (Munhoz et al., 2020). Smart mobility can therefore be an essential strategy in order to reduce and cope with climate changes and in order to achieve energy security. It can be an important initiative for following up on national and global environmental and climate goals such as the United Nations seventeen sustainable development goals (United Nations, n.d.).

Many cities are implementing different modes of smart mobility. With an increasing global urbanisation and economic growth, there is a growing demand for mobility services. According to Munhoz et al. (2020) urban growth and mobility are intrinsically related factors that are enhancing each other. Benevolo et al. (2016) describes mobility as one of the most important facilities to support the functioning of urban areas. Hence, smart mobility is a focus area for many local governances, and common is the aim of greater innovation and collaboration, which includes digitalisation, transparency and automation. Furthermore, Ainsalu et al. (2018) describes an increasing need for effective modes of urban transport in terms of energy and cost. The priority is fossil-free vehicles, micro mobility and enabling for more cycling and walking. Additionally, there is a focus on higher quality of life and citizen satisfaction. This includes traffic safety, clean air and car-free zones. Examples of initiatives includes the implementation of new technology, digitalisation, new forms of organisation, better information flow and better collaboration. One of the growing discussions under smart mobility and smart city agenda is autonomous transport that has its own opportunities and challenges.

2.2 Autonomous public transport as a part of Smart Mobility: opportunities and challenges

In the context of smart mobility, many cities have implemented autonomous public transport. The technology of autonomous vehicle has grown and has developed rapidly and over the last decades. Much research has been conducted on this technology in the private vehicle market and public transportation market. According to Azad et al. (2019, p. 1), an autonomous vehicle is defined as “a vehicle that can drive without any human intervention by sensing the local environment, detecting objects, classifying them, and identifying navigation paths with information coming from different sensors while obeying transportation rules”. The Society of Automotive Engineers [SAE] has divided automated vehicles into five levels (SAE, 2021). First, at level 0, there are no driving automation, and the driver is fully responsible for the driving of the vehicle. At levels 1 and 2, it is the driver who makes all tactical choices, but the system gradually takes over the driving task. At level 3, the driver has a lesser role as an operator, but the driver must intervene in the event of a system failure or if the system for various reasons cannot manage the traffic situation. At levels 4 and 5, the driver no longer has a role in the vehicle and the vehicle is therefore not equipped for manual driving by a person in the vehicle. At level 4, the vehicle can be used within specific road environments and the system manages some driving situations. At level 5, the system must be able to steer the vehicle under all conditions without any restrictions and therefore manage all driving situations.

The development of autonomous vehicles changes the human role from being the active driver in a vehicle to a more passive passenger role. The transition to higher automation levels and higher integration of automation technology into vehicle systems changes the interaction between humans and road users and our way of seeing the transportation systems (Ainsalu et al., 2018; Detjen et al., 2021). Detjen et al. (2021) explains that future autonomous vehicle traveling will be more comfort-oriented and that travel time usage will be more hedonic. Autonomous vehicles affect different aspects of society, such as economy, mobility, safety and the environment (Nordhoff et al., 2019; Nastjuk et al., 2020; Detjen et al., 2021). Also, other aspects are relevant in the discussion. This includes technological capabilities, policy implications, social and economic impacts and user acceptance (Azad et al., 2019). Research on implementation of autonomous vehicles as a mode of public transport in societies has increased, in which the focus has been on technological capabilities, safety, user acceptance, economic and social impact and policy implications (Yuen et al., 2022). This

development represents a socio-technical transition of the mobility system (Milakis & Müller, 2021).

Many cities around the world are experimenting with autonomous vehicles as a mode of public transport. According to Azad et al. (2019) most autonomous bus projects appear to be growing at a faster rate in Europe, and so far about sixty percent of studies on autonomous buses have been conducted in Europe. As described earlier, many researchers have found urban or rural context to influence user acceptance (Azad et al., 2019; Hudson et al., 2019). Previously, the arctic context for autonomous buses has not yet been studied at a larger extent but has had smaller tests with autonomous buses (Hagenzieker et al., 2020). The first project above the arctic circle was in 2019 and was a one-day trial in Svalbard. According to Hagenzieker et al. (2020) the project was deemed impossible or incredibly hard because of the harsh weather circumstances.

Numerous researchers have investigated the promising benefits of autonomous vehicles, including the potential to secure smart mobility promises (Cledou et al., 2018) and bigger agenda of smart city (Vanolo, 2014) and urban sustainability (UN, n.d.). According to Bernhard et al. (2020) there are many potential benefits of autonomous driving and automated functions. For example, accidents and critical situations are often caused because of distractions or erroneous decisions by human drivers. By deploying autonomous vehicles, the risk of accidents is significantly reduced because of the removal of the human impact of driving. Also, autonomous vehicles improve transportation in terms of safety and efficiency. Autonomous buses as a mobility service could potentially meet the rising demands of transportation in urban areas. For example, on-demand, ride-share or other modes of smart transport could decrease the need and number of personal vehicles and therefore reduce greenhouse gas emissions and fuel consumption. Furthermore, the higher energy efficiency of autonomous driving can increase this effect and hence have a positive effect on consumption, cost, and travel time. In addition, automation of public transport can contribute to better financial sustainability by contributing to more cost-effective solutions. Operation costs can be reduced because of less dependence on labour as drivers, operators, and maintenance crew are not needed in the same amount (Yuen et al., 2022).

Smart mobility integrates information and communications technologies, sustainable transport systems and logistics to provide for improved urban transportation and traffic (Benevolo et al., 2016). According to Cledou et al. (2018) does the development of smart mobility

initiatives require addressing the interests and needs of stakeholders involved, such as government, citizens, transport operators, commuters and so on. Challenges regarding mobility affects citizen quality of life and the sustainability of the city. Therefore, it is important to minimise potential negative effects on various stakeholders. As described previously, smart mobility provides many potential positive promises, but it is crucial that stakeholders are taken into consideration when implementing smart mobility systems.

Furthermore, several researchers have studied implementing autonomous buses as a mode of public transport, as it may lead to numerous positive travel benefits for citizens. For example, autonomous buses can drive bus routes in areas that may be unsuitable for ordinary bus routes. Furthermore, it can result in increased departures on ordinary routes, especially since the buses are not dependent on a driver in the future. Also, autonomous vehicles can have the ability to predict traffic conditions and can therefore improve the quality of public transport relating to punctuality, transit time and comfort (Yuen et al., 2022). For citizens, this development can make public transport easier and more accessible. As a result, the need for private cars may be reduced. In addition, citizens do not need to spend resources or time on learning how to drive (Nordhoff et al., 2019). It can be safer and more efficient to travel in traffic. Travel time for citizens may be reduced, since there will be fewer road users and thus less queues. Such a development will have a positive effect on travel costs and make it easier to travel without a private car. It may also increase the mobility independence for citizens and in particular for those who are physically impaired or elderly (Nordhoff et al., 2019).

Yet, despite the positive benefits revealed in the literature, there are still many barriers for the widespread acceptance of autonomous vehicles (Nastjuk et al., 2020). Some research has outlined several individual and social concerns regarding autonomous vehicle deployment. Such concerns include excessive costs related to maintenance, road user fees, and software and hardware components (Nastjuk et al., 2020). There are also concerns regarding increased fuel consumption and increased greenhouse gas emissions as a result of increased travel demand. Furthermore, there have been legal concerns regarding cases of accidents and data privacy. Ethical and social issues include the loss of human interaction and control in public transport, social isolation, dependency on technology, loss of jobs among bus and taxi drivers and over-reliance on autonomous vehicle technology (Nastjuk et al. 2019; Nordhoff et al., 2019).

Therefore, in a broader sense of smart city agenda, the topic can be also criticised that technology is not the central issue for urban sustainability (Vanolo, 2014). Smart cities are viewed as the solution for many urban problems and symbolise a new type of technology-led urban utopia (Hollands, 2015). Still, such development is depending on citizens, government and corporations, and is it unsure how these roles are outlined in the future. Meijer and Bolívar (2016) explain that a city does not become smarter only by implementing new technologies and that governing a smart city is about using information and communication technologies to craft new forms of human collaboration. Focusing on the importance of economic gains and other public values, Hollands (2015) points out that many of our major urban problems are social and not technological, and that the citizens role often has been limited regarding smart city development.

A potential decisive factor for the success of autonomous systems and autonomous buses as a mode of public transport is the user acceptance by users and citizens (Nastjuk et al., 2019). User acceptance pertains to passengers' attitude towards autonomous buses and factors that influence their opinion, with or without the experience of riding an autonomous bus (Azad et al., 2019). According to Nordhoff et al. (2019, p. 682) autonomous vehicle acceptance is “a necessary condition for autonomous vehicles to contribute to improvements in road safety, road capacity, reduction in travel time and greenhouse gas emissions”. The literature recognises a need for further research on the factors that determine the acceptance of autonomous driving. According to Nastjuk et al. (2019) much research has focused on specific acceptance factors such as driving pleasure, safety or trust to understand the acceptance of autonomous driving. There is a need for more studies in order to further understand the interrelation between these factors and behavioural outcomes.

Various research on user acceptance on autonomous vehicles has been investigated in a number of questionnaire studies (e.g., Madigan et al., 2017, Bernhard et al., 2020, Yuen et al., 2022). Bernhard et al. (2020) focused on the intention to use autonomous buses and conducted surveys before and after participants had been introduced to autonomous buses in their case area. According to Nordhoff et al. (2019) most studies have used questionnaires to examine people's attitude towards automated vehicles. Other studies, such as Nastjuk et al. (2020) and Mouradis and Serrano (2020) applied a mixed method approach to their studies. Nastjuk et al. (2020) did so to understand further acceptance factors and use interview-derived acceptance criteria in order to develop appropriate constructs. Nordhoff et al. (2019) presented an interview study that examines in-depth understanding of the acceptance of

automated shuttles as feeders to the public transport systems, revealing that informants perceived automated shuttles as a viable option. Their study presents sought in-depth information from informants that physically experienced an automated shuttle.

Much research has investigated the determinants of autonomous vehicle acceptance.

According to Azad et al. (2019) numerous studies shows that user and potential users have positive attitudes towards autonomous buses, but experience or living in a city with autonomous buses affect their perception and generally improves user acceptance.

Furthermore, they describe demographic and socioeconomic factors and characteristics such as age, gender and the nationality of users. These factors may influence user acceptance. Also, operational characteristics, such as speed or onboard staff, user enjoyment, security and the potential usefulness of the buses are crucial factors in order to achieve user acceptance. In this context, Hudson et al. (2019) revealed that there was lower support for autonomous vehicles in small towns and villages and higher support from city dwellers. They also found that people's degree of comfort with autonomous vehicles increased with their level of education and prosperity. On the other hand, the degree of comfort with autonomous vehicles decreased in the demographic that were unemployed, retired or if the respondent was a farmer or a manual worker. Hudson et al. (2019) emphasise that autonomous vehicle acceptance differs between countries and that acceptance is affected by sociodemographic characteristics. Other studies, such as Bernhard et al. (2020) found performance expectancy and effort expectancy to be the two major predictors of user acceptance of autonomous public transportation.

Some argues that the biggest barrier for autonomous vehicles is psychological and not technical (Nastjuk et al., 2020). There "is a need to study several psychological factors together to extend the understanding of user's perception of autonomous vehicles" (Lee et al., 2019 as cited in Nastjuk et al, 2020, p. 2). Detjen et al. (2021) explains that even the best technology can fail if it is not adopted by people, and that the general user acceptance of new technologies determines its success. Therefore, the user acceptance of autonomous vehicles is essential for the future development of autonomous transportation. Ainsalu et al. (2018) writes that "one of the biggest concerns, along with the technology performance, is to see how people accept autonomous shuttles". Researchers such as Bernhard et al. (2020) describe the need for more empirical theory about autonomous public transport since it is still unclear whether citizens are willing to use such a service at all. Yuen et al. (2022) states that there is a need for further investigation of the factors that influence user acceptance of autonomous vehicles as public transportation at the micro and behavioural level. Furthermore, Mouratidis

and Serrano (2021) describes a lack of research on the usage of autonomous public transport in a city context and in residential areas in cities.

Thus, to summarise the literature, much research has focused on different factors that can influence user acceptance such as safety, usefulness and other determinants. However, less attention has been given to the in-depth analysis of citizen perceptions of implementing autonomous buses and citizens perspective on such a change, with particular attention on the micro and behavioural level in the context of a specific city. By these means and in order to cover some of this gap, this master thesis will explore the existing social, cognitive and behavioural aspects of citizens regarding the change towards autonomous buses. Below, I present my theoretical framework, which will serve in the process of answering the research question presented in the introduction.

3. Theoretical framework

This study explores factors that can influence user acceptance and the intentions to use autonomous buses in the arctic region and the users' potential mental model barriers.

Therefore, theories regarding cognitive, social and behavioural factors have been used to conduct a research model. In the following section, three different theories are presented and will be summarised in a research model describing how these elements influences what and how. This chapter is finalised with an overview over the research model of the study and how it is used when collecting data.

3.1 Acceptance of technology theory

User acceptance can be defined as “the demonstrable willingness within a user group to employ information technology for the tasks it is designed to support” (Dillon & Morris, 1996, as cited in Bernhard et al., 2020, p. 110). UTAUT is a model that integrates existing acceptance models to formulate a uniform theory of user acceptance. The model is a tool for assessing the likelihood of success for new technology introductions, and helps understand the drives of acceptance, to proactively design interventions targeted at populations of users that may be less inclined to adopt new systems (Venkatesh et al., 2003).

The UTAUT model includes three direct effects from three determinants on the behavioural intention. These are performance expectancy, effort expectancy, and social influence. First, performance expectancy is defined as the capability of the technology to provide benefits and enhancing the performance to the user in accordance with their expectations. Effort expectancy, on the other hand, is defined as “the user expectations about the ease of use of

technology” (Venkatesh et al. 2003, p. 450). Social influence, however, is about the expected influence from others on the user regarding the start and continuation of usage of the technology. In addition, the model has two direct determinants on usage behaviour, which are the intention of use and facilitating conditions (Momani, 2020). The behavioural intention concerns the user’s expectation to perform plans and decisions regarding the usage of the technology, while facilitating conditions is the expected level of organisational and technical infrastructure that can support the use of technology. The four moderating variables are assumed to moderate the influence of the four core constructs on behavioural intention and usage behaviour.

Built on the UTAUT model, Venkatesh et al. (2012) introduced the UTAUT2 model that has three new constructs added, which influences the usage of technology. The model has been adjusted to the consumer context and explains a larger portion of the variance in behavioural intention to use technologies. The first new element added is hedonic motivation and is a complementing factor to the performance expectancy. The hedonic motivation is defined as the pleasure or fun the user derives from using the technology and has in many cases been viewed as an important factor for acceptance and usage of technology (Brown & Venkatesh, 2005). The second is price value. For consumers price value is an important factor and the cost and pricing structure could have a significant impact on consumers technology use. In this instance, price value is defined as “the consumers cognitive trade-off between the perceived benefits of the applications and the monetary cost for using them” (Venkatesh et al., 2012, p. 161), The third and last element added to the model is habit and is defined as the passage of time from the initial technology usage.

The framework of UTAUT has traditionally been applied in order to understand the intention to use information systems, such as mobile devices or services, online banking and e-government services. But in recent years, various studies have incorporated elements of UTAUT into their understanding on user acceptance of autonomous vehicles. According to Nordhoff et al. (2020) different studies have shown that UTAUT2 constructs performance and effort expectancy, social influence, facilitating conditions, and hedonic motivation are correlated with the behavioral intention to use SAE Level 4 or higher automated vehicles. Yuen et al. (2021) also used elements of the framework of UTAUT2 and implemented perceived value theory and social exchange theory to their research model. Their study focuses on using sociodemographic variables to explain public acceptance of autonomous public transportation in Beijing, China. Their result indicates that perceived value fully

mediates the influence of the five UTAUT dimensions they used, while trust mediates the influence of perceived value on user acceptance of autonomous public transport. The study emphasises the importance of context, explaining that Beijing is a highly populated metropolis with high percentage of working professional who are expected to be more receptive to new technologies. Other studies, as Madigan et al. (2017) based their research model on UTAUT2 to investigate social-psychological factors influencing user acceptance of automated road transport systems in Trikala, Greece. They found users enjoyment, social popularity, performance of system and the resources provided to support its use as important factors.

3.2 Perceived Value Theory

The concept of perceived value originates from the Theory of Consumer Behaviour. This theory focuses on the consumers feelings and attitudes to understand consumer tendency to buy certain products or services in a competitive environment (Zhang et al., 2021). Perceived value is defined as the “consumer's overall assessment of the utility of a product based on perceptions of what is received and what is given” (Zeithaml, 1988, p. 14). Value is often representing a trade-off of perceived benefits and the perceived costs, and customers perceived value revolves around the customer belief that a product or service has the ability to meet their needs or expectations. To gain a positive customer perceived value, the benefits from the product or service must be higher than the customer's perceived cost.

According to Zeithaml (1988) there are many factors that can influence consumer perceived value and there are therefore many various factors that affect the consumer's decision to buy or use a certain product or service. These factors are psychological, such as quality, reputation or associated with emotional response. Zeithaml (1988) indicates that the relationship between perceived value and behavioural intention are significant and suggest that the behavioural intentions are consequences of perceived value. Therefore, experiencing high value from consumed experience, tend to lead to positive behavioural intentions.

An important factor for perceived value is the perceived cost, and refers to the sacrifice the consumer gives up, in order to acquire or consume a product or service (Wang et al., 2004). Such sacrifice could be monetary, opportunity cost, maintenance and learning cost (Wang et al., 2004). The perceived cost has often been divided into two components, monetary prices and non-monetary prices (Jen et al., 2011). Monetary price refers to the actual sum of money the consumer must pay for the product or service, while non-monetary factors are defined as

other sources of sacrifices perceived by consumers. Such factors could be time costs, search costs, convenience cost, psychological costs, effort or energy. According to Wang et al. (2004, p. 172) the non-monetary factors could play a bigger and more important role than the monetary factor. Jen et al. (2011) expresses that there are many studies that have suggested that the more costs that are associated with monetary prices and non-monetary prices, it could influence and increase the perceived costs and, consequently, decrease the perceived value.

The perceived value differs from the UTAUT2 model price value by focusing on the dimension of price when deciding to adopt a product or technology based on the potential benefits compared to other market options. In addition, the perceived value has many dimensions that are not focusing on the monetary cost, both positive and negative dimensions of value. In the context of this study, it is unsure whether or not the buses will be ticketed. Therefore, the relevance of price value from UTAUT2 seems irrelevant because it is unsure using the autonomous public transport has a monetary cost. Therefore, in the following research model, price value has been replaced by perceived value.

3.3 Mental model theory

Another mechanism that may influence behaviour choice is the cognitive representation of a decision maker (Arentze et al., 2015). “Mental model theory emphasises that internal representations on which individuals act tend to be strong reductions of reality tailored to the specific task and contextual setting under concern” (Johnson-Laird 1983; Johnson-Laird and Byrne 1991, as cited in Arentze et al., 2015, p. 578). Mental models are defined as “mental representations of the external world that humans constantly use when they interact with the environment and systems within it” (Furlough & Gillian, 2018, p. 269). The theory presupposes that people do not innately rely on formal rules or inference, but instead rely on their mental models which are based on their understanding of the premises and their general knowledge.

According to Johnson-Laird and Byrne (1991), human reasoning typically does not incorporate more information than is necessary for a task in a mental model. This is due to memory capacity limitations and the mental effort involved. To save mental effort, individuals may rely on routines or settled solutions, also defined as their habits. Such repetitive choices and routines may also have elements of choice problems, because of potential new contextual settings or needs. Therefore, individuals cannot always rely on routine behaviour. New settings will trigger a process of evaluating alternatives based on a

mental model constructed just for the task and setting. If habitual solutions are no longer an option or an alternative, individuals are triggered to think new to find a solution to complete the activity. Since the view of the world is mentally represented, it may influence on preference formation and is a source of variability (Arentze et al., 2015).

Another understanding of mental models is Norman (1983) where he suggested that people construct internal representations of the systems with which they interact with. Furthermore, these representations provide predictive and explanatory tools to understand the interaction. Norman described mental models as “knowledge about objects and the environment gathered from interaction with that environment” (Norman, 1983 as cited in Furlough & Gillian, p. 269, 2018). Such knowledge is useful because it explains and predicts the interaction between a subject and the world or in understanding of the behaviour of individuals when interacting with systems (Gentner & Stevens, 1983).

Mental models are constructed in multiple stages, and early versions are often based on previously developed models of similar phenomena (Furlough & Gillian, 2018). Mental models do therefore permit reasoning about different situations that has not been directly experienced. Meaning that individuals can make full use of new system features by recognising the need to manipulate an existing model, or if the current model is insufficient, create a new model. Creating a new model is done by assimilating new information and using this information into an existing model. Then, old information is eliminated, and the existing information is adjusted (Furlough & Gillian, 2018). Mental models can also temporary changes as “Influences can also be temporary, such as priming or induction of needs by stimuli in an environment (e.g., leading to impulsive choice behavior)” (Arentze et al., 2015, p. 589).

Previous research on mental models found differing mental models for their participant (Blömacher et al., 2018, Beggiato & Krems, 2013). According to Blömacher et al. (2020) these models are dependent on the preliminary information they had obtained. Their study investigates how different initial mental models of adaptive cruise control affect trust and acceptance in system over time and how experience evolves the mental models of a user’s (Blömacher et al., 2020). They conclude with that initial information has an enduring effect on trust and acceptance of adaptive cruise control and that if mental models match experience, trust and acceptance stables regardless of experiencing a system failure as long as it is known in advance (Blömacher et al., 2020).

According to Wolf (2016), the transition towards automations of vehicles fundamentally changes the demands on the cognitive systems of the driver of a vehicle. Such development induces mental models to modify or restructured. “With respect to the automation of vehicles, both the cognitive-psychological processes of information processing and the influence of higher mental structures (e.g. needs, expectations, wishes, etc.) are important” (Wolf, 2016, p. 109). Furthermore, Blömacher et al. (2020) explains that is it important to examine the influence of mental models on driving in automated systems in order to be prepared for it. Still, it is unknown which attitudes and cognitive factors and emotional representation that would underpin the reluctance or acceptance of automated vehicles (Wolf, 2016).

An accurate mental model is the basis for creating trust and acceptance in new systems. According to Beggiato and Krems (2013) incorrect mental models can lead to misinterpretation of environment information. Therefore, it is significant that a user is aware and can explain or predict system performance in varying circumstances. Both over-trust and under-trust may be signs of inaccurate mental models. “Excessive trust, meanwhile, can lead to insufficient monitoring and control of the automation” (Wolf, 2016, p. 106). Once formed, mental models are not easily changed, since updating them requires cognitive effort (Beggiato & Krems, 2013). Despite mental models not being static and are continuously redefined by experiences. Many researchers suggests that mental models are rarely adjusted and therefore it is critical to promote the development of appropriate mental models at or even before first use. The concept of mental model is closely related to the users trust and acceptance in a system. Therefore, mismatch between experiences and mental models are expected to have a negative effect on trust and acceptance, and trust is considered a key variable for reliance of automated systems (Lee & See, 2004).

As systems develop, humans can experience individual differences in mental models. Previously, trust, has been identified as a key construct for individual differences (Lee & See, 2004). In addition, different knowledge about the system does according to Blömacher et al. (2020) make people create different mental models and is linked to expectations of different driving situations. According to Wolf (2016) many people think of autonomous vehicles as a concept for the distant future and that knowledge about autonomous vehicles are low among the general population. He further explains that the current cognitive and affective representations of the driving role is still strongly associated with the conventional image of an active chauffeur (Wolf, 2016). In addition, their study shows that emotions such as powerlessness and fear are factors having a huge influence on user acceptance and such

feelings can lead to irrational decisions. Meaning that from a user-perspective it is important to consider exciting needs both in terms of “communication and the concrete design of the systems” (Wolf, 2016, p. 120). Furthermore, according to Wolf (2016), for potential users the most important element is the potential added value of an autonomous vehicle compared to manually driving.

Bourmistrov (2017) uses the term cognitive “comfort” zone and “discomfort” zone to explain user’s mental models in conflict with information from a modified accounting report. His study reveals that by giving a public servant a modified accounting report it was not accepted as a complete substitute, but that there were some hopes, as mental models can gradually change. He suggests that “time will always be an important component because it allows mental models to adjust as new experience is gained” (Bourmistrov, 2017, p. 15). In this study, I have chosen to use the term of “discomfort and “comfort” as Bourmistrov (2017), but by applying it into the terms of this study, meaning that the element of comfort will focus on the transition from manually driven buses to autonomous buses.

Blömacher et al. (2020) describes that the development of mental models, trust and acceptance will become an even more important issue as automation becomes more complex and more capable and is considered a key factor in the development from assisted driving towards autonomous driving (Heide & Henning, 2006). Thus, the development makes it difficult to create accurate mental models (Endsley, 2017). In the context of this study, the aim is to capture and explore how citizens and potential users of autonomous buses are responsive to changes in the public mobility services. Furthermore, the study wants to explore how mental models can explain potential reluctance to accept changes in the public transportation services and if there are several mental models of citizens. Importantly, I aimed at focusing on the perceptual process underlying the driving task – having no bus driver. The usage of mental model theory will bring a new aspect into the cognitive aspect of user acceptance of autonomous buses as a mode of public transport.

3.4 Research question and analytical model

This study will focus on the cognitive, social and behavioural factors influencing user acceptance of autonomous buses in a single city context in the arctic region. The purpose of this study is to examine citizens' responsiveness and acceptance of autonomous. Specifically, the main research question is *How do citizen perceive autonomous buses in the Arctic region?* To address the cognitive, social and behavioural factors influencing user acceptance, I apply

mental model theory (Norman, 1983; Wolf, 2016; Bourmistrov, 2017), perceived value theory (Zeithaml, 1988) and the unified theory of acceptance and use of technology (UTAUT2) (Venkatesh et al., 2012). Such combination gave possibility to analyse (1) factors that are most important regarding citizens user acceptance of autonomous buses and (2) the main cognitive aspects of the shift towards autonomous buses. In the following, the research model will be presented and explained (Figure 1).

The UTAUT2 model founds the basic for the research model but has been altered. The following research has extended the UTAUT2 model by adding the determination of *ecological aspects*. The ecological awareness is used in the research of Nastjuk et al. (2020) and is a further personality component of determinations. According to their study, ecological awareness strengthens the perceived usefulness of autonomous driving for individuals with high ecological awareness. But, compared to individuals with low tendency to behave ecologically correctly were the useful of autonomous vehicles viewed as generally low. A focus on the environmental aspects of mental models of citizens can explore how they perceive the implementation of the buses from an environmental aspect. Because it is demonstrated that environmental concerns affect factors such as green perceived usefulness, perceived ease of use and behavioural intentions of autonomous electric vehicles. This aspect brings a focus into the sustainable aspect of smart mobility development and how this aspect influences the citizens perception of autonomous buses.

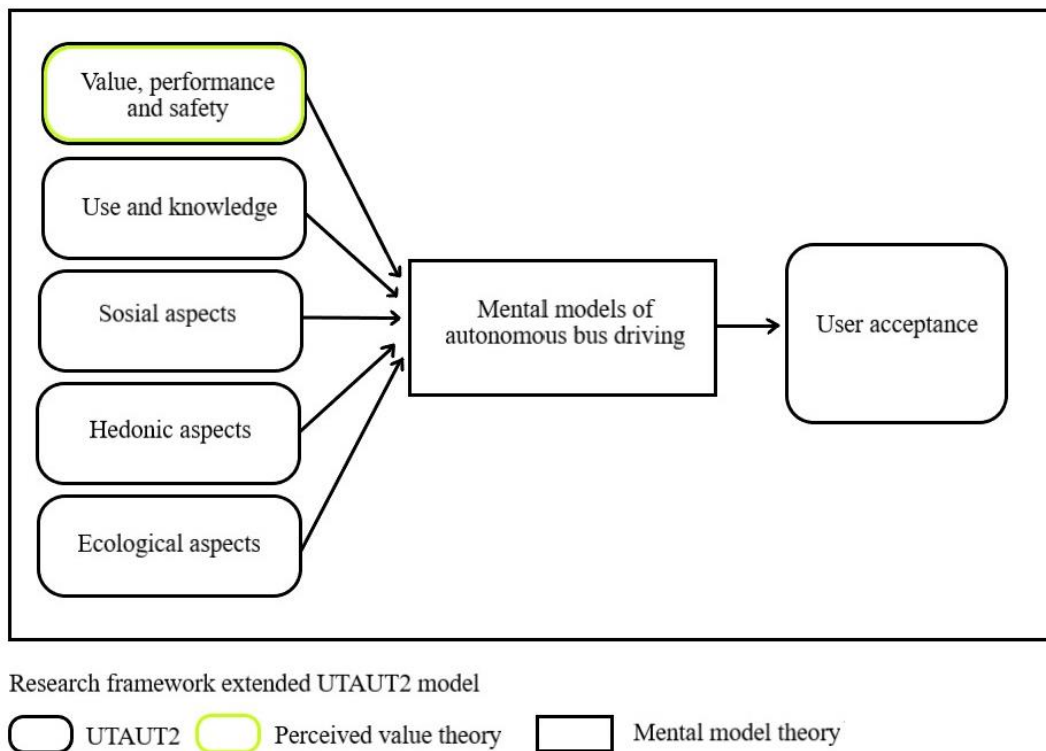
Perceived value has been added to the UTAUT2 model. Currently, Nordland County Municipality has not decided whether the buses should be ticketed or be free to travel with. Therefore, the present study did not examine the influence of price value on behavioural intention as showed in the UTAUT2 model. Instead, perceived value has been added to the UTAUT2 model as a determination to cover the value perspective of using a new mobility service.

In addition, mental model theory is added to the research model to capture a new perspective on the different determinants. The theory is used to capture the mental model influence on user acceptance of autonomous buses as a mode of public transport. To capture the mental model influence on user acceptance, the research model will be using the different determinants developed from the UTAUT2 to set the question and themes for interviews.

Altogether, these three theories have formed two sub-themes of the study. First, based on perceived value theory (Zeithaml, 1988) and the unified theory of acceptance and use of

technology (UTAUT2) (Venkatesh et al., 2012), I explore (1) which factors are most important regarding citizens user acceptance of autonomous buses. Second, based on mental models (Norman, 1983; Wolf, 2016; Bourmistrov, 2017), I explore (2) cognitive aspects of the shift towards autonomous buses.

Figure 1 Analytical model



4. Research methodology

Methodology in social sciences is about studying people and contribute with knowledge of how the social reality of the world looks like. People have various opinions and perceptions about both themselves and others. These are not stable and are constantly changing (Johannessen et al., 2011). According to Crotty (1998), there are four major elements in developing a proposal or designing a study. These are, firstly, the philosophical assumptions, such as the epistemology or ontology behind the study or how researchers gain their knowledge. These philosophical assumptions shape the process of research and the conduct of inquiry. Therefore, inquiries should always be aware of assumptions they make about gaining knowledge during their study because the researcher's values and perception of reality are strongly linked to epistemology and ontology. The next element is the theoretical lens, which are influenced by the worldview, and the use of a theoretical “stance” that the researcher

might be using. Theory is often used as lens in studies, which is a trend throughout the entire study. These theoretical lenses affect the third element, the methodological approach, and fourthly the methodology incorporates the methods of data collection and procedure to gain, analyse and interpret data. Below, I present the main aspects in this regard, reflecting on my philosophical assumptions and related methodological commitments, including data collection and analysis strategy, along with a reflection on the validity and reliability of the study.

4.1 Philosophy of science

The research philosophy is decisive for the outcome of the research, as the researcher's values and perception of reality are strongly linked to epistemology and ontology (J. Creswell & J. D. Creswell, 2018). It is essential that the researcher is aware of their research philosophical point of view as this perception of reality may color and influence the research process. In the following sections, the ontological and epistemological view of the research are elaborated.

4.1.1 Ontology and epistemology

Ontology is about reality and wants to explain the basic assumptions about our social world (Johannessen et al., 2011). Key ontological questions deal with whether there is a reality that exists independently of human interpretations and concepts, and whether there is a shared social reality or whether there are only several context-dependent realities (Johannessen et al., 2011). Easterby-Smith et al. (2018) describe four different ontologies within social sciences. These are realism, internal realism, relativism and nominalism. Within these four ontologies, there are different perceptions of truth and facts.

First, within the ontological position of realism, it is assumed that the physical and social world exist independently of any observations made about them. Meaning that there is a single truth and facts exists and it can be revealed (Easterby-Smith et al., 2018). Secondly, internal realism is a position which assumes that reality is independent of the observer and that the scientist can only access that reality indirectly. Within this perspective, truth exist but is obscure and facts are concrete but cannot be accessed directly (Easterby-Smith et al., 2018). Relativism is the fourth position and assumes that the view of a phenomena depends on the perspectives from which we observe them. Here, there are many truths and facts depending on the viewpoint of the observer. Finally, is the nominalism ontological view. By this perspective, objects in the world is formed by the language used and the names we attach to

phenomena. By this ontological position there is no truth, and all facts are created by humans (Easterby-Smith et al., 2018).

In this research there is a focus on understanding consequences of mental models and the research is centred around the barriers of user acceptance. Such barriers may be indirect barriers for a potential user, as mental models are based on their individual understanding of the premises and their general knowledge about a phenomenon. Due to reasoning, the following research is not realist nor have an internal realistic approach. Still, the research does incline towards relativism and believes that there are many truths, depending on the viewpoint of the observer. This means that the relativist focuses more on the mental capabilities than the physical characteristics in order to understand reality. Therefore, the research is influenced by the worldview of relativism because of the aim to explore reasons and structures of how mental models affects the user acceptance of autonomous buses.

Epistemology is about how to obtain information and knowledge about the world (Johannessen et al., 2011). Epistemology poses similar philosophical questions as ontology, but with a focus on investigating the possibility, limits, origin, structure, methods and validity of knowledge. When conducting research, there are three important questions in particular that needs to be addressed. Firstly, does the phenomenon have an objective existence or does it exist only in the minds of those who discuss it. Secondly, to what extent can one know that something is true. Thirdly, what forms the basis of our knowledge. Easterby-Smith et al., (2018) distinguishes between positivism and social constructionism as epistemological positions within social sciences.

The research paradigm of positivism claims that the social world exists externally, and that properties within this world should be measured through objective methods (Easterby-Smith et al., 2018). Meanwhile, social constructionism is about an idea saying that the reality is determined by people rather than by objective and external factors. Furthermore, that it is most important to appreciate the way people make sense of their experiences (Easterby-Smith et al., 2018). In addition, and according to Esterby-Smith et al. (2018), does relativism also provide an epistemological position. This means that observations will be more accurate if they are made from several different perspectives.

These main two position differ and have contrasting implications. Regarding positivism, researchers must be independent and human interest should be irrelevant. In addition, research should be conducted deductively with hypotheses and concepts need to be defined so it is

possible to measure them. Furthermore, the sampling requires a large number selected randomly and requires statistical probability (Easterby-Smith et al., 2018). Social constructionism, on the other hand, believes that the researcher is included and a part of what is being observed. Human interests are the main drives of science. Also, the aim to increase general understanding of a situation and gathering rich data, where sampling is by small numbers for specific reasons and generalisation is by theoretical abstraction (Easterby-Smith et al., 2018).

In conclusion, the following research believes that mental model barriers of user acceptance do have a subjective existence and that researchers are a part of what is being studied as in social constructionism. Former research on user acceptance is positivistic and uses statistical probability. I will approach this relativism constructionism by using research question and a case study and by doing interviews to acquire primary data. But the knowledge about these realities and whether these are true is limited to the information and data collected. Therefore, it is important to gather multiple perspectives by triangulation and by collecting perceptions and experiences of diverse individuals (Easterby-Smith et al., 2018).

4.2 Qualitative research method

The choice of method should support the opportunity to find answers to the research question and using a method means following a specific path towards a goal (Johannessen et al., 2011). Furthermore, it is about how to proceed to obtain information and how to process and analyse the acquired information. Within social science methods, a distinction is made between two different methods, qualitative and quantitative methods. The qualitative approach allows the capturing of rich information about a phenomenon being observed while quantitative approaches give the opportunity to survey widely and have many respondents to the survey.

Qualitative research methods seek to provide an in-depth understanding of a phenomenon and has the ability to generate a knowledge base with regard to those factors that determine whether a new product or service is eventually approved or rejected (Nastjuk et al. 2020). According to Kleijnen et al. (2009), qualitative methods can effectively identify any existing preferences relating to the use of a product or service, as well as any barriers encountered.

In this instance, the study has an aim to learn in-depth about perceptions and attitudes in detail from citizens regarding the shift to autonomous bus driving. Therefore, I found it most appropriate to perform a case study (Yuen, 2018) collecting qualitative data. The core reason for doing so is that qualitative methods allows for deeper insight and examine only a few

objectives. This chapter presents the methodological choices on which this master's thesis is constructed, as well as the methodological tools that have been used during the research.

According to J. Creswell and J. D. Creswell (2018) qualitative researchers typically work inductively when working back and forth between themes and the database until the researcher has established a comprehensive set of themes. Then, deductively, the researcher looks back at their data from the themes in order to determine if more evidence can support each theme or if they need to gather additional information. Such processing and analysing were used when the data were analysed, starting the research process inductively and then using deductive thinking when even analysing further, i.e. forming abductive reasoning (Easterby-Smith et al., 2018).

4.3 Research design

Research designs are defined as procedures for collecting, analysing, interpreting and reporting data in research studies. When conducting qualitative research there are many types of approaches. J. Creswell and J. D. Creswell (2018) highlights narrative research, phenomenological research, grounded theory, ethnography and case studies as the most prominent forms of research designs. These five approaches have similar structure and data collection processes, but differ from each other in areas such as choice of analysis unit, origin and data analysis methodology.

When I chose the design, I had focus on how to potentially link the data collected, and the conclusions drawn, to the research question. According to Yin (2018) case studies are optional when answering “why” and “how” research questions if the researcher wants to explore context or in-depth findings. J. Creswell and J. D. Creswell (2018) explains that a case study is a type of design where the researcher develops an in-depth analysis of a case. It is bounded by time and activity, and the researchers collect detailed information while using a variety of data collection procedures over a sustained period of time. Yin (2018) claims that the case study method is the best the method to use if the study deals with a phenomenon from reality, further, if the researcher has little control over the events and if detailed descriptions of the phenomenon are sought.

In the case of this study, the research question is set to answer a “how” question and the research problem requires an in-depth analysis of a phenomena. Due to the focus area and research question, a qualitative approach to case study was found to be the most appropriate and the study uses in-depth data collection from several information sources. Since the

research wants to explore an explicit phenomenon, case study implementation gives a framework that provides the researcher with the possibility to give an in-depth description of a phenomena. A primary distinction in designing case studies is between single- and multiple-case study designs (Yin, 2018). In the context of this study, the case that are studied and the informant are neighbours and citizens of a new autonomous bus route in Bodø, in the north of Norway. The purpose of this selected case is to examine their perception and attitudes by using different analytical tools. Therefore, the thesis is designed as a holistic single case study with a single unit of analyses presented below.

As of today, there are none or little research on how mental models influence the barriers of user acceptance of autonomous bus driving. Among others, Beggiato and Krems (2013) explored the influence of mental models on acceptance of driver assistance systems and Blömacher et al. (2020) explored the mental model influence on conditionally automated vehicles. Therefore, the following study does provide an exploratory research design that potentially can create findings that will be useful for further research in the same research area and can form basis for in-depth and more comprehensive research. The data gathered in this study express information about the potential barriers or tension citizens experience regarding the shift towards autonomous bus driving. Such information may be important for policymakers and how they should implement autonomous buses and how to present such change for citizens regarding aspects of information and marketing. Within exploratory research, there is no need for hypotheses, but rather rational understandings for why the given research question should be investigated (Yin, 2018).

4.4 Bodø as a case city

“Autonomous buses” is the seventh subproject of the project Smarter Transport Bodø by Nordland County Municipality (Smarter Transport Bodø, n.d.). The purpose of the subproject is to test the potential future of autonomous buses and pilot such technology in mixed traffic. In addition, they want to offer citizens an even more attractive public transport service and find out how autonomous buses can enrich the existing public transport service.

Furthermore, the project in Bodø wants to make it more accessible for citizens to travel by public transport to the main entrance at Nordland Hospital and to the city centre terminal. In addition, the bus route can make it more convenient for the citizens who lives around the route to travel around in the city centre without a car. The bus route also offers patients or visitors at Nordland Hospital an option to driving a private car and parking in the city centre.

The project aims at covering an existing transport need and establishing an alternative to driving a private car to the city centre.

The project is a Nordic collaborative, with Sensible 4 from Finland, Holo from Denmark, Mobility Forus and Boreal Buss from Norway, Nordland County Municipality and Bodø Municipality. The buses to be used are Toyota Proace and have already been piloted in both Gjesdal and Ski in Norway. What differs from the other test pilots is that the buses in Bodø are fully electric and are going to be tested in a climate with a lot of weather changes in the arctic region. The route has a length of 3,6 kilometres and can have nine passengers including a security host who will be always on board. The pilot project will start driving the autonomous buses in June 2022 and has a duration of six months, which means that the project gets the opportunity to test the autonomous buses in different seasons. The buses are equipped with technology from Sensible 4, which is a Finnish technology company operating in the field of autonomous vehicles technology. The company has solved a major obstacle when it comes to autonomous driving, which are variable weather conditions. They have developed a full-stack autonomous driving software that makes any vehicle self-driving. The technology combines software and information from several different sensors, which makes it possible for a vehicle to drive in all types of weather conditions (Sensible 4, n.d.).

4.5 Data collection

For qualitative methods, there are several methods to collect data, and these are through observation, interview and documentary analysis. The data from observation are based on the researcher's sensory impressions in different situations and actions in specific situations. During the interviews, on the other hand, the data is based on the information that the informant shares with the researcher (Johannessen et al., 2011).

First, I performed documentary analysis related to the case such as Smarter Transport Bodø project description, official documents related to transport and mobility regulation and research related to autonomous buses. This gave me a preliminary understanding of the phenomenon in focus and opened some insights for more detailed investigation. In particular, the main data source for this thesis was interviews.

The choice of interviews was natural because of its ability to capture rich information about a phenomenon and to obtain diverse citizen opinions. According to Carley and Palmquist (1992), language can be used as a window through which to view the individuals mind and can thereby build representation of their mental models that inform social action. The

advantage of interviews is that it is a flexible method of collecting data and allows for comprehensive and detailed descriptions. The qualitative research interview is characterised by it being a conversation with structure and purpose and are suitable when trying to achieve complexity and nuances from interviewees (Johannessen et al., 2011).

It was important to do the interviews in person because of the research goal. In addition, all of the informants were within reasonable distance making it possible to make interviews in person. Doing interviews in person and one at the time, has the potential to create an atmosphere where the interviewee is more comfortable or relaxed and can lead to the interviewee giving complete and honest answers. In addition, having interviews in person makes it easier to clear up the misunderstandings that could arise, and the interviewee does not need to interpret questions on their own, and therefore the risk of misunderstandings are reduced (Johannessen et al., 2011).

4.5.1 Informant selection strategy

When choosing informants, there are several factors that need to be considered. Among other things, one must consider who is most appropriate to interview, how many informants you should have and how many interviews are possible to conduct (Johannessen et al., 2011). Other studies on user acceptance of autonomous public transport have chosen various selection strategies. Nordhoff et al. (2016) conclude that most studies focus on car drivers because of the replacement of conventional vehicles. Since autonomous vehicles could also replace buses and other transportation, they suggest that studies need to include a variety of other potential adopters and groups that use, operate or make decisions about implementing autonomous vehicles. In addition, they describe that most studies are being sampled by early users or users with vehicle automation experience. Other studies, such as Yuen et al. (2022) in Beijing, China, chose to only include current public transportation users as their survey informants. Other studies have focused on asking informants to rate actual automated vehicles after physically experiencing them (Nordhoff et al., 2019).

In this instance, the aim was to capture a broad variety of citizen opinion regardless of their travel habits or age to capture different experiences, opinions, perceptions and perspectives. Therefore, there were not used criteria such as being a public transportation user, car owner or if they have experience riding an autonomous bus or not. Still, there were a few criteria's when choosing the informants. The first criteria is about informant ability: is the informant able to travel on their own by public transport if they choose to. The reason behind this

criterion is that it is important that the informants are potential users of the new mobility service and that they are able to relocate without any further difficulties. The second criteria concern housing locality. The informant must live in close distance to the bus route and be able to walk or otherwise easily access the buses if wanted. The aim of this criterion was to select informants that often will interact with the buses regardless of using them simply because of their place of residence. Such interaction includes seeing the buses several times on a weekly basis, using the same streets as the bus route and so on. This criterion focuses on the proximity to the autonomous buses and how this affects the informants as potential users and neighbours to this mobility service.

This project has a clearly defined time limit. Because of this, I had to adjust the number of interviewees to a practical number considering the project financial and time constraints. The interviewees were recruited via direct contact, and some were acquaintances of the researcher. Also, a few interviewees were suggested after interview and were not acquaintances of the researcher but acquaintances of the interviewee. This strategy is also known as snowball sampling and is useful when interviewees are limited or difficult to access (Easterby-Smith et al., 2018). Overall, this strategy resulted into 10 interviews conducted (see Table 1) until saturation within discovered topic appeared (Easterby-Smith et al., 2018).

4.5.2 Interview guide

An interview guide is characterized by the structure of an interview (Easterby-Smith et al., 2018). Easterby-Smith et al. (2018) explains that when creating an interview guide or interview schedules, the researcher need to revisit their research question, research design and sampling strategy. This helps to clarify the purpose of the interviews that they would like to conduct. In addition, it is important to reflect on how the interviewee would understand and feel about certain questions. Furthermore, the researcher must consider if the interview should be highly structured, semi-structured or unstructured (Easterby-Smith et al., 2018).

A highly structured interview is characterized by a detailed interview guide, where questions are in a predefined order with some of them being narrow selected with predefined answers. Semi-structured interview guides have a selection of topics or issues to be covered, while unstructured interviews have individual questions aimed at stimulating an informal conversation (Easterby-Smith et al., 2018). For this thesis, it is valuable to be able to flow between different topics and questions and go in depth for reflection. Therefore, the interview guide was semi-structured, and I had selected topics and questions predefined (appendix 1). In

addition, I wanted the interviewee to be able to ask me questions or give further reflections on topics, especially if they felt that something was missing or not covered in the planned questions. Easterby-Smith et al. (2018) explains that semi-structured interviews often gives higher confidentiality as the replies of interviewees tend to be more personal in nature. In addition, the interviewer has the opportunity to identify non-verbal clues.

When choosing topics, it was important to make them relevant and in context of the theoretical framework. The interview guide contains three main parts, consisting of opening questions, questions around different key topics and closing questions. I decided to use eight different topics to signify the theoretical model and research question and each topic has suggested question to reflect the theme of the topic (see appendix 1). When developing questions, there was a focus on creating question that were both open for reflections but had a clear topic. Therefore, many questions are “how-questions”, and they are not leading by avoiding negatives and using simple expressions (Easterby-Smith, 2018). The interview started with personal information and questions about interviewees perception about buses in Bodø and their perception of self-driving technologies. Then, different user acceptance constructs from the theoretical framework is used and pictures of a self-driving bus and a bus with a driver is given to the interviewee while responding to questions. The intention behind this, is to give the interviewees a visual understanding and potentially make them reflect more over the transition and if they feel any attached issues to this context. In the final part of the interview, the interviewee are asked if they feel that there are other important aspects or if they have any final questions.

There was only one interview guide made in both Norwegian and English. In addition, before starting the process of recruiting and interviewing, I had a test interview where the interviewee was asked questions about how they experienced the interview and questions. The test was also important to see how natural and spontaneous the informant was able to answer the questions (Easterby-Smith et al., 2018).

4.6 Data collection procedure and analysis

Below I present how the data collection was proceeded and how the empirical findings were analysed. The process of interviewing is outlined, and the interviewees are presented.

Attention is especially paid to the process of translating the Norwegian conducted interview into English and how this process had different challenges.

When recruiting, the interviewees were informed about the project and for what it was to be used for. Furthermore, before the interview the interviewees were informed about the various ethical guidelines and was asked to sign a form of consent. They were also informed about the need to use a sound recorder during the interviews and that the interviewer would take notes. Participants were guaranteed anonymity and that there would be no questions of a person-sensitive nature (Johannessen et al., 2011). Since I wanted a broad citizen perspective, I choose to recruit interviewees in different ages who ranged in age segments from 18 to 84 years. In total, eleven people were asked to participate, but only ten persons accepted the request. In the iterative process of analyzing the interview data, I found a theoretical saturation occurred within the first ten interviews. Thus, I decided to stop the recruitment of new interviewees. All sociodemographic details are summarized in Table 1.

Table 1 Sociodemographic details

Participant ID	Age group	Gender	Employment	Daily commute mode
1	35-44	Male	Employee	Car
2	45-54	Female	Other	Car
3	65-74	Female	Pensioner	Car
4	74-85	Male	Pensioner	Car
5	18-24	Female	Employee	Bus
6	55-64	Male	Employee	Car
7	18-24	Male	Student	Walk
8	45-54	Female	Employee	Walk
9	18-24	Female	Employee	Car
10	45-54	Female	Employee	Walk

Before the interview started the interviewee received an information sheet about the different topics that would occur during the interview (appendix 2). This sheet was in both Norwegian and English. Then, verbal information about the autonomous bus project in Bodø was given

and the interviewee got to see pictures of the bus route and a similar bus as the one that is going to be in Bodø. This information was given to start the thought process and to ensure that the participants had equal understanding of the topic. Nine interviews were conducted face-to-face in the interviewees home, while one interview was conducted in the interviewee's office face-to-face. To do the interviews at their homes or office created a relaxed atmosphere where the interviewee was in their natural environment. The interviews were recorded and had a time range from 8 minutes to 28 minutes. The interviews were conducted in the Norwegian language.

To capture mental models of the citizens, interviews were conducted talking about their travel habits and their perceptions of buses and autonomous bus driving. Then, the different constructs of the research model were discussed from a mental model perspective and if they felt any tensions regarding the shift from human bus driving to autonomous bus driving. The aim was to capture relevant acceptance criteria from a mental model perspective. As described by Bourmistrov (2017), exploring mental models is not an easy task, as they exist in the mind and are not available for direct inspection and measurements. In an attempt to capture mental models of citizens, interviewees got to see two pictures during the interview, one picture with a bus driver and one picture without a bus driver, that is, an autonomous bus. According to Rouse and Morris (1986), there are many limitations regarding the objectivity of the mental models' descriptions, which involves issues of accessibility and credibility among other things. Furthermore, since the conceptualisation of mental models depends on the researchers understanding of the situation, there are possible biases, and these can lead to misrepresentation (Bourmistrov, 2017).

During the interviews, I saw that having the opportunity to outline questions further made many informants more reflective. They took time to view the pictures, and often stopped in their reflections to view the pictures more before continuing their reflections. Often, they would have further reflection after viewing the pictures, and as interviewer, I paid attention to their body language as I saw that they were processing different thoughts. In addition, having a semi-structured interview guide made many informants reflect on different aspects that were not mentioned in my questions. Aspects that naturally occurred during the interview because of the interviewees reflecting while watching these pictures.

After the interviews, I decided to transcribe the recorded interviews by translating the recorded conversations into text (Johannessen et al., 2011). The interviews were transcribed

within a couple of days after interviewing, because of the importance of having proximity to time of transcribing. I decided to describe the interviews into English while listening to the Norwegian conversation. Transcribing and translating the interviews were both challenging and time-consuming, taking three weeks in total. Much time was spent on constructing sentences that express the same meaning as its Norwegian equivalent in the audio recording. Some Norwegian expressions were not easily translated into English, due to its semantic meanings. In these cases, I focused on the on the meaning of the content and tried to capture it in the English translation.

Following the transcribing, all data was sorted into a new document and every citation was sorted under the topic they belonged to from the interview guide. During this part, the topics from the interview guide were used to divide the topics of the empirical findings and also make the topics a little different from the interview guide. Then, in the process of writing the empirical findings, I decided to focus on both more general perceptions as I saw several patterns among multiple informants. In addition, I focused on perceptions that were not traditional in relation to the findings. It was important to show and capture the differences in citizen perception regarding the phenomena being studied. Therefore, I choose citations that were considered the most appropriate in order to describe their different perceptions, i.e. becoming representative quotations for theory related topics.

4.7 Quality of research

A research design is supposed to present a logical set of statements and the quality of a design can be judged and tested by certain logical test (Yin, 2018). Four tests have been commonly used to establish the quality of most social research. These are construct validity, internal validity, external validity and reliability. Each item will be further discussed below and described how this study deals with these tests. In addition, will the credibility of the research be described and lastly, the research ethics are presented.

4.7.1 Validity

Validity is described as the extent to which measures and research finding provide accurate representation of the things they are supposed to be describing (Easterby-Smith et al., 2018). For case studies, Yin (2018) describes construct validity of a research as about identifying correct operational measures for the concepts being studied. Internal validity is about seeking to establish a causal relationship and are only measurable for explanatory or causal studies. While the last is external validity and is supposed to show whether and how a case studies

findings can be generalised. According to Yin (2018), each item needs explicit attention and should be applied throughout the subsequent conduct of a case study.

Firstly, Yin (2018) describes three tactics to increase the construct validity of case study research. The first is the use of multiple sources of evidence and the second tactic is to establish a chain of evidence, while the third is to have the draft case study report reviewed by key informants. Construct validity is affected by method errors and various biases. A bias could be publication bias, interview bias or sample bias. While a method error could be a researchers tend to seek interviewees that supports their own views (Johannessen et al., 2011). Because of time- and recourse limitations, a potential bias could be the snowball sampling as some perspectives could be underrepresented. But, by using ten different informants I have attempted to avoid this bias. In addition, in an attempt to increase the construct validity of the study, two key informants read the thesis.

Secondly, internal validity is, according to Yin (2018), only for explanatory or causal studies where the research aims at explaining how and why an event led to a new event. The following research presents an exploratory study and does therefore not deal with this concept. Thirdly, the external validity, Yin (2018) explains that this concept can be increased by using appropriate theory and that the initial research question can directly help or hinder the preference for seeking generalisation. During this research, I have chosen to use “how” questions as research question and mostly when collecting data since it can provide an analytical generalisation. Additionally, the research question was sat early in the processes of creating the research design and had early in the research process identified appropriate theories to establish the groundwork of the study.

4.7.2 Reliability

Reliability is defined as the consistency of measurement in a composite variable formed by combining scores on a set of items (Easterby-Smith et al., 2018). The reliability of a research should demonstrate that the operations of a study can be repeated with the same result. The goal of reliability is to minimise the errors and biases in a study (Yin, 2018). In addition, in qualitative research, it is important that the findings are a result of the research and not of the researcher's subjective attitudes (Johannessen et al., 2011). According to Yin (2018), a general way of approaching the problem of reliability is to make the research process as explicit as possible.

In this study, reliability was a concern as cognitive aspects cannot be replicated with the same results because of the subjectiveness of the case being analysed. However, it is possible to replicate the processes with other findings depending on the case of the study. Focusing on specific informants and having a strategy when selecting them, can increase the probability of transferability. Therefore, I spent much time and attention on the research process. I aimed to carefully describe each process and why the questions were chosen. In addition, I have used much time on the literature review and have applied a wide range of literature to substantiate the interpretations.

4.7.3 Research ethics

Research ethics refers to a wide variety of norms, values and institutional arrangements that regulates scientific activities (NESH, 2019). It is about key principles to protect research participants and protect the integrity of the research community. When doing research, different ethical issues can arise and there are many measures that can be taken to ensure that research is ethical conducted (Easterby-Smith et al., 2018).

Ethics is about principles, rules and guidelines for assessing whether actions are right or wrong. According to Johannessen et al. (2011) all activities that have consequences for other people must be assessed on the basis of ethical standards. Easterby-Smith et al. (2018, p. 157) describes ten key principles in research ethics, which are to “ensure that no harm comes to participants”, “respecting the dignity of research participants”, “ensuring a fully informed consent of research participants”, “protecting the anonymity of research data”, “avoiding depiction about the nature or aims of the research”, “declaration of affiliations, funding sources and conflicts of interest”, “honesty and transparency in communicating about the research” and “avoidance of any misleading or false reporting of research findings”. These principles are about protecting the interests of the research subject or informants and about protecting the integrity of the research community by ensuring accuracy and lack of bias in research results.

In addition, The Norwegian National Research Ethics Committees in the Social Sciences and the Humanities [NESH] has established guidelines for research ethics which provides guidance and advice (NESH, 2019). These guidelines are mainly constructed into five parts which sets out various research ethical obligations (NESH, 2021). These are about the research community and their collegial responsibilities. The second part is about consideration for persons and the researcher responsibility for all participants in research. The

third part concerns groups and institutions, referring to weak and vulnerable groups that may need extra protection. The fourth guideline is about clients, funders and partners and is about the researcher's obligations towards different partners and being able to balance norms of openness and independence against demands for utility and societal relevance. Fifth and lastly, the research dissemination, which is about researchers and research institutions are responsible for communicating scientific results.

During this research, these guidelines has been used throughout the research process when working with primary and secondary data, collecting, storing, analysis and reporting. Early in the process, the project was registered with the Norwegian centre for research data [NSD]. Here the plan for handling, storing and archiving research data was outlined and described in order to get an assessment and clarification before collecting the primary data. Since it is a qualitative study and requires personal data from interviewees, the project had to be approved by NSD before data collecting. Before interviews, all informants got information about what kind of personal data that would be stored and given a paper of consent to sign.

For many informants it was important to be ensured anonymity. Therefore, when describing the informants, I chose to use age segments and their work status instead of actual age and profession to ensure their anonymity. All primary data was worked with caution and awareness of anonymity. The informants did consent to the usage of a sound recorder during the interviews and the app Nettskjema-diktafon by University of Oslo were used during the interviews (University of Oslo, 2021). When transcribing the interviews, the interviewees were classified with numbers, making the data traceable but anonymous. In addition, I did not transcribe any personal information that they may have said during the interviews. The data was then stored on a Nord university Office 365 account, which is not synchronized with any personal computer in accordance with Nord University guidance and student responsibility for privacy protection (Nord University, n.d.).

5. Empirical findings

In this chapter, I will describe the findings of the qualitative interviews. According to the research design, I have interviewed ten neighbours of the autonomous bus route. After the interviews, I chose to transcribe with a focus on meaningful content. The findings are divided into seven categories “general attitudes toward bus driving”, “self-driving technologies”, “value, performance and safety”, “use and knowledge”, “social aspects”, “hedonic aspects” and “ecological aspects”. These categories are derived from the theoretical framework and

interview guide in order to shed light on the different topics. I have selected the information that would be most relevant for further analysis for the project and also given illustrative quotes from informants on particular themes and possible challenges.

5.1 General attitudes toward bus driving

To start the interview, the informants were asked questions about their travel habits and how they perceive bus driving in Bodø. Many of the informants do not use bus as their daily commute mode and most of them only use car or walk. Just one of the informants takes bus primarily. Informant 10 said that “I have to admit that I rarely take the bus. But it seems like the bus offer is good. I have a positive view of the bus”. Furthermore, informant 1 said the following:

I don't really have much of an opinion about them, I never take the bus, but I see them driving by us in the neighbourhood. They drive back and forth, and many people take the bus and especially in rush hour many people take the bus. The buses drive until late at night, and yes, it is good. I can't even remember taking the bus once.

Others had more negative experience with the buses as informant 9 saying “it has been some years since I used bus. But I remember that they were really annoying. They never arrived at time, and it was difficult to deal with them”. As the only one using bus primarily informant 5 said the following:

Both positive and negative. I think there has been a lot of talk about improving the buses and that it has improved. But I still think there are things that can be further improved. There is great variety, as there is in all professions... But there is great variety in the bus drivers, and I experience many who are not so fond of their jobs. If I can say so... Last week, there was a bus driver who was really angry. He yelled at the passenger, including me, on the bus in front of all the passengers. Because he thought we should have given a sign. But walking towards the bus door is a sign of wanting to board the bus. I have experienced several incidents that are not positive on the bus. It seems like there is a lot of irritation.

Following up this question, the informants were asked about how they experience the buses. The informants used words as “okey”, “well”, “crowded”, “fine”, “nice” and “big”. Informant 10 explained further: “Yes, I don't have any negative impressions. The buses run in my immediate area where I live, but it goes well”. In addition, informant 2 said that “They are big

and nice. They tell me where my stop is. I think they are okey, and they are nice to interact with when driving a car. Generally, bus driving in the city goes well”.

In addition, they were asked how satisfied they are with the job bus drivers do. All of the informants said that they were pleased with the job bus drivers do, but also reminded me that many of them did not have much experience taking the bus. As informant 3 said “I have little experience with how bus drivers act, but I am sure its fine”. Informant 10 explained that “Yes, they stop. As a pedestrian, I am satisfied” and informant 4 said the following:

Of what I have experienced, yes. Yes... But I have seen some instances where the buses are close to hitting another car. But that’s because of the narrow streets. Some places, the streets are too narrow for the bus to swing.

The informants reflected over their interaction with the buses, and one of the informants, informant 2, used an example from a couple of years ago, saying the following:

Yes. But some years ago, a woman fell under a bus in the city centre. Therefore, one must be aware of buses in traffic, especially when they swing. Beyond that, bus drivers are just as attentive as other drivers. But the bus is big, so you have to pay some attention to it. The bus does not necessarily see everything.

5.2 Self-driving technologies

During this subject the interviewees were asked about their perception of self-driving technologies and how weather conditions in Bodø may influence self-driving buses. This topic was important to start the reflections about self-driving technologies and if any informants had any prior experience. However, none of the interviewees had prior experience with riding an autonomous bus. But one of them, informant 4, had seen one before in Bodø a couple of years ago when there where a one-day trial and others had experience with other autonomous transportation modes such as trains in other countries. Many informants automatically answered “no” but were intrigued by the question. Informant 1 said: “Like where?! No, I have never been to a place where they have self-driving buses. I have never seen one in real life either. But I have heard about them”.

Then I asked the informants about how they feel about the development of self-driving buses in society. There were various answers and several informants used time before being able to answer. The interviewees had different perceptions of such development and if it is positive or negative for society. Many had an overall positive perception of it, saying that they are

“curious”, “thoughtful” or “excited” and that it is important to try it. Many mentioned reading articles about self-driving buses while others had no prior knowledge about them. Informant 4 said: “Curious. I think it is interesting. I would have to say it is positive, its positive to think new. One should think new” and informant 9 said: “It sounds fine, as long as it works” and informant 10 said:

I think it might be positive regarding technology. But in relation to society, it raises important questions regarding the human aspect. Such development might reduce jobs, but at the same time... We live in 2022, and we must accept that the development is going in that direction.

Others were more sceptical about the development, questioning safety aspects and work aspect of it potentially losing lots of jobs. Informant 6 shook his head and said: “As the society is today, I do not consider it safe enough” and “I think it is still a long time until self-driving technologies are mature enough to drive buses or cars.”. He further reflected: “It is moving towards a more sterile society where machines are supposed to do everything. This is noticeable in many workplaces”. Informant 5 said:

Both positive and negative. In a way, I am in very much in favour of having workplaces. Many workplaces could be at risk, especially thinking about every bus driver in the whole country. There are many people who work as professional bus drivers. But it is good that we have the resources in Norway to further develop the technology. Especially in the last ten years. It has gone very fast, and it is a good thing that thing develops and that we can try new things. I think it would have been cool.

Many informants talked about “what if” situations focusing on the potential risk of autonomous buses. They showed concerns about the technology aspect and were visible uncomfortable as some raised their eyebrows while others would sigh while talking about this. Informant 7 said: “What if the self-driving technology loses control? What if they crash?” and informant 3 showed further concerns: “How will these buses behave in certain situations?” and informant 8 saying:

It sounds a bit scary. Will the buses stop if something happens? The idea of someone getting hit by the bus, whether it is intelligent enough. For example, if there are two obstacles, which one will the bus hit? Or will it always stop?

When talking about how it would feel to be a passenger on a self-driving bus the informants used words as “a bit scary”, “strange”, “not safe”, “excited”, “fine”, “anxious” and “sceptical”. They were especially referring to using the bus the first time: “I think it will be a bit scary. I have never tried such a bus before. So, the first time, I would be a bit scared” - informant 7. Informant 2 said:

I think it is a bit exciting. Because I have seen many science fiction movies where people drive cars without a chauffeur, and they just sit and look out the window and reads the paper or does whatever. So, it is a little bit exciting, and I think the first time trying a self-driving bus will be exciting. But I am also a bit sceptical. Because you never know, it is only a machine that must keep up with everything and we have to rely on many sensors. I think I will feel some tingling in my stomach. But a bit excited.

Many also referred to the importance of previous experiences as informant 8: “if it has been tested, then it will probably go well. But a little bit scary. I might not want to be part of the first trip. Someone else can take the first trip”. Informant 10 said:

I must admit that immediately I thought it sounded a bit strange. I would not say scary, but a bit different. But I have a general trust that the things that are done, they are done in controlled forms and that the operators knows what they are doing. I have confidence that when various projects are implemented, it is safe.

Talking about how weather conditions in Bodø may influence the self-driving buses there was a huge focus on winter conditions. All interviewees mentioned winter conditions as a potential challenge and no other weather conditions. This was not a surprise, and I did expect this perception because of my own experiences with winter conditions in Bodø. The interviewees focused on the importance of proper ploughing, icy roads, wind and electric buses’ potential problems with charging, range and so on. Many informants also mentioned prior problems experienced in Bodø with electric buses during the previous winter or their own experiences in the city centre. Informant 1 described the weather conditions as quite harsh, saying:

The weather conditions are quite harsh. I heard that in Oslo and in Bergen, where they have had other pilot projects, the sensors of the buses struggled with snow and affected their ability to see obstacles. So, it requires snow removal to be on high alert.

And that the roads must be quite nice all the time for them to be able to drive well. This may be a challenge, but I think they will make it.

Others were more sceptical about winter conditions and the busses' ability to "handle it", mentioning ploughing to be a main potential problem. Informant 4 said "if it is ploughed properly, then it will go well. It is probably winter that can put a stop to this. Or at list slow it down. I think it will be exciting to see". Informant 8 said: "especially if it will be as badly ploughed as the last winter. Then I think the bus will have a problem". This problem of ploughing has been several times stated in media, showing problematic situations because of poor driving conditions. Informant 2 said: "to manoeuvre through this street can be difficult when the weather conditions are at its worst. How will the bus withstand running on slippery ice?" and "I think that the weather conditions can create clutter for the sensors".

5.3 Value, performance and safety

During this topic interviewees received questions about how they perceive a bus with a driver and a bus without a driver regarding the buses value, performance and safety. They were presented with two photos of a bus with a driver and one without. They were asked to look at these photos and evaluate which situation they felt was the easiest way for them to travel based on their existing knowledge. The interviewees took time viewing the photos and would often keep their eyes on the photos while answering me. Many of the informants also used some time to respond to this question and answered that they did not know or were unsure: "I don't know. But I think it is strange that there is no one behind the steering wheel." - informant 9. Informant 4 explained: "I don't know. I would have to try it first. It is not easy to say beforehand which is easiest to travel with when I have never tried it before". Referring to the importance of prior experience or knowledge to be able to have an opinion.

Some also did not see difference or that one of the options were necessarily easier than the other. Informant 5 said: "it does not have much to say. If I had both options available? It depends on what is most easily accessible" and that "You don't necessarily trust that human driver more; he might be thinking about his dinner".

Many said they thought it would be easiest with a driver and said it was because of their prior experience. Informant 1 said: "the one with the driver. Because I am used to see a bus driver". This perception was recurring and informant 2 said: "the one with a bus driver. A human that can evaluate the whole traffic picture. Because he will be able to interpret the whole traffic situation on a more correct way than artificial intelligence".

When asked if the buses respond to their needs as a passenger most of the interviewees said that they did and that both buses are “probably good”. Some focused on the importance of getting from one place to another: “they get me from A to B” -informant 10. Informant 5 focused more on the pictures saying that the self-driving bus looked more attractive because of their sensors and cameras. This influenced her perception, and she said that she did not get an unsafe feeling because of this. While one informant focused on the human aspect of driving saying that “I would feel satisfied in a bus with a real driver. I would feel less satisfied with a machine” -Informant 2.

Afterwards, they were asked which alternative that seemed safest to travel with. The interviewees had different perception of safety and whether or not a chauffeur influenced their feeling of safety. The perceptions did surprise me, but many informants had a conventional view of which one was safest as eight of the informants said that they would feel safer with a driver. Many said it was because they did not have prior experience with an autonomous bus. “One might feel safer with a driver, but that's because it is what you're used to” -informant 9. Many also mention that this perception could change in the future with more experience. Informant 10 illustrated:

As of today, and current knowledge and experience, it is easy to say that it is safest with a driver. But I trust that everything is taken care of without a driver. Just as new cars have sensors and other technologies, I assume it will go well. It will probably be a transition and I guess the first times taking the bus without a driver I would be more aware of the driving. To be more aware and watch the driving. But accidents do happen with a driver as well. Being inattentive and so on. I do have confidence in it going well without a driver as well. But immediately you think that could be safest with a driver.

While other trusted the driver more than the technology. Informant 2 said that she would feel safer on “the one with a bus driver. Because he or she would be able to better form an image of potential danger on the road. Furthermore, make correct decisions” and explains it with “I am scared artificial intelligence will not be able to make correct interpretation. Therefore, I will not feel 100% safe with it”. Informant 8 explained “I think the bus with the driver is safest. Then you have someone to ask if something happens on board. It may be safer to have someone you can turn to”.

Informant 5 were not sure which she felt was safest and said:

I am not sure. Even if there is a human driver, it does not affect my perception of safety. Because we know how humans are. When we drive or work, we can get unfocused or distracted. We are humans. So even if there is a human driver there, that does not mean that it is safer.

Respondent 1 did also feel some of the same feelings as informant 5 thinking that both options could be safe:

I think that I would feel safe in both. Of course, I feel safe with the bus that has a driver, but if they tried the self-driving buses and they work, I would also have felt safe there too. The self-driving bus looks a little sophisticated. There are many cameras and sensors. So, I think I that could be safest.

Then we moved on to the next question. I asked the informants how it would feel to walk close to these different buses. Again, experience was an important factor when reflecting on this topic. Many informants said that not having experience with self-driving buses did influence their perception of safety and that experience could change their perception: “you become safer the more you see such a bus in the city and experience that it goes well” - informant 10. Informant 10 further pointed out that:

Before getting used to it, I would probably think that a driver, he sees you, and one would be unsure if the self-driving bus sees you. And I think that, if one knows there are self-driving buses, one would be more aware of them. Be more aware when crossing streets or when it passes by. At least in the transition phase until one feels safe that the bus sees you.

The informants mentioned that it is a bit strange with a self-driving bus and some said that they would be more aware of the bus or a bit scared and would keep extra distance. Their concerns made sense to me, as neither of the informants had prior experience with autonomous buses. “I think it might be a bit scary. I would keep extra distance. But buses with drivers are much safer. We know that they will not hit us” -informant 7. Informant 2 said and also illustrated her perception:

I would have felt very unsafe next to the self-driving bus. I don't feel 100% safe next to an ordinary bus either. Regardless of it being self-driving, I don't feel 100% safe because of their size and because they have many things to deal with. When I meet buses, I don't insist on their duty to give way to me as a pedestrian. I would rather

wait. I may be extra careful or scared. But in time and after getting used to self-driving buses it might be even better at taking care of soft road users.

During her reflections, Informant 5 used a lot of time viewing the photos saying that “My first thought was that the situation with a driver is safest, but after reflecting on it, I think maybe the self-driving is safest” and that “Automation can be just as safe as a person that does not see me in the mirror”. While Informant 8 and others did not feel that having a driver or not influenced the perception of safety: “As long as the bus stays on the road and where it should be, I would not have thought about it”. Other informants were much more positive towards self-driving buses even though they had no prior experience with them, like informant 1:

I think it is safest to walk next to the self-driving bus. Because the bus stops if I am too close. I am 110% sure that the self-driving is safest, because the driver may be drunk or something else. You never know.

5.4 Use and knowledge

During this part, the interviewees were asked about how they perceive the use of a bus with a driver and a bus without and if knowledge had a potential influence on their usage. Firstly, they were asked about the usage of the different buses and if they saw any challenges using them. Some saw potential challenges with the driver, focusing on the driver’s potential to be unfocused: “Well, yes. The bus driver might be tired, sick, he might get an acute disease, he might have been drinking alcohol or are under the influence of other intoxicants. We know that this happens” -informant 6. While others did not see any challenges using a bus with a driver and informant 5 said:

What kind of challenges? I also think it is very nice to take the bus. Early in the morning or late at night, when there are no one on the bus... To have that contact, to say “hi” or smile when boarding or say “goodbye, have a nice day” when disembarking... It is very pleasant. Even if I think that technological development is good, I do think that it is important that the human contact does not totally disappear. We only become robots at the end.

Talking about the self-driving buses the informants saw potential different challenges and opportunities. Some focused on the comparison of a bus with a driver and a bus without one. Informant 7 said that as long as the procedure to use the bus and buy tickets is the same, he did not see any challenges using either option. Therefore, he did not perceive it as potentially

challenging. Informant 8 also focused on the comparison and potential benefits of automation saying that a self-driving bus may be more accurate:

No. Maybe the self-driving bus is more accurate. Maybe it does not have as many things to focus on as a bus with a driver. Maybe the ticket must be purchased before boarding. There is not much that can delay the bus. Because there is no one on the bus to ask questions to. That must be an advantage. Maybe the bus will be more precise.

Informant 10 reflected on potential challenges regarding how to receive information about direction or where to get off the bus and said that such service will not be available on a self-driving bus and showing certain reluctance to driverless buses. Informant 2 also saw potential challenges with how to receive information and said:

If something happens, there would be no one to help or tell me anything. No one to guide those who are onboard the bus. There is no one who is responsible. You are there at your own risk, and there is no one to help you if something occurs.

In addition, informant 2 further thought that:

No, the only thing I am thinking about is who is responsible if an accident occurs. I feel it is very important. We have to know who is responsible, and that cannot be an operation system or firm when someone has been injured. There must be a direct correspondence between an incident occurring and someone being responsible.

Afterwards they were asked if it would be a problem riding with either of the buses. Many of the informants first said no, but that they would prefer a driver. Informant 6 said:

No, I don't think so. But I would prefer a human driver. Also, who is responsible? Is it the company who operates the buses? Is it the municipality? Is it the mayor? The law says that the driver of the vehicle is the responsible part if something happens. But who is responsible on a driverless bus? I think it is important that the passenger of the bus knows who is responsible if something happens. What if a passenger gets acute disease, how can they stop the bus? Is there an emergency button?

Informant 3 pointed out:

No, not a problem, but I am a bit unsure about this driverless bus and that it will behave as it should. Of course, with a driver, an accident can also happen. Mistakes can happen for humans also. You can get hit by a vehicle or similar. That is certain.

Some did not see any difference between having a driver or not and informant 9 said: “No, not really. I don’t think it would be any more challenging than a bus with a driver” and informant 1 said “No, I don’t think so. Yes, if they get so far that they can be driven in mixed traffic and that they work, then I do not see any reason why it cannot be a success” and informant 4 said “No, it is not a problem being a passenger with a driver. But I am curious about the self-driving bus. I would have tried it”.

Then we talked about knowledge and if they felt that they needed extra knowledge about self-driving buses. Many did respond that knowledge affects their perception and prior readings and information had influenced some of their opinions. Informant 7 said that having more knowledge about the sensors and how they work would affect his feeling of safety. Informant 5 said:

Yes, I would have had even more trust in the technology if I had more knowledge about it. Now, when I am looking at these photos. My first thought is that the bus driver is the safest option, but after viewing the technology in the second photo, I get more trust in the technology just by looking at it.

In addition, when asking if knowledge about the technology is important, informant 5 said that: “Yes, I think so. To further develop and get people to use it, you have to gain trust from the people using it. The more you know about something, the easier it is to form an opinion”. Informant 1 also reflected on this saying “yes, knowledge is very important. Knowledge makes people feel safe and makes them use the transportation” and informant 10 said that “knowledge and information will make the project more positive”.

Others did not see the importance of knowledge about the technology as informant 9 said no to the question and informant 8 said: “No. I do not have much knowledge about self-driving technology in the first place. But I reckon it is tested properly”. I was stunned by this perception, but it illustrates the differences in how citizens view what is of important for them personally. Informant 4 said that knowledge is important, but it should not be important for the passenger. But still, he addressed that such knowledge would be important for him.

Then they were asked which of the two situations they would feel most at ease in. This was a difficult question, making many of the informant reflect over their current knowledge and perception of driving. Several informants said that as of today they would feel at most ease with a driver and reflected on the importance of experience: “No... I have not tried one of them yet. I don’t know. You may choose the one you have tried before, what you have

confident in in the first place” -informant 8. This perception was also shared with informant 10 saying that:

As of today, and my current knowledge, I would feel at most ease with a driver. If I had taken one bus with a driver and another without today, I would be more aware of the driving in a self-driving bus. While with a driver you are more relaxed and trust the driver to do his job.

Other informants did also prefer a driver based on previous experiences and potential needs while using a bus:

The one with a driver. Because you can talk to him, you cannot have a dialogue with a self-driving bus. It might be... From experience, I know that if you are not sure where to exit the bus you can talk to the driver. He would most likely know with stop you should use. -Informant 6

And informant 2 illustrated:

The one with a bus driver. I see a man that holds the steering wheel and looks awake, he has glasses meaning his vision is good. I can trust that he keeps up with the traffic and that he will bring me safely to my destination.

Still, there were other perceptions of the situation. There is a repetitive factor influencing informants which is the influence of experience and the importance of trying it themselves:

Once again, I have not tried this one. I have not tried a self-driving bus, so I don't have any point of references. I need to try it first, and then see what happens, before I can exclude it. -Informant 3

One informant had another reflection, focusing on their overall trust in technologies. His reflections did surprise me as the only one being generally positive regarding the shift to autonomous buses:

The self-driving bus registers everything, in the back, in the front. The sensors are everywhere, and it is quite sophisticated. It keeps track of speed limits. Everything. Then it becomes quite comfortable and pleasant. -Informant 1

5.5 Sosial aspects

At this point, they were asked questions about how other potential users may influence their usage of the self-driving buses. First, they were asked how they would feel if they saw many

people using the self-driving buses. Many informants said that seeing many people using them would influence them to try it themselves. Informant 7 said: “If many people use it, then of course, I will also want to try it. To see how it works and if it works well. So yes, if everyone else uses it, then I also will” and informant 1 saying that: “I think that would have been positive. If one sees many people using it on a daily basis, the limit for trying yourself becomes lower” and informant 9: “It would probably have a positive effect and influence my own usage. You are influenced by others. So, if you see that others think it's going well, then it feels safer”. Before the interviews I did not see the potential link between social influence and the perceptions of safety; therefore, I found this link interesting.

In addition, other informants compared self-driving buses with other experiences, illustrating how the informants tried to use previous experience to explain how they would react to autonomous buses. Informant 1 explained: “I'm already pretty positive about the buses. So, like I said, when smartphones first came along, people were very sceptical. But after time and use this changed”. Likewise, informant 4 said:

The more people who use it, the more you will be affected. I would have become more positive about it. The more people who travel and the more often with it. The first time I flew, I was also very sceptical. There is something in us, the new is interesting, exciting and one is curious.

Others were more negative feeling that it would not influence them at all. They were quite clear in their reflections and Informant 2 said the following:

People are supposed to live and thrive, while cars and buses should be as high-tech as possible. I think you can enjoy a standard bus and a standard way to drive. I do not think you need self-driving vehicles at all. So, if others start using them, then okay, that's the way to go. But that does not mean I am for it. I'm not for it at all. I think we are doing ourselves a disservice by leaving these important decisions to a technical system because it looks cool.

And informant 6 pointed out the following:

I would not feel any difference. No... No, not really. But of course, it is important to know if the people using it are pleased and that their trip went well. It is clear that the people that needs and uses it and are pleased with it, will help to influence the

attitudes of those who are not dependent on the bus and make them change their view of it.

Then they were asked how positive or negative experiences of friends or family would affect them. Many of the informants said that of experience, such as feedback of friends or family would affect their perception. But at the same time, they explain the importance to try it themselves to conduct an opinion. Still, I was surprised to hear that some of the informants could potentially change or alter their perceptions a bit as they had previously said that they would not be socially influenced. Informant 6 said the following “I might get a more positive impression of the bus, but I would not use it. I don’t need it today. But who knows what happens in 5 to 10 years? Or 20 years? I don’t know”, and informant 2 said the following:

Maybe a little. I do like new technologies. So, it may well be that the things that make life a little easier, and if friends and family like it, then yes, then it will affect and make me more positively minded primarily. Because basically, I am not. In can absolutely influence me.

Other informants pointed out other reflections on the potential influence of negative experiences:

Maybe a little. If it is negative, then you become more sceptical. It depends on how many situations you hear about and the situation in general. Because it could be a user error. But I reckon that the technology has sensors to capture potentially dangerous situations. Such as a foot stuck in the door. I think I would have to try it myself. At least once. -Informant 8

Furthermore, informant 5 reflected:

In a way, all negative feedback will influence absolutely everyone when it comes from someone you trust. But when comes to... Technological stuff. I don’t think negative experiences will influence me as much as my own experience. Because it is not the same as a bad hamburger. It will be something completely different. In addition, we are young and based on my perception, young people are much more open to unknown things. Whether it's unknown cultures, discoveries or technology. We are very open to everything that is new and things that we do not know. So, if grandma had told me she had a bad experience, I would have felt sad, but I would have tried it myself anyway.

5.6 Hedonic aspects

This topic reflected whether or not the interviewees perceived the use of self-driving buses as potentially enjoyable or other thoughts. Many said that they were excited to try them, but that they would be more observant of the driving; “I think it would be a little exciting. Maybe keep an eye on the driving” -informant 8. This was also further reflected on with informant 6:

I might be... Not nervous... But more observant and pay attention to the driving. To monitor that it goes well. I would not have felt asleep as I would have done on a regular bus with a driver. I would have been more tense, at least the first time.

Other thought that self-driving buses may have a positive influence on the usage of buses and were generally more positive about them:

Good, it is exciting. I would have a bit more confidence that I would arrive at my destination at correct time. That I would not have to plan to take an earlier bus at this route. I believe that the planning and that thought might disappear. -Informant 5

The first trip I think I would have been a little excited and a bit like "how will this go". But after a few trips and if it goes well, then it will probably be completely normal. It will be fun, and it is a big development to be a passenger in a bus without a driver. I have previously taken trains in Paris that are self-driving, and they are so brilliant. There is no reason why this should not be a success. -Informant 1

In addition, informant 1 reflected over the potential negative effects from speed limitations:

Yes, I was thinking about speed. I do not know how fast they drive. I read in some articles that they only drove in 18 km/t, and I think that would be an annoyance for car drivers. That could potentially lead to dangerous overtaking. If I was a passenger in such a bus, I don't think that would have been fun. It would not be fun to be bothering the traffic if it goes too slow. I would not have liked that. Speed limit does have a lot to say and would affect my wellbeing when using such a bus. The bus should contribute to good traffic flow and not be an obstacle or annoyance for others in traffic. I look forward to seeing them.

While others did not want to use these buses because they prefer driving car or are sceptical about the potential radiation from the self-driving buses. Informant 3 said:

Emotionally, I do not like to take the bus at all. To be totally honest. I prefer to drive myself or being a passenger in a personal vehicle. Because the buses are often

crowded and the on- and offboarding and other things. The seats and other factors influence why I don't want to take the bus. At least not that often.

And informant 2 explained:

No, primarily because of personal health issues, and I believe there is going to be a lot of radiation from these buses. I think I would experience discomfort if using the bus more than 5-10 minutes or a half-hour. My prejudice is very sceptical, and maybe even a little scared. Or maybe not scared but thoughtful. And since I do not know how I will react to the bus, I am sceptical and per now I do not want to ride with the bus.

5.7 Ecological aspects

During this topic, discussions about whether or not potential positive environmental benefits of self-driving buses influences their perception and their potential usage of the buses. What I saw during this question was that many informants did not feel that they had enough knowledge about it, and many did not see the environmental difference between an electric bus with or without a driver. Also a few mentioned the potential benefits of not having a driver. Informant 8 said the following: "It is probably good. They don't have any emissions, so that must be good. It is also economical not to have a driver. It costs money to drive a bus. Maybe this bus can drive without having it to be full at all hours. Because then, you do not have wage costs on the driver" and informant 10 said:

Well, I don't have enough knowledge to have an opinion about it. I think electric buses is a good development, but I don't know if a bus with or without a driver influences the environment. I have not reflected enough on it, whether it matters. Still, there is always one discussion about reducing workplaces and this society development. Where everything gets more automated. But usually, such development is positive for the users. As long as you manage to keep up with development.

Others were mainly positive as illustrated with what informant 1 said:

It is clear that it is very good for the environment, that they do not use fuel and are fully electric, so it is fantastic. Yes, you could not ask for better. You get safety, security and at the same time save the environment. It is a win-win situation.

Many reflected on the other electric buses that are in Bodø and compared them to these new self-driving buses; "We have electric buses, so I don't see the big difference" -informant 5.

When asked if it affected her usage of buses, Informant 5 continued her analysis and said the following:

Yes. It does... The old buses in Bodø, that used fuel, had a sign that said: "this bus saves so much emission or queues", it made you become aware of it. But now, since the buses are electric, I feel that I can take as much bus as I want. Because now, the only negative thing, is that it costs me money. Not the release of emissions because I do not bother to walk.

Informant 7 said that "I am not sure. The other buses in Bodø are also electric. It is probably better for the environment. It affects me that it is good for the environment". Informant 4 pointed out the following:

No difference compared to other electric buses. The only difference is that the driver is gone. No, I drive an electric car myself and that's fine. If it has so much to do with the environment, no, but for my wallet it has something to say.

And informant 6 illustrated:

Well. I do not know if it is more environmentally friendly to drive an electric self-driving bus than an electric vehicle. There are electric buses now in this city. I do not think it will be more environmentally friendly to have a bus without a driver than with.

While informant 2 described it as:

I think it is just nonsense. If you have an electric bus, then you do not have any emissions. If you have a driver, then you have a person that follows everything and someone who is responsible for what could occur in traffic. Then you also have a workplace and no emissions. Tell me how it is supposed to be much better with a self-driving bus for the environment.

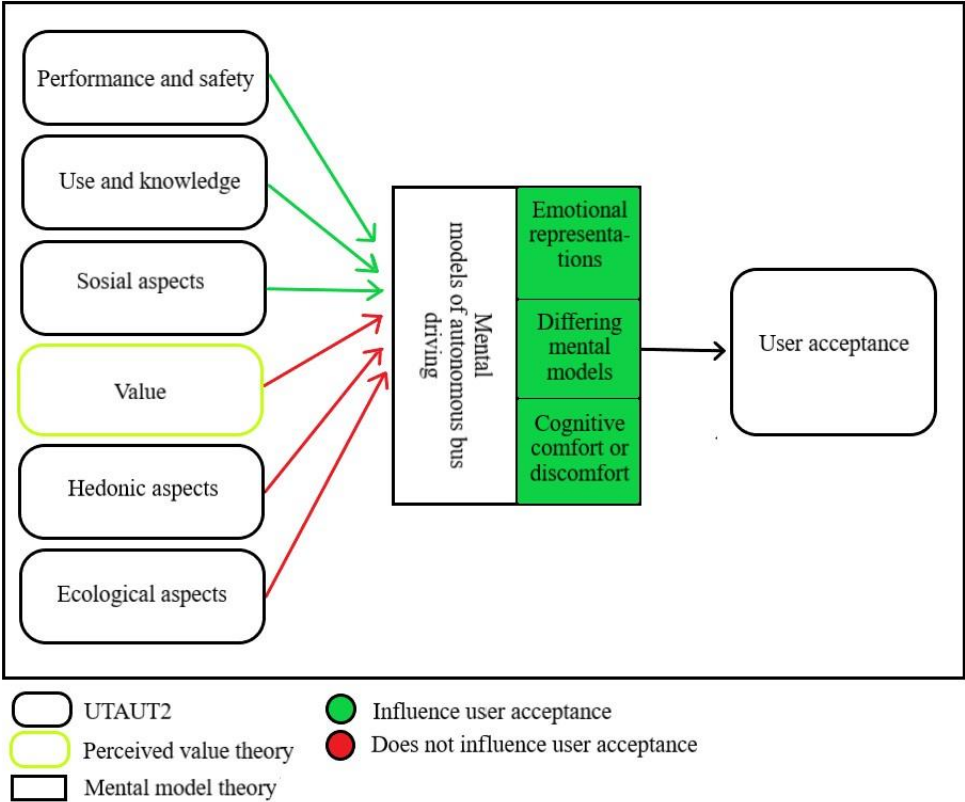
6. Analysis and discussion

The purpose of this study is to examine citizens' responsiveness and acceptance of autonomous buses with a focus on social, cognitive and behavioural factors in a single city context in the arctic region as a topic which is still undertheorized (Hagenzieker et al., 2020). Particularly, the main research question is *How do citizen perceive autonomous buses in the Arctic region?*

To answer this question, theoretically, the thesis applies combination the unified theory of acceptance and use of technology (UTAUT2) (Venkatesh et al., 2012) with perceived value theory (Zeithaml, 1988) and mental model theory (Norman, 1983). Such combination gave possibility to analyse (1) factors that are most important regarding citizens user acceptance of autonomous buses and (2) the main cognitive aspects of the shift towards autonomous buses.

Empirically, I conducted a case-study of Smart Transport Bodø project related to autonomous buses. Based on documentary analysis and ten interviews with citizens, the empirical findings will now be further analysed regarding their contributions to understanding citizens potential reluctance to accept autonomous buses as a mode of public transport. The analysis is divided into two main parts focusing on the user acceptance aspects (Venkatesh et al., 2012; Nastjuk et al., 2020) and mental model aspect of this study (Wolf, 2016; Bourmistrov, 2017), revising the initial analytical model into new one based on the analysis (Figure 2). With the empirical findings, other studies from the theoretical framework and literature review will be discussed as a part of abductive reasoning (Easterby-Smith et al., 2018).

Figure 2 Revised analytical model



6.1 Determinations of user acceptance in the Arctic region

The revised analytical model (Figure 2) exemplifies different determinants would affect user acceptance or the adoptions of new technologies (Venkatesh et al., 2012; Nastjuk et al., 2020; Zeithaml, 1988). In the following, these determinants are further analyzed and described in relation to the empirical findings and to the literature review. The determinants will be described under three different subchapters.

6.1.1 Value, performance and safety: the importance of context

Firstly, the concept of value refers to users' perception of a product or service and is influenced by both monetary and non-monetary factors (Jen et al., 2011). As most of my interviewees uses a car or walk on a daily basis, they did not see a personal need for this new autonomous bus route in Bodø. Some informants acknowledged that the route could be valuable for some other citizens. Even the only person who travelled by bus primarily, had troubles in finding a personal value of the bus since she usually walks in the city centre. Only one informant acknowledge that the bus route could be personally useful as if she had to go to the hospital. These perceptions could be influenced by the fact that all informants live in the city centre and therefore does not have problems with relocating in the city centre.

Secondly, in my model, performance expectancy and effort expectancy from UTAUT2 has been converted into the "performance" aspect of this determination. In my case, the informants did acknowledge that performance was an important factor regarding both autonomous buses and buses with a driver. Many informants implied that as long as the technology performed well, they could potentially use both options. Bernhard et al. (2020) found performance expectancy and effort expectancy to be the two major predictors of user acceptance of autonomous public transportation. Similarly, Madigan et al. (2017) found performance expectancy to be a key contributor. In line with their findings, the performance of autonomous buses is important when deciding on the future usage of citizens.

Thirdly, the aspect of safety has previously been studied by various researchers and is known to be a factor influencing user acceptance of autonomous buses (Nordhoff et al., 2019) and much research acknowledges that automated systems can contribute to safer roads (Azad et al., 2019). The perception of the safety of automated systems from researchers' perspective differs from many of my informants. Many of the informants said that they would feel unsafe or sceptical when using autonomous buses, at least the first time. This perspective was also recurring being a pedestrian. These findings are line with Nordhoff et al. (2019) saying that

the general public are not willing to accept potential fatalities which could arise because of automation. Still, a differing finding is that some informants did not necessarily perceive being a passenger on a bus with a driver safer than being a passenger on an autonomous bus. The findings found the same result regarding pedestrian. They did trust the technology and also referred to the problem of humans potentially being distracted or influenced by other means in traffic. The focus on accidents also occurs with human drivers and one could therefore feel that autonomous buses could potentially be a safer option.

Another element relating to the issue of safety is the perception of how weather conditions could influence the autonomous buses (Nordhoff et al., 2019). My findings show that all informants did express fears or critical thoughts about autonomous buses in Bodø during the winter season. The majority of informants did not trust the technology to be able to manage difficult winter conditions, especially referring to previous experiences with poorly ploughed roads and fears that snow could potentially interrupt sensor or cameras. They also referred to events last winter. In these cases, electric buses in Bodø had difficulties getting through the city and other areas on icy and snowy roads. Such perceptions can have a negative effect on user acceptance of the autonomous buses, in particular during the winter season.

6.1.2 Use, knowledge and social aspects: great importance in the Arctic

My analytical model uses the term “use and knowledge” instead of the term “facilitating conditions” from the UTAUT2 model. “Facilitating conditions” refers to the consumers’ perceptions of the resources and support available to automated road transport systems (Madigan et al., 2017). Studies, like Nordhoff et al. (2019), acknowledge the importance of facilitating conditions for behavioural intentions to use autonomous vehicles. In my study, there was a strong relationship between use and knowledge and the perception of using autonomous buses. Many informants outlined a need for more knowledge about the autonomous buses. Knowledge would here be an important factor and necessary in order to gain their trust in the autonomous buses. They implied that knowledge could make them feel safer and they could potentially therefore use the buses more.

Regarding the social aspect there were different perceptions of autonomous buses. The informants did express different concerns as described in the safety aspect. These concerns regarding the social aspect were related to job losses, loss of human interaction, dependency on technology and the responsibilities regarding accidents. Many informants did express these concerns, while others mainly thought about autonomous buses as being a positive

development as long as they are able to drive properly in mixed traffic and that it does not disturb other road users regarding speed. These concerns are in line with the findings of Nastjuk et al. (2019) and Nordhoff et al. (2019).

Furthermore, the informants did recognize that the usage of other citizens could influence them, but more importantly, friends and family would have had a greater influence than if strangers used the buses. But, seeing many people using autonomous buses did give an overall more positive perceptions of them, referring to that if everyone else uses them, then it must be a good transportation option. This perception was also found in Madigan et al. (2017) in which social popularity was seen to be of much importance. Nordhoff et al. (2019) expressed that social influence is correlated to the behavioral intention to use automated vehicles. My findings are in line with these previous findings, seeing that the social influence does have a major impact on the overall perception of autonomous buses.

6.1.3 Hedonic and ecological aspects: fun but nothing to do with ecology

Hedonic aspects refers to the enjoyment of autonomous transportation systems. According to Madigan et al. 2017) hedonic motivation is the strongest predictor of behavioral intentions to use automated road transport systems. Furthermore, Brown and Venkatesh (2005) and Nordhoff et al. (2020) also have pointed out that hedonic motivation is a key factor for usage and acceptance of technology and automated vehicles.

My findings discover that the informants are exciting to try autonomous buses. Some described it as a potentially good and had more confidence that she will arrive at her destination on time. However, many explained that using them would make them more aware of the driving and therefore they would not be able to relax as much as they would with a human driver. In addition, one informant said that she did not generally like taking the bus, which would also influence her perception of using autonomous buses. Overall, the informants said that using the bus, at least the first time, would make them have different negative or nervous feelings.

Still, even though having negative feelings about being a passenger on an autonomous bus, it did not influence their overall intention to try it at least once, mainly because of curiosity. This means that even though some of my informants did not perceive being a passenger as enjoyable, they still would like to try the buses. These findings are not in line with other literature. In other cases, the enjoyable aspect of using autonomous vehicles is a crucial factor influencing user behavioral intentions. This determination may be more important regarding

multiple usage and not the first-time usage. This is also therefore more important for the general user acceptance for autonomous transportation systems.

The ecological aspect had varying significance for my informants. Nastjuk et al. (2020) describe the ecological awareness as a determination that could strengthen the perceived usefulness of autonomous driving for individuals with high ecological awareness. On the other hand, compared to individuals with a low tendency to behave ecologically correctly, the usefulness of autonomous vehicles were perceived as generally low.

My findings show that many interviewees did not experience a difference between having an autonomous electric bus or having an electric bus with a chauffeur, because many buses today are in fact electric. These perceptions were further described as a lack of knowledge of potential ecological benefits from autonomous buses compared to having a bus driver. One informant did express that not having a driver could potentially be financially sustainable and lead to more frequent bus departures. Overall, the informants recognized the importance of electric buses, and some informants were more positive and did also mention that it affected her usage of public transport. This perception is in line with the findings in the literature, saying that people with high ecological awareness would perceive the buses as more useful (Nastjuk et al., 2020). Still, the overall perception shows that the informants focused more on the electric aspect than on the autonomous aspect.

6.2 Citizens' acceptance of autonomous bus from cognitive perspective: diversity of emotions, lack new mental model and comfort zone formation

In the following, several aspects of mental models are further analysed with focus on the empirical findings, theory and other study findings. These aspects have been divided into three different subchapters describing their different influences on user acceptance.

6.2.1 Diversity in citizens emotional representations

When it comes to emotional representations, I found out that in many cases, informants felt critical about the transition towards autonomous buses. The interviewees had to give a comparison of the expectations and attitudes towards the two different scenarios, being a passenger on a bus with a chauffeur and being a passenger on a bus without a chauffeur. Arentze et al. (2015) describes that cognitive and emotional representations influence the behaviour of a decision maker. The interviewees described the existing buses in Bodø with driver as “okey”, “well”, “crowded”, “fine”, “nice” and “big”. They were overall positive about the current buses but emphasised their personal experience and in particular their low

personal experience, which may have influenced their perception positively. Others, with more experience, had a more negative view of the buses and of the driving. Thus, it shows that their emotional representation is affected by their current knowledge and experience (Furlough & Gillian, 2018).

Regarding the autonomous buses, many were sceptical and did not see the need to remove the chauffeur, while others thought that it might provide better mobility services. The different interviewees were overall positive, in which they focused on the importance of trying the buses themselves. The result from the interviews shows that the interviewees had differing cognitive and emotional representations by using words such as “curious”, “thoughtful” or “excited” regarding the shift to autonomous buses and said that using an autonomous bus would make them feel “a bit scary”, “strange”, “not safe”, “excited”, “fine”, “anxious” and “sceptical”. These descriptions show that there are various emotions and that there were mostly negative feelings associated with being a passenger on an autonomous bus, at least during the first ride.

These results give a differentiated picture of the emotions citizens experience and feel towards buses and autonomous bus-driving. Many of these feelings are in line with the study of Wolf et al. (2016). They found emotions of powerlessness and fear to dominate regarding full automation where a driver is extended available. According to Wolf (2016, p. 116) “the feeling of being at the mercy of forces beyond one’s control is associated with these feelings and represents a major hurdle to acceptance”. As described earlier, many studies explain trust to be the most important factor regarding automations of systems.

6.2.2 Differing mental models: traditional perceptions dominates

The perception of systems can create different mental models as the system develops (Beggiato & Krems, 2013). The interviewees had different experiences and knowledge about autonomous buses, as some had read about it in newspapers or social media or tried other autonomous transportations. Others had very little or no knowledge about autonomous driving. However, none of the informants had personal experience with being a passenger on an autonomous bus. These differences did reflect their perceptions, showing that excitement and knowledge did influence both positively and negatively on their mental models. These findings are in line with Blömacher et al. (2020) saying that knowledge and different expectations are closely related to the mental models of a system.

The interviewees said that they had little or no knowledge about self-driving buses. However, most informants were positive in their thinking and said that the buses would probably work just fine as other buses with chauffeur. This means that they used little or no energy in order to create new mental models of the phenomena. This compromise the crucial element of knowledge and when new knowledge is presented to humans, because it makes them change or alter their current mental models (Furlough & Gillian, 2018). Lee and See (2004) described trust as a key factor for individual differences in mental models. In line with the literature, the informants who had a more positive mental model of autonomous buses also explained that they trust the automation or that they trust the governance who is responsible for implementing the new mobility service.

On the other hand, the informants who said that they did not trust the technology had a generally more negative perception of autonomous buses. As informant 6 said, he did not think the technology was mature enough to handle various driving situations. These expectations are in line with Blömacher et al. (2020), as it influences his mental models of autonomous buses negatively. Furthermore, in line with Strand et al. (2018), pre-knowledge, practice or expectations is of importance for mental models.

Still, when talking about this transition, most informants did prefer having a chauffeur when they were reflecting over these two scenarios. This perception is much in line with Wolf (2016), saying that the current cognitive and affective representations of the driving role is still strongly associated with the conventional image of an active chauffeur. The informants explained their perceptions by saying that it is what they are used to and therefore it is easiest to use a bus with a driver. According to Wolf (2016) does this transition fundamentally change the demands on the cognitive systems of a driver of a vehicle. But it could also potentially be argued to fundamentally change the cognitive systems of a passenger. As seen with some of the informants, it is also a huge transformation to use a bus without a driver as their present mental models trust and associate buses with a chauffeur. Here also referring to the importance of exciting mental models and that changing these are not easily done and requires much cognitive effort (Furlough & Gillian, 2018).

Therefore, as described previously, the majority of informants did have a traditional mental model of bus driving. This traditional perspective was often viewed as the best because they did not have enough knowledge or previous experience with autonomous buses. They presented multiple challenges or fears related to being a passenger on an autonomous bus.

Such challenges were related to travel information, trust in technology, jobs losses and lack of knowledge about responsibilities regarding accidents. These factors were important regarding the trust aspect of autonomous buses, which influence their mental models. On the other hand, some informants generally felt safer and put more trust and faith in a human chauffeur more than in autonomous technologies. These findings are in line with Wolfs (2016), which found that half of the respondents expressed fear regarding automated driving and doubted that the technology would function and be reliable.

Other informants did not have a traditional mental model saying that they would feel equally safe or safer with a self-driving bus depending on future personal experience and depending on the technology working sufficient. Such differences could be explained by the importance of predictability considered having a major impact on the factor of trust (Lee & See, 2004). Furthermore, it can be explained by the significance of a correlation between experiences and current mental models. If a correlation exists, it is expected to have a positive influence on trust and acceptance (Lee & See, 2004). In line with the literature, these informants' do rely on their initial assumptions about these autonomous buses and that the technology will work properly and potentially operate better than a bus with a chauffeur. Therefore, these informants have a higher degree of trust and acceptance.

These perceptions indicate that there are differences in citizens' mental models regarding if they are ready or not for autonomous bus driving in the public mobility services, since mental models are based on previous experiences and are adjusted or changed with new information or new experiences (Furlough & Gillian, 2018). As seen with Blömacher et al. (2018) and Beggiano and Krems (2013) the initial mental model is dependent on the preliminary information obtained. Therefore, in this case, as the interviewees did not have any previous experience, they rely on their perception and preliminary knowledge about personal driving experiences, bus experiences and autonomous driving experiences or knowledge.

6.2.3 Cognitive comfort or discomfort: an intriguing society transition

The idea of removing the bus driver did come in conflict with many citizens' existing mental models. This conflict was especially visible when several informants talked about "what if" situations where they described concerns about how the technology would perform. Such discomfort was especially related to the unknown scenario of autonomous buses and not having experience with the technology performance. These conflicts were related to trust, performance, usage, safety, job losses, experience, knowledge and responsibilities. As the

majority of the informants were reluctant to consider autonomous buses as potentially more valuable in comparison to a human bus driver, as described in the empirical findings, many had a conventional mental model of bus driving (Wolf, 2016).

Still a few informants did not see any difference between having a bus chauffeur or not. They perceived the difference as unessential as long as performance and the procedure to use the buses were similar to their existing knowledge. Therefore, they did not perceive it as challenging. This shows that existing mental models of the phenomena bus-driving could potentially easily be altered as long as other elements of bus driving is similar to existing mental models of the phenomena. Furthermore, safety is an important factor in these illustrations, in addition to the need of transportation, i.e., the importance and need of going from one place to another.

The importance of necessary transportation had a greater influence of their perception of autonomous driving compared to having a human driver. One informant, who also uses buses in general for transportation, also emphasized and focused on the potential benefits they could experience and receive from autonomous buses compared to human driven buses. Such benefits were described as potentially more accurate buses, a possibility of not having to take an earlier bus to be sure of arriving on time and that the technology of sensors and cameras could provide safer traffic compared with a human chauffeur.

Even though all informants mentioned this transition to be exciting, the main difference were seen to be whether or not they perceived the influence of a driver as important regarding being a passenger on a bus. Since none had any actual experience with autonomous buses, these perceptions were based on how they now viewed autonomous buses and the implementing of such services. In this study, many informants experienced that their expectations of a bus came into dissonance when presented with the scenario of autonomous buses. However, there is a gap between the assumptions of performance of autonomous buses in which it is seen that some informants does have more trust in the technology than the human chauffeur.

This gap can be described as the mental model discomfort as some of the informants have established confidence in human drivers and did therefore reject the alternative of autonomous buses. These findings are in line with Bourmistrov (2017) who describes that the consideration to substitute of traditional 'way of doing things' made the humans experience ambiguity in how to perform their work. Still, having a few informants that did not reject

autonomous bus driving shows that some citizens does perceive such a development as more positive and that they are in particular influenced by the issue of trust.

Another observation is that even though most informant do prefer a human driver, all are intrigued by this transition as a result of their own curiosity. They all said that they wanted to try the autonomous buses themselves. In line with the previous research, personal experience is important and could lead to the altering or adjustment of existing mental models (Furlough & Gillian, 2018). Therefore, autonomous buses in Bodø do have the potential to be accepted by citizens, if the population receives more knowledge and experience with these systems. In this manner, the potential of an automated system to substitute a human bus driver would be shown more clearer to the public population.

7. Conclusion

This thesis reports on a qualitative study of cognitive, social and behavioral factors. It provides an empirical illustration of citizens perceptions of autonomous buses in the Arctic region. Specifically, I explore *How do citizen perceive autonomous buses in the Arctic region?* Drawing on ideas of acceptance and use of technology (Venkatesh et al., 2012), the perceived value (Zeithaml, 1988) and the mental models (Norman, 1983), the thesis discusses significant factors regarding citizen user acceptance of autonomous buses and related cognitive aspects.

The thesis concludes that the factors *safety and knowledge* was recurring key factors for the informants in this study and had a major impact on my informants. Furthermore, social influence made them feel potentially more positive about autonomous buses. The influence of family and close friends were of particular importance. This determination could also lead to a perception of trust and safety regarding the autonomous buses.

The central claim in this regard is that it is important to listen to voices in the general population regarding perceptions of implementing new mobility services, because they will be the users of such services. Still, different user acceptance determinations are important, as well as their mental models. Citizens´ concerns will be of crucial importance since they may affect and determine the overall success of a project, in which the overall aim is to provide a new mobility and transportation service and to test such technology for further development. As described earlier, citizen perceptions are therefore important as a part of smart city development (Vanolo, 2014) and smart mobility (Cledou et al., 2018; Munhoz, 2020) and also related to ensuring sustainability goals (FN, n.d.).

Surprisingly, the determination of value (Zeithaml, 1988) and hedonic aspects (Nordhoff et al., 2020) were not in line with other findings in the literature. A possible reason for this could be that the informants in my study did not necessarily experience a personal need for the autonomous buses, even though they were curious to try it at least once. This shows that even though they did not feel a personal need for the buses, they still were curious and wanted to try them. This also includes the informants that thought that they would not enjoy taking an autonomous bus or regular bus, but did in fact want to try this new autonomous bus. This may also imply that hedonic aspects may not be as important as other studies, or the literature found it to be (Nordhoff et al., 2020).

Safety and performance were prominent factors that influenced both mental models and the user acceptance of autonomous buses in my findings. These findings are in line with Beggiato & Krems (2013) saying that over-information about problems lowers trust and acceptance in the beginning. But if the mental model matches the experience, trust and acceptance will grow steadily – regardless of the experience of, for instance, system failures. In this case, the informants explained that they did not have any experience with autonomous buses and therefore only explained their perception based on their present knowledge. Maybe the citizens would feel different about the performance aspect if they had more personal experience and would still trust the system regardless of failure. But as seen, it can be considered important that the system performs properly in introduction periods, as it may affect the trust and feeling of safety among citizens.

7.1 Theoretical contributions

The present master thesis thus contributes to the literature in several ways. First, it responds to recent calls to increase the research on autonomous modes of transportation and perceptions of these in the general population. By employing qualitative interviews and analyzing these, different factors are discovered and understandings that can influence the implementation of autonomous vehicles. Secondly, this thesis provides new knowledge on perceptions in the Arctic region. The key observation in this regard relates to security aspects and winter conditions.

In particular, related to smart city literature, I show that citizen involvement could be important as they are stakeholders in the city (Hollands, 2015). In addition, context does have an effect on citizen perceptions (Azad et al., 2019; Hudson et al., 2019). Furthermore, related to smart mobility literature (Cledou et al., 2018; Munhoz et al., 2020) these findings show the

importance of the social, cognitive and behavioural gap related to smart mobility development and implementation. Which are in line other literature arguing that technology is not the central issue for urban sustainability (Vanolo, 2014). Furthermore, regarding autonomous public transport and user acceptance literature, I found many determinants to be in line with other findings. Such as knowledge, safety, social aspects and performance to be of great importance. Furthermore, that hedonic aspects, value and ecological awareness were not as important in this study (Madigan et al., 2017; Nordhoff et al. 2020; Bernhard et al., 2020; Nastjuk et al., 2020). In addition, this study emphasises mental models and their influence on user acceptance and shows new dimensions of the importance of cognitive elements related to citizen user acceptance (Wolf, 2016). The study reveals a link between user acceptance and mental models and how these are influenced by each other, and that user acceptance is thereby complex.

7.2 Practical contributions

The analysis of the interviews shows that my informants had various opinions regarding a potential shift towards autonomous bus driving. They experienced different challenges, and these are general perceptions that can influence their usage if the buses are implemented in the city. On a general note, I would like to emphasise four points that may influence user acceptance on the implementation of autonomous buses. These assumptions are made as a result of the empirical findings from my interviews and from the theoretical data that have been studied and used in the context of this paper.

The first point is about social influence. Social influence can be perceived to be a key factor regarding user acceptance and the use of autonomous buses. This is a factor that can be utilises to influence and encourage the usage of for instance a new mobility service. The other factor regards winter conditions and can be considered of particular importance when discussing developments in an Arctic context. By providing good conditions regarding snow ploughing and other types of road maintenance, local governments can contribute to better driving conditions for autonomous buses and therefore reduce potential unfortunate situations regarding performance and safety, which again are important factors that can influence the mental models and user acceptance of citizens.

The third and fourth factors concerns knowledge and citizen involvement. By properly campaigning a new initiative, such as autonomous buses, citizens can gain more information about performance, ecological aspects and other issues as those described by my informants.

This includes the responsibility if accidents should occur and so on. By gaining such new knowledge citizens may be able to alter or adjust their current mental models and perceptions of autonomous driving and may therefore experience more trust and user acceptance. In a smart city context, citizen involvement is an important element of smart city development. By involving citizens in this process of implementing autonomous buses, it may allow governments to respond to constantly evolving situations and therefore provide changes that are in the public's best interest.

7.3 Suggestions for further research

The thesis has several limitations which also open avenues for further reflection. Despite searching for theoretical generalization, the thesis is limited to a single case and the findings from qualitative data in this context. Future research should be able to discover more empirical examples and may discover other or varying factors of importance. Finally, the study can be criticized for being too limited, as only ten informants were used. Because of this, the study is potentially not representing a more complex picture of citizens' perceptions. Still, I believe by having different age segments and different transportation users the picture captured does illustrate some important citizen perspectives of autonomous buses.

Suggestions for further research would be to further study the questions related to citizen perception. Since this study takes place before the implementation of autonomous buses, it could be interesting to see if mental models and user acceptance of citizens changes as they gain more experience and knowledge with autonomous buses. In addition, there could be performed a study focusing on how citizens experience citizen involvement in the context of smart city development.

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Appendices

Appendix 1. Semi-structured interview guide

(Giving interviewee verbal information about project and show picture of bus and route)

1. About the informant and general attitudes about driving in Bodø

- Could you tell me about yourself, e.g., where do you live, age, profession?
- How would you describe your travel habits on a daily basis?
- What are your attitudes towards bus driving in Bodø?
- How do you experience the buses?
- Are you satisfied with the job bus drivers do?

2. About self-driving technologies

- Have you tried a self-driving bus before?
- How do you feel about the development of self-driving buses in society?
- How does the idea of driving with a self-driving bus make you feel?
- How do you think weather conditions in Bodø will influence the self-driving buses?

(Showing interviewee pictures of a bus with and without a driver)

3. Value, performance and safety

- Which of these alternatives do you think is the easiest way for you to travel?
- Do the buses respond to your needs?
- Imagine that you are inside these buses. Which of these options seems safest to travel with?
- Imagine you are outside these buses. How does it feel to walk close to these different buses?

4. Use and knowledge

- Do you see any challenges when it comes to using this bus with a driver? What about this bus without a driver?

Imagine you are going into a bus with and without driver.

- Will it be a problem for you riding with this any of these buses?
- Do you need extra knowledge about the technology?
- Which of these situations makes you feel most at ease?

5. Social aspects

- How do you feel if you see many people using self-driving buses?

- How will positive or negative experience of friends or family affect your usage of self-driving buses?

6. Hedonic aspects

- How does it make you feel emotionally driving this bus with and without a driver?

7. Environmental aspects

- How do you feel about the environmental aspects of self-driving buses?

8. Closing question

- What do you think about other important aspects would be that were not covered in my questions?
- Do you have any final questions?

Appendix 2. Information to interviewee about topics during interview

1. About the informant and general attitudes about driving in Bodø

During this part of the interview, the interviewee will receive question about personal information and their travel habits. Also, about how they perceive the buses driving in Bodø.

2. About self-driving technologies

Interviewee receives questions about their perceptions of self-driving technologies and whether they believe weather conditions is a factor that influences self-driving buses in Bodø.

3. Value, performance and safety

During this topic, the interviewee receives questions about how they perceive different bus options regard their value, performance and safety.

4. Use and knowledge

During this part, the interviewer will ask questions about how interviewee perceives the use and knowledge of a regular bus and a self-driving bus and how this affects their potential use.

5. Social aspects

Here, interviewee receives questions about how other potential user affect their usage of self-driving buses.

6. Hedonic aspects

This topic reflects whether or not the interviewee perceives the use of self-driving buses as potentially enjoyable or other thoughts.

7. Ecological aspects

During this topic, we will discuss whether or not potential positive environmental benefits of self-driving buses affects interviewee and their potential usage of the buses.

8. Closing question

During this part, interviewer will ask if interviewee has final questions, or if there are other aspects they think need to be addressed before ending the interview.