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Governance of autonomous public transport in Norway: institutional perspective

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Preface

This thesis is the final step of my studies of the Master of Science program in Global Management at the Business School at Nord University in Bodø. This program helped me to grow not just professionally, but personally and find out what I am passionate about. As a global management student, I have gained a lot of knowledge about various aspects of sustainable development within entrepreneurship, energy, leadership, and urban development. The study has given me new knowledge in sustainability and has been very educational.

In the last semester before writing my master's thesis, I was lucky to become an intern at Nordland County Municipality, where I worked on the project Smartere Transport Bodø and Autonomous buses. I was very excited about the inner complexity and cross-disciplinarity of autonomous public transportation, and that served as a reason and opportunity for writing a master's thesis about it. Overall, the whole process was craving, however, the reward is much higher. I enjoyed absolutely each step of this research, and now I am ready to take the acquired knowledge and experience into working life.

What was the most important for this work to be done, is the support and motivation from many wonderful people around it. First, I would like to thank my informants for their insight, knowledge, experiences, and reflections, that made this journey much more interesting and valuable. I thank my attentive and encouraging supervisor Rune Eiterjord for helping to establish a solid network and become confident in my working area. Thanks to my supervisor Evgenii Aleksandrov, Associate Professor at Nord University Business School. Your feedback and comments on my thesis were of exceptional importance and helped me to put everything in place.

The special gratitude I would like to dedicate to my beautiful Mother. Her professional advice and support were the most inspiring during my challenging and happy times. Thank you so much for believing in me no matter what.

Bodø, 21.05.2023

A handwritten signature in black ink, reading "Anastasiia Kolesnikova". The signature is written in a cursive, flowing style with a horizontal line underneath the name.

Anastasiia Kolesnikova

Abstract

Autonomous public transport (APT) is an important part of the smart and sustainable cities agenda with its potential gains for society. However, the research demonstrates the growing concern about the challenges of its implementation. While much research was done related to technological challenges and user acceptance sides, the governance of APT is one of the ongoing concerns in the research that requires further investigation. In this regard, the goal of this study is to understand the governance of APT with particular emphasis on how governance of autonomous transport may be implemented in practice.

Theoretically, this study is framed by the institutional theory with a particular view on APT governance as an institution within regulative, normative, and cultural-cognitive dimensions to answer this question. Methodologically, this thesis is a qualitative case study of the real finished project of autonomous busses in Bodø, where the data consists of interviews with a related network of 16 professionals both within and outside the project, documentary analysis, observations during an internship at Nordland County, and self-ethnography.

This thesis concludes that regulative, normative, and social dimensions are important for understanding how APT can be implemented in the future. In particular, the findings show various tensions on the several layers of the governance of APT. In addition, this field of research is covered by substantial uncertainty that formed several barriers on regulatory, professional, and social levels. Finally, the social aspect addresses several layers of actors whose perception of APT influences its future implementation. Those are concerns of political will, overcoming professional conservatism of the industry, and moving away from the culture of driving private cars by passengers.

By these means, the thesis has important insights into the previous literature on understanding the uncertainties and challenges of APT development. Moreover, it opens up a broader concern on the APT role in smart and sustainable cities agenda along with giving knowledge on APT in Norway. Last but not least, the thesis gives important insights for practitioners and policymakers regarding the interpretation of regulations by different sectors, time and geographical dimensions of APT contracts, demand for competence and complexity, and how it is distributed around actors.

Sammendrag

Autonom kollektivtransport (AKT) er en viktig del av agendaen for smarte og bærekraftige byer med potensielle gevinster for samfunnet. Forskningen viser imidlertid den økende problemstillingen for utfordringene ved implementeringen. Mens mye forskning ble gjort relatert til teknologiske utfordringer og brukeraksepsjoner, er styringen av AKT en av de pågående bekymringene i forskningen som krever ytterligere forskning. I denne forbindelse er målet med denne studien å forstå styringen av AKT med særlig vekt på: *hvordan styring av autonom transport kan implementeres i praksis*.

For å svare på dette spørsmålet, teoretisk sett, er denne studien innrammet av den institusjonelle teorien med et spesielt syn på AKT-styring som en institusjon innenfor regulerende, normative og kultur-kognitive dimensjoner. Metodisk er denne oppgaven en kvalitativ case-studie av det reelt ferdige prosjektet med autonome busser i Bodø, hvor dataene består av intervjuer med et relatert nettverk av 16 fagpersoner både innenfor og utenfor prosjektet, dokumentaranalyse, observasjoner under praksis i Nordland fylkeskommune, og selv-etnografi.

Denne oppgaven konkluderer med at regulative, normative og sosiale dimensjoner er viktige for å forstå hvordan AKT kan implementeres i fremtiden. Spesielt viser funnene ulike tensjoner på flere nivåer av styringen av AKT. I tillegg er dette forskningsfeltet dekket av betydelig usikkerhet som dannet flere barrierer på regulatoriske, faglige og sosiale nivåer. Til slutt innebærer det sosiale aspektet flere lag av aktører hvis oppfatning av AKT påvirker dens fremtidige implementering. Dette er problemstillingene om politisk vilje, å overvinne profesjonell konservatisme i bransjen, og endre reisevaner ved å gå bort fra kulturen med å kjøre privatbiler.

På denne måten har oppgaven viktig innsikt til tidligere litteratur om å forstå usikkerhetene og utfordringene ved AKT-utvikling. Dessuten åpner det opp for en bredere diskusjon for AKT-rollen i smarte og bærekraftige byers agenda, sammen med å gi kunnskap om AKT i Norge. Sist, men ikke minst, gir oppgaven viktig innsikt for praktikere og beslutningstakere angående tolkning av regelverk fra ulike sektorer, tids- og geografiske dimensjoner av AKT-kontrakter, etterspørsel etter kompetanse og kompleksitet, og hvordan det er fordelt rundt aktører.

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1. Introduction

There is a lot of literature discussion about the potential of autonomous vehicles around the globe to insure sustainability, governance, urban planning, and general city infrastructure development (Maldonado Silveira Alonso Munhoz et al., 2020; Giffinger, 2010; Flügge, 2017; Seuwou et al., 2020; Campisi, et al., 2021). For example, while reducing the reliance on private vehicles and promoting energy-efficient mobility, intelligent mobility solutions can provide users with more transportation options as well as more adaptable and affordable travel. According to Flügge, (2017) autonomous technology can contribute to creating a different type of habitat inside the vehicle, and parking places will become a space for activities rather than for cars. Moreover, the value that APT will bring in the form of social, economic, environmental, and safety advantages is starting to be understood and accepted by cities (Campisi, et al., 2021), making it an important part of the cities heading for sustainability and smart mobility (Flügge, 2017; Giffinger, 2010).

The future is promising, however, there is still much discussion about the challenges of implementing APT. Previous research highlighted the importance of technological (Scurt et al., 2021), user acceptance (Yuen et al., 2022), and governmental (Anderson et al., 2014) aspects of implementing APT. Paulsson and Hedegaard Sørensen, (2020) argued that despite the availability of technical solutions and pertinent proposals for institutional changes, citizens are ultimately responsible for the transition to APT. It means that technology is not the main focus in this context, the problem is on the level of people's behavior, and society will be the key to enabling the technology to find its implementation in future city development. Therefore, user acceptance and governance are the remaining crucial issues to address in future research. User acceptance seems to be a well-studied aspect and much research has been done on investigating it (Yuen et al., 2022; Nastjuk et al., 2020).

On the other hand, there are still many uncertainties and challenges that prevail with regard to APT and its governance (Abbot, 2012; Fryszman et al., 2019; Tan & Taeihagh, 2021; Mordue et al., 2020; Yuen et al., 2022; Paulsson & Hedegaard Sørensen, 2020). There are obstacles relating to a city's administrative structure and governance that are incompatible with or insufficient for these initiatives, such as APT (Fryszman et al., 2019). APT is igniting discussions about accountability, liability, and the technological advancement of urban environments (Aoyama & Alvarez Leon, 2021). For example, one of the still unanswered dilemmatic questions is how to maintain public safety while allowing for increasingly rapid technological advancements (Straub & Schaefer, 2019).

Thus, considering the complexity of the research field, there is a call for more knowledge about the governance of ATP. There is a lack of information from a practical perspective that considers the regulatory and administrative aspects while addressing social norms and acceptance under the governmental agenda. Regarding this, Azad et al., (2019) argued that the policy and regulations issues are the least studied aspects of the APT agenda.

To address the presented gap and related call, this thesis will broaden the aspect of challenges of future technologies and try to capture how the practitioners reflect on these issues, whether they are prepared or not. In particular, the research question is: *How governance of autonomous transport may be implemented in practice?*

To answer this question, theoretically, the thesis employs one of the streams of institutional theory, namely three pillars of institutions by Scott (2008). This theory frames the investigation of governance of autonomous transport as a formation of an institution within regulative, normative, and cultural-cognitive dimensions. In the context of the governance of APT, the regulative pillar gives the reflections on laws and policy, the normative pillar is related to the professionalization of the actors in the field, and last but not least, the cultural-cognitive pillar reflects on societal acceptance of the APT. Overall, this theory is useful to understand the governing mechanism from the institutional perspective, reflecting upon which aspects could be “taken for granted” and what kind of barriers may occur.

As a method, I employ a qualitative case study, where I interviewed 16 professionals with experience working with ATP, both inside and outside the project of autonomous busses in Bodø. In addition, I conducted a thorough analysis of related documentation and observations while working as an intern with the project at Nordland County. Overall, I used self-reflections to set me inside the topic and improve the quality of the research. With such a theoretical and methodological approach, empirically, I investigate the development of autonomous buses in Norway.

The remainder is organized as follows. In the second chapter, the background information and literature on smart cities for sustainability, smart mobility, and the governance of APT are presented. The third chapter discusses the theoretical framework that was employed in this study. Chapter four presents the research methodology and provides examples of the methodological decisions that were made and the methodological tools that were employed. The empirical findings are introduced in the fifth chapter, and they are analyzed and discussed in relation to the literature review and theoretical framework in the sixth chapter. Finally,

chapter seven's conclusion offers both theoretical and practical contributions as well as recommendations for further research.

2. Literature review

In this chapter, I do an analysis of the existing literature on the topics of smart mobility, as well as governance, opportunities, and challenges of APT. The purpose is to understand the current literature discussions about APT and focus areas of the previous research in order to identify a research gap from the literature perspective. The review of the topics is organized as follows. In the first section, I make a review of the smart mobility agenda and its relevance to autonomous transport. The second section gives the perspective on the opportunities and challenges of APT. I made a review of the governance agenda as well as the challenges related to APT in section three.

2.1 Smart mobility and autonomous public transport

More and more cities are trying to be sustainable (Vanolo, 2014; Grossi et al., 2020; Mora & Deakin, 2019). Public transport is one of the sectors that has a huge potential to resolve global environmental problems (Low, 2013). For example, road traffic is responsible for 18% of total CO₂ emissions in Norway (Miljøstatus, 2022). Moreover, from a global perspective, public transport is responsible for about 23% of all energy-related CO₂ emissions (Sims et al., Citation2014, p. 603). The use of public transportation significantly contributes to the reduction of CO₂ emissions and the improvement of energy efficiency in the transportation sector (Sims et al., 2014).

Improved urban mobility is crucial for a city to become smarter and more sustainable (Maldonado Silveira Alonso Munhoz et al., 2020). One of the key conceptual elements of the smart sustainable city in this regard is smart mobility (Giffinger, 2010). The idea of "smart mobility" has recently entered the theoretical discussion. It is a novel approach to using mobility that puts an emphasis on ICT. Smart mobility, which is supported by ideas like car sharing and autonomous driving, should be seen as a framework that gives everyone more freedom and a better quality of life, regardless of where the need for transportation is being created and met (Flügge, 2017). Moreover, according to Finger and Audouin, (2019), automated mobility, in the form of autonomous vehicles, is identified as a turning point that forms a smart transportation system. As a result, APT is increasingly important and essential to a smart, sustainable city (Seuwou et al., 2020). According to Taeihagh and Lim (2018), we can determine that APT are those that can navigate safely through their environment with little to no human intervention. APT can be divided into three categories: (1) private

autonomous cars, (2) shared autonomous taxis or taxies, and (3) autonomous buses or shuttles (Anderson et al., 2014; Azad, 2019; Ainsalu et al., 2018). This study is concentrated on the (3) autonomous buses and shuttles and further related to this category of vehicles as autonomous public transport.

The Society of Automobile Engineers (SAE) has updated its standard SAE J3016 (2021) for the different levels of automatization. There are six levels: 0 (no automation), 1 (limited support for the driver), 2 (partial automation), 3 (conditional automation), 4 (high automation), and 5 (full automation). Level 0 means that all tasks associated with driving are performed by a (human) driver (Foss, 2017; SAE, 2021). At level 1, the driver provides limited assistance at a basic level, with their hands constantly on the steering wheel and their feet on or next to the pedals all the time. Level 2 indicates partial automation, where the driver still has control over the vehicle, but in some cases can let go of the pedals and the steering wheel. A good example of this level is “adaptive cruise control”, where the system assists in keeping the car in the middle of the road. In addition, the system will notify the driver if you are driving too close to the car in front of you. Level 3 is an introduction to driving, in which the system can perform all driver-related tasks within the scope for which it has been programmed. This means that the driver, or so-called safety operator, is ready to take over the steering of the vehicle at any time. The maturity of the technology on this level is not sufficient to handle complicated traffic situations and unpredictable events that are not configured with the vehicle. The same rules are applied for level 4; however, it is no longer expected at this level that the safety operator will act as a backup solution for the vehicle (i.e., the vehicle has its own independent solutions to the applicable conditions in the relevant area of operations). The highest level of automation (level 5) means that the vehicle is fully automated and performs all the driver’s duties with no restrictions regarding areas of operation. Such vehicles require neither steering wheel nor pedals (and no driver’s license or wages) for providing transportation services (Foss, 2017; SAE, 2021).

Up to and including level 2, the driver is responsible and must have full control. At SAE level 5, the vehicle is considered to be an autonomous vehicle, without the need for a responsible driver in the driver’s seat. In this case, it should be clear that the supplier of the AV is responsible for any transport errors. For levels 3 and 4, the situation is slightly more complex, where there will be a sliding scale of responsibility between the person who is driving and the supplier. For levels 4 and 5, a responsible operator must be defined (Foss, 2017; SAE, 2021).

Cities are beginning to understand and accept the value that APT will bring in the form of social, economic, environmental, and safety advantages (Campisi et al., 2021). Over the past few decades, the technology underlying the APT used in cities has advanced dramatically (Campisi et al., 2021). In numerous completed, ongoing, and upcoming pilot projects, autonomous buses are being incorporated into public transportation. Public and private automated transportation have both been the subject of extensive research (e.g., Yuen et al., 2022; Wu et al., 2019).

As a summary for this section a few points can be drawn. First, the technology behind autonomous transport is developing quite fast. Second, there is growing research about the role of autonomous vehicles in broader smart mobility discussions. In the section below I would like to present the main promises and challenges of APT under the alleged agenda.

2.2 Opportunities, current results, and challenges of autonomous public transport

Only when used as autonomous shuttles, which are shared with other passengers, are APT considered to be the best option for public transportation (Ersoy & Tayyab Waqar, 2020). APT is anticipated to play a significant role in the development of a smart city, according to (Iclodean, et al., 2020). Potentially, APT has the ability to reduce a number of major issues facing our societies today, such as safety, traffic congestion, and the costs that go along with it (Anderson, et al., 2014). Furthermore, Wadud (2017) claims that up to 60% of operational costs could be saved because autonomous vehicles don't need bus drivers.

The shift from an active driver to a more passive passenger with no responsibility for the tasks typically performed by drivers signals the start of social change among the drivers themselves. As the level of vehicle automation rises from level 0 (no automation) to level 5 (full automation), the driver's responsibility is becoming less and less important (Foss, 2017; SAE, 2021). People will view the transportation system differently as a result of this shift to higher automation and integration (Ainsalu et al., 2018). The findings of a study by Nastjuk et al., (2020) supported the existence of a positive correlation between enjoyable features and perceived ease of use, as well as a positive correlation between price assessment and utilization. Even though the fundamental (social, economic, and environmental) factors are at the heart of these developments, it's critical to develop a comprehensive understanding of the range of aspects of life that APT could impact, either directly or indirectly. Technology, infrastructure, city planning, policy implementation, and economic impacts are some of the effects on users (Anderson et al., 2014; Azad, 2019). For instance, according to the findings

of Yuen, et al., (2022), a campaign to inform the public about the advantages of using APT for transportation could have a significant impact on user acceptance. These advantages are described as better accessibility, reliability, and safety, as well as less traffic congestion (Yuen, et al., 2022).

A key focus of the discussions among researchers is dedicated to identifying the various benefits of APT. For example, Anderson et al. (2014) summarized several reasons why APT is becoming increasingly important. First, the technology is currently undergoing development, suggesting that the technology is mature enough to be nearly ready to implement, albeit with an operator behind the wheel. Despite this drawback, the speed of innovations is happening faster than ever. The full-scale commercial introduction of APT is predicted to take place within 5 to 20 years. Moreover, the current number of road accidents is unacceptable and must be eliminated or considerably reduced. By decreasing the possibility of human error, APT has the potential to significantly reduce the number of road accidents. Furthermore, APT could ultimately reduce congestion and its associated costs. Such an effect could be accomplished by adopting effective road capacity and sharing options for collectively used APT. For instance, to meet the rising demands of transportation in urban areas, on-demand shared autonomous buses would decrease the need for and number of personal vehicles, and thus reduce CO₂ emissions, fuel consumption, and traffic load (Waqar & Ersoy, 2020; Yuen et al., 2022). In addition, energy use could be reduced by efficient road planning operations (Anderson et al., 2014). Finally, APT can potentially operate 24 hours/day and 7 days/week without the need for a human driver, which means they will be universally accessible to individuals who cannot drive themselves; for example, those who are disabled, have reduced mobility, or lack a driver's license (Camps-Aragó et al., 2022).

The problem is that the current results are not in accordance with these promises. In this regard, technological development is not the main issue, and it will be developing rapidly (Campisi et al., 2021; Camps-Aragó et al., 2022). The current state of operation of APT is at an experimental level or has been put into use under limited conditions, such as low speed and operating on less-traveled routes without obstructing traffic (Iclodean et al., 2020). It means that the future is unclear and we do not know what kind of results APT will bring.

2.2.1 The challenges of autonomous vehicles implementation

The outcomes, integration, and collaboration on the use of APT and smart sustainable cities are acknowledged to face numerous difficulties and uncertainties in the current research. The safety of passengers and other drivers, in particular, as well as technological advancements,

laws and regulations, public perceptions of them, and psychological acceptance of them remain crucial concerns (Yuen et al., 2022). For APT to produce the desired results, more research and impact analyses are required.

Surprisingly enough, the main barriers to the adoption of these shuttles are social (citizen acceptance) and economic rather than technological or political (Camps-Aragó, et al., 2022). Despite the many benefits, certain downsides to autonomous mobility remain. APT could have many negative effects due to the reduction in the time costs of driving. For example, as the technology becomes increasingly available and cost-effective, more people will be encouraged to utilize APT, particularly in cases when it is not necessarily a need, or when another type of mobility option (i.e., a more sustainable one) can be utilized. Overuse of APT could lead to certain undesirable results, including an increase in the total number of vehicle miles traveled (VMT), leading to more congestion (Anderson et al., 2014). The increased accessibility, convenience, and affordability of APT, compared to existing options, could change travel habits and patterns in a way that indirectly leads to a higher demand for less environmentally friendly travel options (e.g., increased demand for private autonomous taxis without ridesharing). Such behavior would subsequently lead to more and longer trips (Camps-Aragó et al., 2022). This factor depends on the mode of APT utilization. As previously mentioned, APT or buses are not only a more sustainable option than single-passenger APT, but would also reduce traffic congestion.

In addition, there are many challenges and uncertainties regarding the infrastructure of smart mobility in smart cities, including the type of APT, speed of integration, and safety (Maldonado Silveira Alonso Munhoz et al., 2020; Giffinger, 2010). The current road system was built for human drivers, so it might not be able to accommodate highly automated vehicles (Lengyel et al., 2020, Liu et al., 2019).

Moreover, there are risks associated with the software management of APT. A major challenge is to provide a reliable and uninterrupted connection between vehicles and infrastructure. If this connection were to fail, it could lead to increased hazards for passengers and other vehicles. The same issue applies to the internal systems of the vehicles and their hardware. Sensors, cameras, and radar must be synchronized and coordinated with advanced internet communication, which could potentially get hacked like any other computer (Anderson et al., 2014; Khan S.K. et al., 2020). For example, Chowdhury et al. (2020) identified three main areas that are vulnerable to potential cyberattacks, including in-vehicle

systems (e.g., sensors, software, and in-vehicle network), vehicle-to-everything communication networks (V2X), and supporting digital infrastructure (V2I). The study concluded that an appropriate level of cyber-security is a necessary component in the safe operation of autonomous vehicles connected to the internet (Chowdhury et al., 2020).

Another issue associated with data privacy focuses on the information collected from personal trips, other drivers, and pedestrians. APT are constantly collecting large sets of data that may have some degree of sensitivity (Lee & Hess, 2022), such as traffic violations of other drivers or the failure to register parked cars where APT drives.

Other issues are associated with the fear of loss of driving skills and job loss among professionals, including truck, bus, and taxi drivers and delivery services (Anderson et al., 2014; Taiebat et al., 2018). In addition, economic barriers such as the cost and economic impact of AV implementation are concerns that need to be addressed. For example, 5G technology is not universally available and is still expensive. Or the hardware in the AV is expensive and requires skilled workers to maintain (Scurt et al., 2021). Moreover, testing and piloting APT is a complex process that requires substantial investment. Revenue from parking fees, which are a major source of income for municipalities, might be considerably disrupted due to the transition to APT (Anderson et al., 2014). Prior studies have concentrated on many elements that may affect consumers' acceptance of autonomous vehicles. This covers characteristics like safety, perceived utility, and other elements (Bernhard et al., 2020; Nastjuk et al., 2020).

Much research has been done about the future challenges of particularly governing autonomous vehicles (Abbot, 2012; Tan & Taeihagh, 2021; Mordue et al., 2020; Aoyama & Alvarez Leon, 2021; Paulsson & Hedegaard Sørensen, 2020). For example, Tan & Taeihagh, (2021) have identified the main technological risks in APT implementation as safety, cybersecurity, privacy, liability, and effects on the incumbent industry. It is a very difficult challenge to maintain public safety while allowing for increasingly quick technological advancements (Straub & Schaefer, 2019). In addition, policymakers should take into account a number of issues, such as the behavior of actual vehicles in a dynamic transportation system, feedback from other road users, the diversity of state-to-state rules, and unwritten social norms and acceptance (Straub & Schaefer, 2019). According to Abbot, (2012), the particularly important challenges are those related to future risk and uncertainty, resource asymmetry, and regulatory disconnect that all together pose challenges in terms of regulatory

design. Besides already identified risks, it's also crucial to understand that a strong regulatory framework needs to take into account the potential social, economic, religious, and ethical risks associated with new technology (Abbot, 2012). Mordue et al., (2020) pointed out that the regulation of highly autonomous vehicles may be impacted by issues of ethics and values. This relation is made more complicated by the fact that ethics and values differ among people, organizations, cultures, and regions (Mordue et al., 2020). Moreover, the development of high-level autonomous vehicles may ultimately be hampered by ethical and value-based issues, as well as the unwillingness of policymakers to take action (Mordue et al., 2020).

Another challenge in governing smart mobility is that technological change is developing faster than the governance responds to the disputes that occur (Docherty, 2018). In addition, the book *Shaping Smart Mobility Futures: Governance and Policy Instruments in Times of Sustainability Transitions*, Paulsson and Hedegaard Sørensen, (2020) summarizes that the introduction of autonomous vehicles may result in conflicts with various sustainability objectives, such as accessibility and climate, which require political resolution. Moreover, the authors conclude that making sustainability the main goal of policymaking and connecting the discussion of policy instruments to sustainability goals are the key challenges.

The mobility system runs the risk of being locked into transitional paths that worsen rather than address the larger social and environmental issues that have presented planners with challenges throughout the automobility transition (Docherty, 2018).

As a result, it is possible for regulators and regulated entities to lack clarity regarding how emerging technology comports with current laws and regulations (Lewallen, 2020). Moreover, the absence of a regulatory framework for APT policy has been a significant impediment to the full-scale deployment of APT (European Transport Safety Council, 2016). Thus, despite the potential of APT, cities have not been able to achieve the desired results due to associated governance issues (Ruhlandt, 2018). Many researchers agreed that governmental issues are the most important hindrance to the integration of autonomous vehicles in public transport (Straub & Schaefer, 2019; Ruhlandt, 2018; Aoyama & Alvarez Leon, 2021; Abbot, 2012).

In the section below I will broaden the aspect of governance, by making an overview of the challenges related to regulating APT. By means of effects, I address the difficulties in implementing and governing APT. First, on a general level, and then more specifically related to the governance agenda.

2.3 Governance of autonomous public transport

In order to move further it is important to define what governance in the context of his research is. According to Stoker (1998), governance is generally understood to refer to the formal and institutional mechanisms that operate at the national-state level to uphold stability as well as promote solidarity. Ability and capacity are the main characteristics of governance (Stoker, 1998). In this context, "governance" refers to the official state institutions and their exclusive right to use coercive force. Punishment and thorough monitoring are forms of coercive force (Hofmann et al., 2017). One of the positions to refer to governance is to look at it as a group of institutions and actors that are both inside and outside of the governance (Stoker, 1998). The main issue of this view is a separation between the normative codes used to define and support governance and the complex reality of decision-making associated with governance (Stoker, 1998). In order to weaken this imbalance, the institutional theory (Scott, 2013), where both formal and informal factors are seen as interconnected elements, is applied in this research.

The penetration of new technological solutions creates the emergence of new political frameworks (Hansson & Nerhagen, 2019). The existing patterns have been challenged, creating additional uncertainties for future development (Tan & Taeihagh, 2021; Hansson, 2020). New technologies create new challenges, widening the alleged gap between what is governed by existing laws and regulations and what is not (Lund-Tønnesen, 2022), creating even dilemmatic questions that require the active participation of governance to solve them (Abbot, 2012). One such kind of issue occurs from the discussion about balancing the number of safety measures of APT piloting while allowing the technology to be tested in more advanced traffic situations (Paulsson & Hedegaard Sørensen, 2020). According to the findings of Moscholidou & Pangbourne, (2019) we can determine that cities should think about how smart mobility will impact transportation in the future. Moreover, to direct and mold smart mobility, the state must step in (Moscholidou & Pangbourne, 2019).

The prospect of automated vehicles using public roads has now become a reality, raising several new policy-related issues (Straub & Schaefer, 2019), and being a disruptive innovation that brings myriad uncertainties to the transportation sector. Autonomous transport is a concern of the social acceptance to a greater extent than technological (Marsden & Reardon, 2018; Pigeon et al., 2021). It has been concluded by Marsden & Reardon (2018) that smart mobility both disrupts and confirms dominant framings of transport governance, especially in relation to automobility, and that further challenges will need to be met as

autonomous vehicles become more widespread across transport infrastructure. Debates over responsibility, liability, and the technological development of urban environments are being sparked by autonomous vehicles (Aoyama & Alvarez Leon, 2021). The establishment and use of autonomous vehicles are inextricably linked to concerns over how cities will grow in the future, moreover, the viability, efficiency, and safety of the next generation of urban mobility services depend heavily on governance (Aoyama & Alvarez Leon, 2021).

Marsden & Reardon, (2018) identified three key factors that might explain the need for transportation governance to change in light of technological development. Firstly, transport governance systems and networks, which are already fragile, are being further disrupted by a number of new and potent players, such as the world's largest computer companies and agile service providers. Secondly, the emergence of prosumers in the frame of sharing economy and the new set of expectations that it brings. And last, but not least, governance and other public sector actors who are accustomed to enforcing regulatory control through (exclusive) ownership and management of data are seeing this control erode as the data required for smart mobility is crowdsourced and/or produced by automated sensors.

Thus, the basic knowledge about smart mobility and autonomous technology seems to be very divisive and multi-dimensional. As well as the perspective of governance and the challenges of regulating the new technology in the transportation sector are covered by a myriad of different factors. The positive side of the future implementation of APT seems to be reasonably well theorized (Waqar & Ersoy, 2020; Yuen et al., 2022; Seuwou et al., 2020; ; Iclodean, et al., 2020 Wadud, 2017; Anderson, et al., 2014). However, the current results or effects from the real examples of practical experience are not satisfying (Chowdhury et al., 2020; Scurt et al., 2021; Khan S.K. et al., 2020; Lee & Hess, 2022). Figure 1 is mapping the overview of the central factors of promises and results (effects) of the implementation of autonomous vehicles in a transportation system.

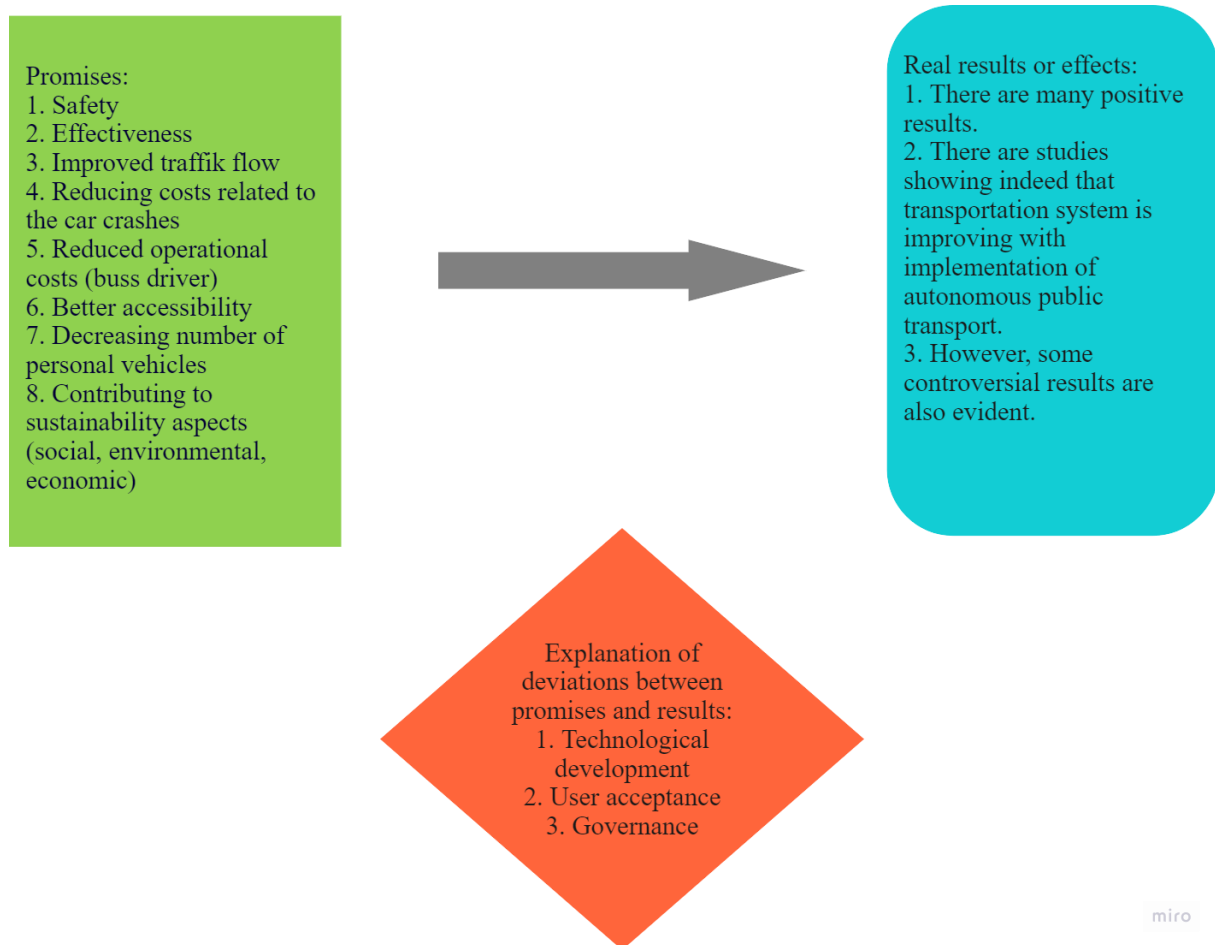


Figure 1. Promises and results of autonomous public transport.

As literature review revealed, there are many potential promises that autonomous vehicles can bring into the future transportation system, including sustainability. Yet, the results are positive but also questionable. There are studies showing indeed that the transportation system is improving with the implementation of APT (Mahmoodi Nesheli et al., 2021). However, some controversial results are also evident. In practice, these promises are not fulfilled, therefore deviations between promises and results have occurred.

The previous literature explains this divergence by the current state of technological development, user acceptance of autonomous transport, and governance of APT. Firstly, technological development is not the central issue (Camps-Aragó, et al., 2022). Technology is developing rapidly, as well as a number of pilot projects (Ainsalu et al., 2018). Secondly, the phenomenon of user acceptance of APT has been studied most, and autonomous vehicles will be accepted in the future (Pigeon et al., 2021; Nastjuk et al., 2020; Wu et al., 2019; Yuen et al., 2022). Thirdly, the question of governance of APT has remained the central barrier to

getting the promises to be fulfilled (Marsden & Reardon, 2018; Lund-Tønnesen, 2022; Abbot, 2012; Straub & Schaefer, 2019). For example, according to Azad et al., (2019), despite the significance of policy and regulatory issues, there isn't much literature in this field.

Therefore, this thesis claims that despite its significance, there are still little research around governance compared to technological challenges and user acceptance studies. The governance aspects become demanding to understand more about how we can address all the challenges in practice and what kind of uncertainties it brings to the future. Because much is done in APT research, yet, less on issues related to the governance of APT. By this means, this thesis aims to fill the gap in the lack of research related to the governance of APT and calls for more future investigations.

Furthermore, methodologically, this is a challenge in itself, because there are not many examples of APT as a permanent offer. All the knowledge available is based on pilot projects where autonomous vehicles have different forms, sizes, and applications. Moreover, the regulations related to the piloting of autonomous vehicles on public roads are significantly country-specific. Considering this, the master thesis aims to contribute to new reflections by the practitioners from real projects. It aims to answer the research question: *How governance of autonomous transport may be implemented in practice?* To address the formed research gap, this master thesis is calling for more knowledge about APT integration in existing governance mechanisms in the city from the institutional perspective that is presented below.

3. Theoretical framework

In the previous section, the need for more research about how the governance of autonomous vehicles may be implemented in practice has been identified. In order to frame the study, I will look at the future governmental mechanism of autonomous vehicles as an institution, applying institutional theory (Scott, 2008). In order to understand the practical side of the implementation of autonomous vehicles and the governance elements, the institutional theory is most relevant, because it has its main focus on the structure and conduct of the institution and the interactions with society (Scott, 2008). It is most relevant to look at the practice in order to understand whether and how new governance mechanisms may be implemented or not. It is important to note that there are no real examples of such institutions in operation. Thus, I will look into the future of governing APT as a future institution.

Unlike other theoretical perspectives, Scott's institutional theory pursues a broader spectrum of aims by applying a three pillars framework. One of these aims is to connect theory with

empirical research. This approach represents creativity and diversity are the primary objectives of institutional research. The following section presents the main theory and how it will be adapted into the theoretical frame. At the end of the chapter, the overview of the theoretical frame and its relevance to the data collection and analysis is explained.

3.1 The three pillars of institutions

In the fields of economics, social theory, and political theory, institutional theory has a long history and has gained popularity (Royston Greenwood et al., 2017). In that it recognizes that institutions must engage with their local social system, it has a lot in common with legitimacy theory. In contrast to that, it is more interested in what this means for the composition and behavior of the institutions.

Institutional theory's central concept is the institution. According to Scott (2013, p. 56-57), “institutions comprise regulative, normative, and cultural-cognitive elements that, together with associated activities and resources, provide stability and meaning to social life”. These components serve as the main structural pillars of institutional structures and provide the elastic fibers that regulate behavior and resist change (Scott, 2013). Institutions are typically discussed in terms of their ability to constrain and control behavior. Institutions impose limitations by outlining the ethical, moral, and cultural bounds that separate acceptable from unacceptable conduct. The essential components of institutions are regulatory systems, normative systems, and cultural-cognitive systems.

3.1.1 Regulative pillar

Regulative pillar explains the processes of constraining and regulating behavior. For example, by rule-setting, monitoring, and sanctioning activities. According to this definition, regulatory processes involve the ability to create rules, assess how others are following them, and, when necessary, manipulate sanctions (rewards and punishments) in an effort to change behavior in the future. In general, regulatory processes in the market-based private sector tend to rely more on positive incentives (e.g., increased returns and profits), while public actors tend to use more punitive action (e.g., taxes, fines, incarceration) (Scott, 2013, p. 61). The regulative pillar's institutional logic is an instrumental one: People create laws and rules they think will advance their interests, and they follow them because they want the benefits that come with them or because they want to avoid penalties. The institutions that adhere to the regulative pillar are those that are based on expediency, where rules, laws, and sanctions are enforced by a coercive third party, typically the state.

However, the regulative element is largely influenced by new connections and networks between public and private actors. In regard to this increasing interdependence, Mukhtar-Landgren et al. (2016, p. 11) suggest extending the understanding of regulative elements to also include multi-level interactive forms of governance, which could be "national action plans/visions/scenarios, material produced by state agencies, but also state subsidies and access to financial resources in terms of funding from for example innovation agencies at the national and EU levels". Despite not fitting into the category of rules or laws, they still offer precise frameworks for the practices and actions.

According to DiMaggio and Powell (1983), the regulative pillar primarily employs a coercive mechanism derived from political influence and the issue of legitimacy. The authors contend that "both formal and informal pressures exerted on organizations by other organizations upon which they are dependent, as well as by cultural expectations in the society within which organizations function," are the causes of coercive mechanisms. However, because laws tend to be contentious and abstract, different people's interpretations of how laws and rules should be interpreted and understood in society can also be used as coercive elements (Scott, 2008).

In this study, the regulative pillar is about how APT is regulated. It answers whether it is a space for the implementation of APT based on the perspective of constraining or regulating behavior. Moreover, it reflects on the regulation of autonomous transport as a process, where different actors have their roles of contribution. The legislation must stimulate business development and cooperation between partners; however, the perception of the law can vary depending on the sector of the single actor. Projects with autonomous transport involve representatives both from the public and private sectors, and the interests of those can potentially conflict. Because these actors tend to prioritize different incentives and goals in their approach to regulating behavior. The next pillar addresses the consequences of the penetration of autonomous transport to different actors that are involved.

3.1.2 Normative pillar

Values and norms are both parts of *normative systems*. Values are ideas of the preferred or desirable along with standards that can be used to compare and evaluate existing structures or behaviors. Norms define the proper way to do things. It consists of the rules and principles that govern the organization and give it its morals, uniqueness, and "personality." Through the systems of education, accreditation, and personal development, expectations of how to behave and perform are upheld (Scott, 2008). Sociologists, who are most likely to study institutions like kinship groups, social classes, religious systems, etc., generally embrace the normative

conception of institutions. Normative systems are typically seen as imposing constraints on social behavior. Normative institutions share certain traits, including the importance of shared beliefs and values as a foundation for social obligation and the role of morality and binding standards in determining how people should behave (Scott 2013, p. 64).

Normative components establish a legally binding expectation that might give rise to social obligations. Its main purpose is to establish goals and objectives, which include things like "making a profit" for businesses, "acting in the general interest of citizens" for municipalities, "reducing carbon emissions" for the transportation authority, and "choosing sustainable means of transportation" for an individual (Mukhtar-Landgren et al. 2016, p. 12).

Different from regulative elements, normative elements may only apply to specific individuals or to entire groups, giving rise to a variety of roles within the institution and defining expected behavior. These social obligations from other actors may put the focal actor under external pressure to make the right choices (Scott, 2008). In the context of APT, this pillar reflects the consequences for different professionals in the area. For example, bus drivers and governance officers work both with public transport and road planning. These actors often originate from both the public and private sectors. The private sector is responsible for technology because of competence. Whereas the public sector facilitates autonomous vehicles to operate on public roads. For example, it helps to understand how the work of the actors will be influenced by a new type of transport that requires new competencies.

Some examples of normative elements are rights and obligations, privileges and responsibilities, licenses, and mandates. The normative mechanism derives from professional groups' shared attitudes and strategies, which use the same structures, procedures, and methods of problem-solving (DiMaggio & Powell, 1983)

3.1.3 Cultural-cognitive pillar

Finally, it is the *cultural-cognitive* pillar, these are the methods of accomplishing tasks are the "taken for granted" ones. When an institution has assimilated the society's culture and methods of doing things, it can coexist peacefully within that society. This means that in order to comprehend or justify any action, the analyst must consider both the objective conditions and the actors' subjective interpretation of those conditions (Scott, 2013, p 67). This pillar asserts that institutions copy or imitate environmental behavior in order to adapt to their environment. In addition, the cultural cognitive components give meaning to action and

behavior by referencing the identities and self-images of individuals, organizations, and corporate cultures (Mukhtar-Landgren et al., 2016). In addition, culturally supported shared beliefs and logics of action serve as the foundation of cultural cognitive institutions (Scott, 2013).

Shared understanding in this work's context could be discussed in relation to broader social issues like the emergence of new transportation technologies, the shared economy, or a sharp increase in the significance of mobility (Mukhtar-Landgren et al., 2016). The mimetic mechanism, according to DiMaggio and Powell (1983), is used by the cultural-cognitive components and is a result of the environment's ambiguity and the goals' lack of clarity. When an organization encounters a problem for which the cause could not be established or for which the solutions were not clear, they adopt novel concepts and innovations by imitating other organizations that appear to be successful and legitimate.

For this study of the implementation of APT the cultural-cognitive aspect is reflected through the citizen's perception of this technology. This factor is of high importance, as these people are future passengers of APT (Yuen et al., 2022) because autonomous transport is a concern of social acceptance to a greater extent than technological (Marsden & Reardon, 2018). However, social acceptance is broader than a pure user perspective, it covers the perception of different professionals both from the public and private sectors. For example, low acceptance from public organizations can eventually have a negative influence on the technological development in the area. Because as mentioned before, technology brings some disruption to the traditional work order in the municipalities, and how the society within the municipality perceives APT is one of the most important issues that are applicable to this study.

What is also significant, the pillars may be out of alignment: They could encourage and support different choices and conduct. According to Strand and Sine, (2002, p. 499), "When cognitive, normative, and regulative supports are not well aligned, they provide sources that different actors can employ for different ends". Such circumstances exhibit both confusion and conflict and offer circumstances that are very likely to result in institutional change. (Kraatz, and Block, 2008). Therefore, this study concentrates on the implementation process, which could lead to the creation of new institutions, in relation to these institutional approaches.

In this study context, the cultural-cognitive pillar reflects the perception of autonomous vehicles both by professionals, politicians, and citizens. Furthermore, the cultural cognitive

components give meaning to action and behavior by referencing individuals, organizations, and corporate cultures' identities and self-images.

To sum up, in this study I will look at the future mechanism of governing autonomous transport as an institution and find out what can be taken for granted according to the institutional theory. Because there are no real examples of an institution that would govern APT, I will use this theoretical framework to look at the future of institutionalization of governing APT. Moreover, I will apply each of the three pillars for framing the interview guide and eventually for mapping what are uncertainties in each dimension, i.e., regulative, normative, and cultural-cognitive.

3.2 Research question and analytical model

The main focus of this study is the governance of APT which will be addressed through the regulative, normative, and cultural-cognitive pillars of institutions in order to understand whether it is a space for the institutionalization of autonomous vehicles in existing governance mechanisms. By institutionalization, I mean the process by which an institution attains a stable and durable state or property. In this context, the regulative pillar is about the state of regulations in terms of testing autonomous vehicles on public roads, at the normative pillar the professional aspect will be uncovered in the form of the consequences for different professionals such as bus drivers, public officers, and private actors. And, last but not least, a cultural-cognitive pillar is related to citizens' perception and acceptance of autonomous technology. This exercise will help frame the future uncertainties of governing autonomous vehicles from the institutional perspective.

Thereafter, these three pillars of institutions will be a frame for constructing an interview guide in order to look at it from different perspectives to identify both possibilities and challenges in practice.

Table 1. Analytical model

Governing autonomous public transport		
Regulative pillar	Normative pillar	Cultural-Cognitive pillar
State of the art of regulations of autonomous public transport	Consequences for different professionals (e.g., bus drivers, public officers, technology providers)	Reflects how citizens and professionals perceive autonomous public transport

Promises and challenges of regulation of autonomous public transport	Promises and challenges of the consequences for professionals of autonomous public transport	Promises and challenges of citizens' and professionals' perception of autonomous public transport
Assumptions and uncertainties for the future institution regarding regulation of autonomous public transport	Assumptions and uncertainties for the future institution regarding consequences for different professionals	Assumptions and uncertainties for the future institution regarding citizens' and professionals' perception of autonomous transport

4. Methodology

Studying people and contributing to our understanding of how society functions in the world are key components of social science methodology. Individuals have varying perspectives about both them and other people, which are in the dynamic process of being not consistent, shaped, and always changing, depending on the context (Johannessen et al., 2020). Science, social science, and many other fields of study all place a high priority on research design. The most crucial choice a researcher makes is choosing the best design, perhaps even more so than deciding on the research topic and developing research questions (Abutabenjeh & Jaradat, 2018). In this study, I want to understand better the governance mechanisms of APT and its implementation.

The research methodology allows a researcher to show an understanding and further to make a study open for further advancement by other scientists. In order to design a study, one may have different approaches. For example, Crotty (1998) identified four key components for designing a study that can be considered as a frame for further positioning toward a philosophy of science, ontology, and epistemology.

First, there are *philosophical presumptions*, such as the ontology or epistemology of the study or the method by which researchers acquire knowledge, that influences how research is done. Because epistemology and ontology are closely related to the researcher's values and conception of reality, inquiries should always be aware of any assumptions they make about learning new things while conducting their research. Another element, according to Crotty (1998), is a *theoretical framework* of the study that is influenced by researchers' perceptions

and attitudes toward the study. It serves as a thread that directs research from the beginning and the end. The last two elements are *methodological approach* and the tools of handling the data: interpretations, collection, and analysis. 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 philosophy of science is an important part of research because it answers the question of how we can know something about something (Benton & Craib, 2011). Here we distinguish on an ontological, epistemological, and methodological level. The main question here is a reflection on what we are doing and how we come up with new knowledge and how we can practice this knowledge in a proper way.

4.1.1 Ontology and epistemology

This is a technical term used in philosophy, and regrettably, it has very different meanings in various schools of philosophical thought. What one would say in response to the question, "What kinds of things are there in the world?" is what can be considered ontology (Benton & Craib, 2011). According to "materialists," who believe that everything in the universe is made of matter (or "matter in motion"), the various traits of physical objects, living things, humans, societies, and other entities can all, in theory, be explained in terms of the degree of complexity at which matter is organized. The ultimate reality, according to "idealists," is mental or spiritual (Benton & Craib, 2011).

There are numerous ontological viewpoints (Feyerabend, 1981; Morton, 1996; Stokes, 1998; Johnson and Gray 2010; Easterby et al., 2018), but the contrast between *realism* and *relativism* can be used to show how crucial ontology is to scientific research. According to realist ontology, there is only one reality that can be studied, comprehended, and experienced as "truth"; the real world exists apart from human experience (Moses & Knutsen 2012).

According to relativist ontology, reality is created by the human mind; as a result, there is no such thing as a single true reality; rather, the reality is relative to each individual's perception of it at a particular time and location.

This research is focused on individuals' perceptions and reflections on their own experiences. As reasoned above, relativism is a more appropriate ontological standpoint than realism.

Because relativism holds that our understanding of a phenomenon depends on the viewpoints

from which we view it. Various truths and facts exist, depending on the observer's point of view (Easterby et al., 2018). As a result, the research is influenced by a relativism-based worldview because it aims to investigate uncertainties about how autonomous buses can be governed from an institutional standpoint.

Epistemology is concerned with every facet of the validity, scope, and procedures of knowledge acquisition, including what qualifies as a knowledge claim, how knowledge can be produced or acquired, and how the scope of its applicability can be established. Because it affects how researchers frame their work in an effort to gain knowledge, epistemology is significant to conservation science. For instance, is human knowledge something that can be positively and objectively identified by researchers, or is knowledge value-laden? How scientists respond to this question will significantly affect how they conduct and interpret their research (Crotty, 1998). As epistemic stances in the social sciences, Easterby et al. (2018) distinguish between positivism and social constructionism.

The social world is external, according to the positivist research paradigm, and its qualities should be assessed using impartial techniques (Easterby et al., 2018). Social constructionism, on the other hand, is the theory that people, not objects or outside forces, determine reality. Additionally, it is crucial to respect the way in which people interpret their experiences (Easterby et al., 2018). In addition, relativism offers an epistemological viewpoint, according to Easterby et al. (2018). This means that if observations are made from a variety of angles, the results will be more accurate.

As a result, the research that follows holds that social constructionism applies to research and that there is subjectivity involved in investigating the practical administration of autonomous transportation. In order to get primary data, I will address social constructionism with a research topic, a case study, and interviews. However, the information and data gathered are all that is known about these realities and if they are true. In order to obtain a variety of viewpoints, it is crucial to triangulate data and compile the perceptions and experiences of other people (Easterby et al., 2018).

4.2 Qualitative research method

The qualitative approach is linked to a lot of variety and diversity (Thagaard, 2009, p. 13). Research is a situated activity that is grounded in a theoretical framework and set of assumptions. Researchers make an effort to interpret or make sense of the phenomenon in light of the meanings the informants offer. As a result, research questions that speak to these

interpretations and experiences of individuals or groups with the theme are developed. This kind of research frequently takes place in settings that are familiar to the informants and locations being studied.

In this case, the study aims to gain in-depth knowledge of governance and attitudes regarding the implementation of autonomous buses into the public transportation system from practitioners. So, I thought it would be best to conduct a case study (Dul & Hak, 2008) and gather qualitative information. The main justification for this is that qualitative methods enable in-depth analysis and focus on a small number of goals. This chapter outlines the methodological decisions that have been made and the methodological resources that have been employed throughout the research for this master's thesis.

4.3 Research design

Procedures for gathering, analyzing, interpreting, and reporting data in research studies are known as research designs. There are many different approaches that can be used when conducting qualitative research. According to J. Creswell and J. D. Creswell (2018), the most popular types of research designs are case studies, grounded theory, ethnography, narrative research, and phenomenological research. These five approaches are comparable in terms of their structure and methods for gathering data, but they are different from one another in terms of the methodology used for data analysis and the choice of analysis unit.

I had to consider how to possibly connect the data gathered and the conclusions reached to the research question when I made the design decision. Case studies are optional when addressing "why" and "how" research questions if the researcher wants to examine context or in-depth findings (Yin, 2018). A case study is a type of design where the researcher develops an in-depth analysis of a case (J. Creswell and J. D. Creswell, 2018). According to Yin (2018), the case study method is the best approach to take if the research involves a real-world phenomenon, if the researcher has little control over the course of events, and if detailed descriptions of the phenomenon are desired.

The research problem in this study calls for a thorough analysis of a phenomenon, and the research question is designed to provide a "how" answer. A qualitative case study methodology was found to be the most appropriate given the focus area and research question, and the study makes extensive use of data collected from various information sources.

In the context of this study, the case that is investigated and the informants are practitioners of an autonomous bus pilot in Bodø, in the north of Norway. Moreover, the reason for choosing this pilot project is that I was a member of a team during my internship period. As a result, I was able to get a holistic overview of the complexity of the whole experiment, both practically and theoretically. The goal of this particular case is to use institutional theory to examine their reflections and experiences.

4.4 Bodø as a case city

Bodø is a town-regional capital in Bodø Municipality in Nordland County, which is located north of the Arctic Circle. Nordland County contains 25% of the Norwegian coast, which is a relatively large area of space compared to the number of inhabitants. However, the overall area is long and narrow, and it typically takes more than 13 hours to drive from north to south. Bodø, with approximately 53,000 inhabitants, is considered an urban area. Moreover, it has flexible mobility opportunities and is known as a “10-minute city,” where a person can reach various types of activities without spending a lot of time on transportation.

The seventh component of Nordland County Municipality's Smarter Transport Bodø initiative is "autonomous buses" (Smartere Transport Bodø, 2022). The aim of the sub-project is to pilot autonomous bus technology in mixed traffic and evaluate the viability of autonomous buses in the future. They also want to investigate how autonomous buses can improve the current public transportation system in order to provide residents with a public transportation option that is even more alluring. In addition, the Bodø project aims to improve accessibility for residents using public transportation to reach the terminal in the city center and the primary entrance at Nordland Hospital.

Sensible 4 from Finland, Mobility Forus and Boreal Buss from Norway, Nordland County Municipality, and Bodø Municipality are all participating in the Nordic collaborative effort. Sensible 4, a Finnish technology firm that specializes in autonomous vehicle technology, provided the technology used in the buses. Variable weather conditions were a significant barrier to autonomous driving that the firm has now overcome. Any car can now drive autonomously thanks to the development of full-stack autonomous driving software. A vehicle can now operate in all types of weather thanks to technology that combines software and data from a number of various sensors (Sensible 4, n.d.).

The Toyota Proace vehicles that have already been tested in Gjesdal and Ski in Norway. However, the buses in Bodø were entirely electric and were tested in an environment with

frequent weather changes in the Arctic area, which sets them apart from the other test pilots. The 3,6-kilometer route could accommodate nine people, one of whom will always be a security host.

Bodø is known for challenging weather conditions, including snow, heavy rain, strong wind, ice, and fog (plus any combination of the aforementioned conditions). According to Vargas et al. (2021) only some of the sensors utilized by APT are affected by lighting conditions; however, all sensors are affected by weather conditions. In situations where the APT must drive under sub-optimal conditions, there is a high probability that the sensors will be impeded from obtaining accurate information, resulting in a higher risk of accidents.

Using Bodø as a case city for this research is of high relevance due to the possibility to capture a lot of information from the project “Autonomous busses in Bodø”.

4.5 Data collection

There are several ways to gather data for qualitative methods, including through observation, interviewing, and documentary analysis. Based on the researcher's sensory impressions in various situations and actions in particular situations, the data from observation were gathered. The information that the informant shares with the researcher during the interviews, on the other hand, forms the basis for the data (Johannessen et al., 2020).

I started by conducting a document analysis specific to the case using sources like the description of the Smarter Transport Bod project, official documents about mobility and transportation laws, and studies about autonomous buses. Moreover, I have collected a lot of data by being a part of the team of the pilot project in Bodø. This provided me with a basic understanding of the phenomenon of APT under study and provided some new perspectives for a more thorough investigation and later self-reflections. In particular, interviews served as the primary source of data for this thesis.

In addition, I have tried to employ all the contacts that I gained during my internship and my self-ethnography to conduct high-quality interviews. I have created a solid network of professionals both within the project and with external actors. I made self-reflections on my work at the project in Bodø and profound retrospective analysis of documents from the working meetings and the project. During the weekly meetings, at least one representative from a technology company and several representatives from the public sector were connected. It has often been discussed, the status of operations, technology, economy, barriers for the projects, and feedback from the different parts. This scope gave me the opportunity to

add important factors and bring up broader discussion in relation to the research question. For example, that municipality served as a factor that increased the overall costs of the project, or that the quality and motivation of a security operators team that work had a significant influence on the value acquisition.

What is special in this study is the way I designed the interview guide (see Appendix 1). The interview guide must be created to fit the circumstance and include inquiries that reflect the major themes of the study. In order to ensure quality, it is crucial to use questions that motivate respondents to provide specific accounts of their experiences and viewpoints (Johannessen et al., 2020). Because the goal is to look at the future governance of autonomous transport, the three pillars of institutions served as a frame for the interviews. While interviewing participants, I assessed different assumptions and uncertainties for the possible future implementation of APT according to the elements borrowed from institutional theory. The purpose of concentrating on assumptions and uncertainties in interviews is to encourage professionals to think about a future institution.

The interviews were conducted both physically and digitally. However, I was trying to reach physically as many participants as possible to make them more open and comfortable. In addition, conducting interviews in person makes it simpler to resolve any potential misunderstandings because the interviewee is not required to interpret questions on their own, which lowers the risk of misinterpretations (Johannessen et al., 2020).

The time frame for this project is very specific. As a result, I had to reduce the number of interviewees in light of the project's financial and time constraints. Some of the interview subjects were the researcher's former coworkers, and others were found through direct contact. Additionally, a few interviewees were recommended after the interview but weren't the researcher's colleagues; they were the interviewee's colleagues, this method of also known as snowball sampling (Easterby-Smith et al., 2018). 16 interviews were conducted overall as a result of this strategy (see Appendix 2) until saturation within the found topic materialized (Easterby-Smith et al., 2018).

I applied a few criteria in order to choose the informants. First, they must have experience of working with APT. And second, they must be actors from the public administration. I believe that these two factors are crucial in order to ensure the quality of empirics. In order to get a more holistic perspective, I chose to include practitioners not only within the autonomous buses in the Bodø project but from other projects related to the APT as well. The core for the

interview in this study is the three pillars of institutions that form the questions. In addition, there is an introductory and concluding stage with the opening and follow-up questions and a general question for a summary of the three dimensions that were discussed.

4.6 Quality of research

The quality in qualitative research should be considered to make it credible for others, and highly depends on the researchers' approach to the study (Easterby et al., 2021). In a broader sense, quality and credibility are often correlated with the reliability of methods and the validity of data (De Vaus, 2001). According to Guba and Lincoln, (1994), qualitative surveys need to be evaluated differently from quantitative surveys. The validity and reliability criteria, according to their argument, assume that it is possible to discover an invariable truth about the social reality we live in, and there is more than one description of this reality. In this study, I use the terms reliability, internal validity, external validity, and objectivity in order to describe how well a qualitative investigation is done. Below, I go over each point in more detail and explain how this study approaches the tests. Finally, research ethics are discussed along with a description of the research's credibility and a short summary of the chapter.

4.6.1 Reliability

Data from the survey is related to reliability. For instance, what data is used, how it is gathered, and how it is handled. Structured data collection methods are not used in qualitative research, and data is frequently gathered through verbal exchange. Furthermore, observations are obviously context- and value-dependent. Another researcher won't be able to replicate the findings of another qualitative researcher. It's also possible that the researcher uses himself as a tool. Therefore, nobody else can interpret in the same way because they lack the same background and experience as the researcher.

By emphasizing appropriate evaluation criteria, the researcher can further strengthen reliability. In this study, I increase reliability by providing the reader with a thorough account of the context, which takes the form of both a case description and an open, in-depth presentation of the procedure throughout the entire research process. I create a procedure for evaluating my documentation of data, methods, and decisions made while conducting research, including the final outcome (Ryen, 2002).

4.6.2 Internal Validity

According to Yin (2018), internal validity for case studies focuses on attempting to establish a causal relationship and is only quantifiable for causal or explanatory studies. The extent to

which the researcher's methods and findings accurately reflect the study's purpose and represent reality is known as the validity of qualitative research (Johannessen et al., 2020).

According to Lincoln and Guba (1985), triangulation and ongoing observation are two techniques that increase the likelihood that the research yields reliable results. In order to be able to distinguish between information that is relevant and that is not, as well as to establish trust, present observation entails spending enough time to thoroughly understand the field. Without knowing the context, it can be challenging to comprehend a phenomenon. Therefore, it is important to use a combination of methods to increase the internal validity of the study. When a researcher uses multiple research methods, such as observation and interview, they are said to be using method triangulation (Johannessen et al., 2020). In the context of this study, my own experience of working with autonomous busses in Bodø, documents, and resources analysis served as a background for a solid understanding of the context of the phenomenon. In addition, all of my informants have received the interpreted results of the research. That is an approach to ensuring increased internal validity (Johannessen et al., 2020).

4.6.3 External validity

Instead of generalization, which is associated with quantitative studies and statistical generalization, one speaks of the transfer of knowledge in qualitative research (Thagaard, 2009). The usefulness of one's descriptions, concepts, interpretations, and explanations in contexts other than the one being studied is what is meant by an investigation's transferability. Since most qualitative research entails gathering information from a small number of people or a group with a few shared characteristics, qualitative findings frequently focus on the contextually specific and the meaning(s) of the aspect(s) of the social reality under investigation (Johannessen et al., 2020).

By giving thorough and at the same time easy to understand descriptions of every component of a culture or phenomenon, I increase external validity in this study. According to Guba and Lincoln (1994), complete descriptions make it simpler for others to determine whether the study's findings can be applied in other contexts.

4.6.4 Objectivity

It is expected of qualitative researchers to bring a distinctive perspective to the studies they conduct, but it is crucial that the findings are the product of the research and not the

researcher's personal opinions (Johannessen et al., 2020). There are several methods to guarantee the highest level of objectivity (Johannessen et al., 2020).

First, in order for the reader to understand and assess the researcher's decisions, it is crucial that they be described in detail throughout the entire research process. Second, verifiability can be strengthened by the researcher determining whether the interpretations are supported by other academic works and, arguably, whether they are supported by the informants of the research (Johannessen et al., 2020).

In this study, I was trying to maintain objectivity throughout all processes by supporting my interpretations with literature, data received from the informant of this study, and not least personal self-ethnography. However, being personally involved in working with APT and knowing some of the informants beforehand, make it hard to be completely detached from the feelings and personal opinions. Therefore, I paid extra attention to the informants by checking whether they support my interpretations of the collected data.

4.6.5 Research ethics

Ethics is primarily concerned with how people relate to one another and what we can and cannot do to one another. The study of people's behaviors and actions in social research can raise ethical issues and questions, perhaps even more so than other types of research.

Numerous ethical issues can arise when conducting research, but there are many steps that can be taken to ensure that the research is conducted ethically (Easterby et al., 2018).

The National Committee for Research Ethics in the Social Sciences and the Humanities (NESH) has adopted research ethics standards. The five parts of the guidelines address various ethical obligations (NESH, 2021).

The first one is the research community. Researchers should act honestly, show respect to one another, and acknowledge one another's contributions to projects and publications. In their teaching, supervising, disseminating, and publishing, researchers have a responsibility to advance the principles and standards of research ethics (NESH, 2021).

The second one is research participants, meaning that researchers have obligations to everyone who is part of or impacted by their research. Respecting the participants' human dignity means taking their personal integrity, safety, and well-being into account. Generally speaking, consent and information should be the foundation of research participation (NESH, 2021).

The third one is groups and institutions. It is about particularly vulnerable and disadvantaged groups that require protection. When conducting cross-cultural or cultural heritage research, special consideration may be necessary. Both public and private organizations are jointly responsible for making sure that their involvement in research complies with accepted standards of research ethics (NESH, 2021).

The fourth one is about commissioners, funders, and collaborators. Researchers and research organizations have duties to collaborate, funders, and commissioners. Other research actors also owe researchers and research institutions obligations. The requirements for social utility and relevance are balanced against the standards of openness and independence in research ethics (NESH, 2021).

And finally, the fifth one is the dissemination of research. It covers the duty of researchers and research institutions to inform the general public about the scientific findings of their own and other researchers' studies. Research dissemination includes interdisciplinary discussion, engagement with various social groups, and participation in public discussion (NESH, 2021).

During all of the stages of this research the guidelines have been followed thoroughly. The informants of the study were treated with respect and ensured fully informed consent, privacy, and confidentiality. To ensure the protection of the integrity of the research community, one of the main principles of this study is to avoid misleading or false reporting of the study results (Easterby et al., 2021). I allowed the informants to fully express themselves by listening to them without interjecting during their responses. If anything was unclear, follow-up questions were asked to elucidate the statements and determine what they meant.

4.6.6 NSD

Writing a master's thesis involves several steps, one of which is submitting an application to the Norwegian Centre for Research Data (NSD). Their goal is to enhance the environment for empirical research and offer instructions on how to handle informants' personal data. On February 28th, 2022, I submitted my project for approval, and NSD approved it on March 3rd, 2022. 772380 is the project identifier. I then began conducting interviews. Additionally, I created a consent form and had copies signed by each of my informants before sending it to them. This indicated that they gave their permission to be interviewed and to have the interview recorded. The recorded interviews were used to produce accurate transcripts of the interviews, which were then forwarded to the informants' review. They were informed that

they were welcome to add to, supplement, or remove any information from the transcript. I didn't get any feedback about mistakes or requests to retract or explain any statements.

5. Empirical findings

This chapter presents the main findings from the data collected. This resulted in forming three main groups with related sub-topics. These groups are the regulative aspect, normative aspect, and cultural-cognitive aspect.

In the regulative aspect, I try to reflect and summarize the main points of data I collected during the interviews, my observations during the internship, and documentary analysis about what the regulations of an institution can look like, and what the challenges and uncertainties related to that. When it comes to the normative aspect, I focus on the consequences for different professionals related to APT. In this aspect, I try to find out what kinds of challenges and uncertainties may arise and how they influence professionalization. The cultural-cognitive aspect is about reflections on how citizens and professionals perceive APT and in what way it forms a future institution. Moreover, I try to capture and understand what might be most challenging and uncertain.

The empirical findings will be presented in the form of illustrative quotations based on the reflections and opinions of different actors related to each aspect. In addition, while presenting, I concentrated on the most relative and even sometimes contradictory information from the informants. The figure below gives a full overview of the data structure of empirical findings that I further unpack below.

Figure 2. Data structure of empirical findings



5.1 Regulative aspect: different flows of regulation as barriers and uncertainty for APT future

The main goal of this study is to into the future governance of APT as an institution.

Regulations are the first of the aspects to consider. It revolves around what will be a “taken for granted” way to regulate the field. During the interviews, I found that there are several emerging matters that are related to the formation of the future regulative pillar of the institution and what kind of uncertainties, challenges, and tensions appear. Specifically, three aggregated topics came up from the discussions in qualitative interviews, documentary analysis, and my personal self-reflection from the internship.

The first one is the different flaws of regulations which manifested and presented as: tensions between regulation and technological development, the dissonance of public and private interpretation of regulations, and last but not least, funding sources and their influence on regulations.

The second part of the regulative pillar that appeared from my data is related to tensions between safe and sound regulations and future-oriented business models. In particular, there were issues of the balancing between experimenting and safety regulations, the inner complexity of regulations to keep up with the connection of several systems, the deviations between past-oriented regulations and service of the future, uncertainty about the use of regulation by private actors, and tension between technology-focused and citizens focused regulations.

Finally, I found out that regulation is not a problem, but an issue of how it is interpreted and administrated. It is revealed by explaining the issue via the understanding that regulations are both enablers and constraints and that regulations give room for flexibility. Overall, a person's attitude toward regulations greatly depends on whose voice, whether public or private, an informant represents. The research revealed that while the regulations were not a problem for some, they were the biggest problem for others.

5.1.1 Different flows of regulation: balancing public and private interests of APT

The first topic discussed during the interviews was how they perceive the current regulation and possible barriers to the future regulations of APT. All the informants had a lot of information regarding this question. The majority of informants recognize that the current regulations have a lot of weaknesses. The current level of regulations makes it difficult to pursue technological development, namely, technology is advancing faster than laws. Some of my informants were explaining the same issue of these *deviations between technological*

development and regulations. For example, one of the informants (A) from the private sector claimed: *“To see the effects of self-driving, we need to get them to drive as a fixed offer. According to regulations, it is important that the authorities monitor and facilitate piloting on public roads. It is important that rules are updated in parallel with technological development. For example, the technology is ready to run at level 4, but the regulations do not allow this.”* And an informant M from the public sector reflected: *“The problem is that regulations come later than technology. We have to work with the ecosystem around this. Society's need is to transform transport so that it becomes sustainable. There must be transport needs anyway, we cannot stop transporting goods and people. It is the regulations that must adapt to the technology, and this is going too slowly. There is a need for new services that do not exist today that we must be allowed to develop business models for. And when we get it, it will be sustainable because then we can transform transport into a shared common mobility like on electric energy.”*

One of the possible explanations for this issue may be a different understanding of the existing regulations. The governance provides more general rules because of their limited competence in self-driving technology; however, the private sector requires more detailed instructions to run their projects. Tensions dissonance between the *public and private interpretation of regulations* is one of the central issues according to the findings. This difference in perceptions of the regulations might be explained as difficulties in administration and understanding of these regulations.

One of the informants (I) from a private company claimed: *“I feel that we provided only with umbrella regulations, and then companies really need to figure out themselves how they going to effectuate these laws. And I think is quite a strange point. Because now it is a lot of learning by doing and we don't have ABC rules for doing things.”* However, informants from the public sector do not see this point as a barrier or problem. For public actors, it is a process of learning by doing, where regulations are evolving gradually. Informant K explained: *“It is natural that we do not have ABC in the regulations, because it is the only way to learn new things. We did not experience that the regulations significantly delayed our projects. The regulations could be more flexible, but it is not a big problem.”*

How ATP is motivated in the monetary manifestation is a significant factor that affects regulations. In addition to domestic investment, participation in EU programs is an option. Still, the ownership of autonomous technology may be in jeopardy because EU financing is

higher than local funding. As a result, the governance may not be particularly willing to participate in larger international schemes. *Funding sources and their influence on regulations* are further connected to political will and readiness to support APT.

Both informants from private and public entities brought up the financing model as important barriers. Informant A from a private company claimed: *“The EU must be a very important actor, but we also need funding locally. This should strengthen ownership. The challenge is how we can make this happen, i.e. prioritizing exactly this. Here we have to get the politicians to see the benefit in this. You have to take a step back and see how this could turn out in 5-10 years.”* A public actor C stated: *“The EU is important here in terms of funds, but the governance must ensure that all counties have good autonomous services in the future.”* And finally, informant K from the public sector explained: *“The Ministry of Transport is financing autonomous public transport through smarter transport. But also, if we want to pursue further development of this, we must have external funding. Because the public transport companies do not have enough money to carry out this type of development themselves”*

In the next subsection, I reflect on the different approaches to regulations when considering safety as a central focus.

5.1.2 Future-focused business models or “business-as-usual” secure regulations?

The issue of safety is a significant regulatory roadblock, so policymakers are trying to take additional precautions when drafting laws for emerging technologies. The current laws were developed to deal with the traffic that is made easier for individual cars driven by humans, but APT requires more futuristic business strategies. This aspect can be categorized as a tension between *safe and sound regulations and future-oriented business models*.

One of the issues that occurred is strained relations between (1) experimenting and safe regulations. It means that there is a need to create a space for the piloting APT and keep up with experimenting in order to improve technology, while regulations try to be safe. An informant B from a private company stated: *“It is very important to be able to test technology within a safe framework. Because if a serious accident occurs, there can be an extremely large brake on development.”*

Another point that unpacks dissonance between “business as usual” and future-oriented business-led models is related to (2) inner complexity of regulations to keep up with the connection of several systems. The machinery directive and the vehicle part are the two main

components of regulations for APT. Each dimension also has a number of layers that combine to create a complicated regulatory structure.

This creates barriers for regulations because some parts of the laws might be mistaken. One of my informants (M) from the public sector explained in details: *“Another problem with the regulations is that you also relate them to electric cars, so there would have been a number of problems with where these charging stations are located, can they cooperate with other functions, where do they get power, capacity, cost, and then this turns against self-driving services, they must be connected to physical places and people. Goods to be delivered somewhere encounter closed doors or stairs or ramps, and then the goods have to be picked up. There are a lot of such changes that have not been included in the regulations. So the regulatory plan for a city that is not adapted to technology.”*

Additionally, the orientation of the goals plays a crucial role in the implementation of APT, because regulations are about the past even though the service is about the future orientation. Current vehicle regulations were created with human drivers in mind, but because APT will make driving safer and more efficient in the future, some of these regulations will need to be revised. A public actor (informant M) followed up by explaining the *deviation between past-oriented regulations and service of the future* and stated: *“The regulations are one of the factors. The regulations delay testing to mature the brand and business models. Because the person who is going to buy a service or deliver a service does not see that opportunity because you then look in the rearview mirror. The regulations are conservative because they are safe and sound. Then you don't see the new opportunity that digitization provides. And then the regulations prevent.”*

Another point that emerged during the interviews is *uncertainty about the use of regulation by private actors*. This ambiguity has been identified as one of the determining elements for the future creation of regulations. Because the private sector has a significant influence over shaping regulations by providing consultancy services for the public sector or lobbying for more technological-focused regulations. Furthermore, it will establish a dependency between the sectors. One of the informants (D) from the public sector pointed out: *“With regard to competence, it is important to ensure that private actors do not use the regulations for their own gain. And this happens in the private sector with many experts providing advice to the public sector. And I believe that the public sector will be dependent on consultancy services in*

the future to meet the needs of rapid technological development and competence around technology. And it will create more challenges in relation to changes in the regulations.”

In more broader sense, the issue of regulation use by private actors is reflected in a (5) tension between technology focused and citizens focused regulations. And eventually, the choice of who will be held socially responsible for providing transportation for citizens. This factor was also evident to me while working with Smartere Transport Bodø project with autonomous busses in Bodø. According to my observations, the technology providers were concentrated on maximizing technological advancement and testing, even though it might result in uncomfortable experiences for passengers, such as abrupt and harsh braking. However, the comfort and level of service provided to passengers were central for public actors.

One of my informants (N) from public service provided an example of this: *“What challenges self-driving cars is that they have a lot of the technical stuff. And the actors who work with it know a lot about technology. So, the technical suppliers have a focus on technology. As a public transport company, we don't know much about technology. One of the technology companies we worked with, they lost focus on customers overall, they focus on testing technology. At an intersection or where there is a duty to give way, the vehicles must stop and analyze. And this is not a good service for passengers.”* On the social responsibility issue another public actor (C) reflected: *“In addition, it is a lot about social responsibility. We are almost obliged to offer the best mobility solutions to society. Today, not all public transport companies work the way we want. If the governance and public transport companies are not going to take over that part of the development, they can risk that private industry will take it over. In other words, the social responsibility that should lie with the public.”*

In the next subchapter, I describe barriers related to the external environment of regulations, such as management and interpretations.

5.1.3 Administration and interpretation of regulations as barriers for implementation of APT

Some of my informants, both public and private actors, argue that the issue is more covert and do not see the current regulations as a barrier. It means that *regulations are not a problem, but an issue of how it is interpreted and administrated*. Because the regulations are not the problem in themselves, the more it is the issue of bureaucracy.

An informant D from a public entity stated: *“The regulations provide ample room for us to remove the driver from the vehicle. So the law provides a great deal of scope in itself. The*

question here is how that regulation is administered. It is quite difficult to understand this. Because there are people who decide on these applications that come in. We do not see quite clearly whether the authorities that assess the applications take a position on the need that we will solve. Or takes a decision on a technology and what requirements they should set for remedial measures if there are risk factors. So the application of the regulations could have been more business-oriented, i.e. directly aimed at business, and it is not.”

Another issue that came up during a conversation with a public actor is the fact that current laws are developed enough to be applied to APT, but that more administration is required to keep up with advancements and enhance the service. It means that *regulations are both enablers and constraints*, depending on the approach to working with them. Informant D from the public sector stated: *“I perceive that the regulations actually comply quite well with regard to autonomy. But it is clear that there is still much to regulate, and much to be explored further. But I understand that the regulations are largely in place, so that there are enough regulations to enable us to get started. It is not the regulations that are the limitation. It is mature.”*

In addition, current *regulations give more flexibility*, meaning that they are easy enough to comply with and shape in the future. As informant I from a private company explained: *“The law for 3-4 is quite good. It is fairly easy because regulations are there, we just need to apply them. If you don’t like them, you need to cope with them or get good lobbies to shape them in the future.”*

The findings associated with the actors working with APT are presented in the following chapter.

5.2 Normative aspect: tensions between demand for competence and complexity and how it distributed around actors of APT

The second aspect of the future institution of governing APT is the normative one. It consists of discussions around consequences for the professionalization of different actors, both private and public. Having analyzed the qualitative interviews, I came up with 3 professional areas that influence the governance of the future institution of APT.

First is a group of hardware and software producers that represents the voice of the private sector and the challenges and uncertainties related to their professional development. The second group speaks for the transport departments at the county level and transport companies and operators. In the Norwegian context, those are the voices of public actors that work with

public transport services. In this part, I present several emerging tensions and uncertainties for the future implementation of APT as an issue of competence and complexity of the contracts for public transportation. The third group is dedicated to local public road administration and their professional roles, the challenges, and barriers related to competence and management processes within the entity.

5.2.1 Hardware and software producers

Professionalization and norms development for APT is highly connected to relations with manufacturers, the cars industry, technology professionalization, and orientation of current economic incentives. It means that there is *a link between the way autonomous technology is developing depending on the other hardware and software manufacturers*. Namely, these are cars, technology, and bus manufacturers. As an illustration, automakers that adopt autonomy early can become competitors for other tech-oriented companies. A private actor (E) reflected on this issue as follows: *“Private car sales will reach their peak in 2030. And then the question is what should we do next? There is going to be a restructuring process, some people are going to disappear. But there is also going to be a niche market such as camper vans.”* And an opinion from a public actor (K): *“The car manufacturers have a different market, the technology manufacturers also have to throw themselves into that race. They can make good money both if they are the first out and can sell cars that have self-driving technology, and then there are a number of players (car manufacturers and technology companies) who will enter the mobility market to deliver mobility services. Because without a driver they can provide such a cheap transport service that it will compete with the subsidized public transport that we operate. And this is good in a way. The public authorities do not have to spend a lot of money on public transport.”*

Another aspect of the professionalization of private actors has to do with project management rather than technology. In these terms, informant C from public service highlighted: *“I perceive that this has been start-up organized. Small technology companies and small suppliers supply self-driving transport. I believe that as suppliers eventually become professionalized, there will be room for a competent environment with consultants. Which do not necessarily deliver services, but they stand for project management and specialist knowledge, implementation, and change.”*

Bus manufacturers is a sensitive group because they are depended on the incentives from the public transport companies' orders. This phenomenon is often called as demand-side innovation economy (policy), where the uptake of an innovation driven by the increased

demand from the public sector. According to my findings and personal reflections, *bus manufacturers are lagging behind in professionalization since there is no or little demand from municipalities*. Regarding this, an informant D from public sector claimed: *“The traditional providers of public transport are moving very slowly. They think very little digitally, both on the vehicle side and everything around the vehicle. And this is because they are trapped in a role. To a large extent, they are financed by the Country Municipality. And if a County Municipality does not make demands for innovation and change, then there is no funding to make any change. This means that the County Municipality and the state have a big responsibility for that market change.”*.

Basically, bus manufacturers do not have sufficient incentives from public transport companies in the form of more sophisticated procurement that contains digitally and technologically higher standards for bus producers. In other words, *economic incentives and current money focus make car manufacturers limit the professionalization of the field*. A public actor K explained: *“There will be major changes for those who make other types of vehicles. I think that bus manufacturers are far behind car manufacturers. And we who buy buses are to blame for that. When we go out to tender and have new bus contracts, we look at the price (98% of occasions). The consequence is that those who make buses have no incentive to rush to produce self-driving buses. They make buses that are simply cheap, which they can deliver to the auditorium within the tenders and then they will make money. We set requirements in the tenders and then the price that applies is what we get back.”*.

The next sub-chapter discusses barriers of transport departments at the county level and transport companies/operators.

5.2.2 Transport departments at the county level and transport companies/operators.

In this category, the informants were asked to shed light on the role of public transport companies and the consequences and barriers to their working agenda under the development of APT. A major problem that affects all professional field actors, whether directly or indirectly, is the tension between the demand for competence and complexity and how it circulates among the actors. Both actors from the public and private sectors agreed on the demand for new skilled professionals in this area. Moreover, multisectoral local cooperation is required for APT to succeed. An informant B from a private company reflected: *“It will require new skills. Perhaps you have to realize that you cannot collect all your expertise in one house. This means that you need to collaborate with others who have core competence in other areas. Autonomous*

transport consists of an unimaginable number of different competencies. You can't just sit on your own field.”

Additionally, the following voice of a public figure (L) on this issue: *“Competence is a challenge. If we are to look at business development, they get a lot of local development from the new companies that solve these challenges. And then they get more local development and knowledge. For example, those who work on buses in Stavanger use knowledge from their own country. And then we sit on the bus and see how these upgrades work in practice. And then we get much faster and correct development of the autonomous system.”*

During the discussion over barriers, contradictions of the contracts and lack of competence were the most repeated topics. In particular, the contract challenges are reflected in the tension between contracts about the future needing flexibility or to be shorter and being locked into 10 years. This reflects the time dimension of the public transport companies and operators who experience difficulties in *adding autonomous technology to their usual long-term contracts*. A representative of public authority (K) explained: *“Today, this is in the pilot phase. What can be challenging and time-consuming is getting self-driving in our regular contracts. They last for 10 years and then we have to specify things that may not exist yet. And it can become very difficult to predict what may happen in 5 or 8 years, and then make good contracts based on this. So that transition to getting autonomy in the usual big bus contracts that last a very long time is disadvantageous.”*

Another contract-related issue for public transport companies is related to geographical space. In those terms, the tension *between open and flexible geographical zones of operations and being locked in geographies in contracts has occurred*. An informant L from public service provided an example: *“It concerns these long agreements with. We (public transport company) have formulated in these agreements that there should be an opening for testing new technology. What is a bit difficult is that the contracts apply in different geographical zones, and in fact, very few of those are betting on autonomy. So if we are going to test a self-driving bus on a route that is in the geographical zone, there may be a conflict with the contracts. And that is something that is an obstacle and should be resolved in order to move forward. We should be allowed to test self-driving regardless of where it may be.”*

The second topic related to the professionalization of public transport companies and operators is a shift in their strategies related to the future need for competence. According to my findings, there is tension between *future-oriented and current-oriented professionals*. An official (D) of

the governance clarified this as follows: *“For the public sector, it can be very challenging, because we work in silos and need a lot of new skills, and this requires working with a different type of everyday life. So I think that it is the organizations that will deliver this that will have the biggest problem. As a public actor, we can offer much more transport with the new technologies. Transport is going to be safer, more secure, and use less space. Many social benefits lie in autonomous transport. As we (Public Transport Companies) should be keen to get this started. As an actor, our role is being changed. We will not just announce contracts with specifications as we do today. We will set different types of requirements, we will be the driving force for suppliers to deliver other services than they deliver today. There is a major shift in competence.”*

The willingness of public transportation companies and operators to impart their acquired expertise to other public transportation companies and operators is another issue connected to the demand for qualifications. It means that a public transport company or an operator that concentrated most of the new technological-oriented competence in their house will have a more competitive advantage. In other words, it creates *tension between openness and willingness and reluctance for competence share*. For instance, a public actor (C) referred to it as a competitive advantage: *“Public Transport companies happily share their reports, but the challenge is that the competence is in their house, the core competence lies with them, and then in a way, they have a competitive advantage compared to other Public Transport companies”*.

In addition, a private actor (A) sees the lack of competence in public transport companies as the most important barrier to the future implementation of APT: *“The biggest barrier is if the public transport companies will be unable to adopt new technology and acquire technological competence.”*

Another competence-related category is *professionalization change of bus drivers*. Bus drivers are a significant professional group whose work will be disrupted by the introduction of APT. During the interviews with public and private actors that work with APT, only a few of them mentioned challenges regarding professionalization for bus drivers. Otherwise, bus drivers were seen as insignificant, as many countries experience a shortage of skilled drivers and there will be a lot of new interesting and demanding types of jobs for these drivers.

In particular, two main tensions have emerged. The first one is the uncertainty of *how creating new various jobs will be integrated for bus drivers*. Regarding this issue, informant C from the public sector pointed out: *“The profession is undergoing extreme change. They must have a*

larger working environment and more interesting tasks because they will be working with fleet management. They have a lot of expertise on the road, on routes, on functionality on the bus, on optimized driving, and on the timetable. And this is something that must be taken forward so that this does not disappear. At the same time, the situation of change is quite demanding.”

A private actor (B) stated: *“There will be new jobs to control the vehicles, as well as in operation and maintenance of the vehicles. In addition, these new vehicles are zero-emission vehicles, and this will require new expertise both with the mechanics and the infrastructure.”* In addition, another private informant (A) explained: *“There will be a need for more people to monitor, program, and control the vehicles from the control center. In addition, new types of work will appear, for example, cleaning and maintenance. Some of them will have to readjust a bit and get slightly different tasks.”*

The second issue is related to the uncertainty of the lack of bus drivers both nationally and internationally. The informants recognize that there is a significant shortage of bus drivers internationally, however, there is no clear roadmap to how it should be tackled. Informant N from the public authority illustrated: *“We have a large shortage of bus drivers in Norway, so it gives us the opportunity as an intermediate phase to step in and support and supplement the fact that we have a shortage. And so by using self-driving vehicles, we shall maintain a good public service that way.”* An international perspective on this factor has been derived from a private actor (I): *“We will have more autonomous public transport in the future and there is a lack of drivers that we need to fill somehow in Germany, especially after the war.”*

Additionally, a public informant (K) reflected: *“I think it is really a very small problem that the bus drivers will lose their jobs. We do not have enough labor, and this is not only for our sector, but for other sectors as well.”*

However, I have interviewed a bus driver (O) regarding the current challenges for his work and future-related uncertainties that the introduction of APT can bring. According to the data analysis, the lack of bus drivers is more an issue of political will than the professional area in itself. Regarding this, a bus driver stated: *“We tried to negotiate better working hours through the union, but they were met with a lot of resistance because there are very few drivers. But in my opinion, this is “bullshit”. If the will is there, then one can make this happen.”*

Another issue of the reluctance and willingness of traditional bus drivers to transform their usual work routines. This is linked to a single professional's qualifications and knowledge as well. The bus driver reflected: *“If I can switch over?... Maybe if this had been the only option.*

I don't think it applies, this is a different job. Experience of course has a lot to say, but this is a different working day. Let's say, if I had two options, to work as a security operator or as a regular bus driver, I would rather be a bus driver.”

I discuss the analyzed data about the function of public road administration and related issues in the following sub-chapter.

5.2.3 Public Road Administrations

The informants were asked about their experiences and assumptions of working with the public road administrations and the role of the organization in relation to APT. This topic was broadly discussed with the majority of interviewees. Many of them are referred to this authority as an actor with the biggest potential for improvements, making it one of the main obstacles to the current and future use of APT. Namely, *local public road administration is not open to new competence building and joint professionalization*. In particular, its *silobased thinking* serves as a barrier. There are different departments but weak connections between them, and it brings more problems in terms of coordination of their work. Both the public and private sectors appear to share the same perspective on this matter. An informant (E) who speaks for the private sector stated: *“The Public Road Administration's role here is very exciting. Urban development and site development is a very underestimated subject area. They have to turn around in another direction because they are starting from private cars when doing their plans. And this is completely understandable because there is a huge number of registered private cars. They also need to start thinking about level 4 of autonomy, because this is a public transport offer. For example, in investigation reports, they tend to think in silos. Long it in the porridge (langt nede i grøtten), but it is high time to think horizontally.”* One of the informants (D) from the public sector pointed out: *“Public Road Administration currently needs to revolutionize because they use all their resources to lay asphalt. They have the power to change.”*.

Another issue is related to the *lack of competence and resources to process experiments*. Working with approvals for piloting APT is one of the responsibilities of the Public Road Administration. This requires a high level of expertise in this field, which, according to the findings, is insufficient. A representative from public transport operator (N) reflected: *“It was uncertain and unclear for us as to what was needed. And they were very slow with responses. They do not have enough capacity for case processing. So there were several things that were challenging also in dialogue with them. We had not received clear answers, and they pointed*

out that it was the Ministry of Transport's nuisance cases. It wasn't quite designed for this to work together.”

One more obstacle is that the Public Road Administration has a *narrow focus on private cars and their future*. The lack of competence in APT may be one of the explanations for it. Because in order to fulfill the positive effects that autonomous vehicles can bring, there must be a collective solution. Sustainable future mobility means moving away from privately owned cars and leaning towards collective and shared solutions. In other words, the infrastructure planning has to be shifted from private cars oriented to a public transport-oriented model. One of the informants (M) from the public sector illustrated: *“Those who represent the regulations quickly become idealistic, they think immediately about level 5 of autonomy. But it is always a step in development. This does not go from one to the other. We may have to accept intermediate solutions along the way. We also try to tell SVV that business is also part of the social mission.”*

In addition, there is an issue of bureaucratic red tape that is reflected through the complexity of submitting documentation for approving driving APT on public roads. It opens up an issue of *bureaucratic thinking and not being open to joint competence*. Both voices from public and private sectors agreed upon this point. An informant E representing private sector stated: *“We have to send the same applications over and over again every year, this part could have been easier”*, and the public actor (M) gave an example: *“We tried to extend a project and take out the host to increase the complexity. We thought the technology was safe enough. The road authorities said no, they believed that we must drive in the technology park, where there is a closed area. We drove for 5 years and showed that there is no risk of collision or collision, but we got a “no”. Then we did not get the learning and demonstration that this can work in a complicated city in order to scale this further in commercial service.”*

In addition, as I personally observed and experienced while working on project autonomous buses in Bodø, the local public administration, was a relatively passive actor. We did not have any physical or digital appointments while the buses were in operation. Even potential informants for this research did not see their relevance to participating or were not interested in responding to the invitation.

In the following subsection, I present findings related to the behavior and perceptions of professionals and nonprofessionals that are involved in experiencing APT.

5.3 Cultural-cognitive aspect: professionals' conservatism and culture of driving private cars as barriers for the future of APT

The social acceptance and perception of APT is the third main category in this chapter. This aspect is divided into two groups: the acceptance of professionals in the face of local public administration and public transport departments and the acceptance of users of APT. There are several tensions that emerged from the discussions with informants regarding their perception of APT. However, it was crucial whether an informant from the public or private sector. Because companies that work with autonomous technology seem to be more critical than public officers. It may be explained as public actors are less competent and have less contact with both autonomous vehicles and public.

Overall, our interviews give the impression that this aspect is undervalued. Most of my informants who work with APT expect user acceptance of technology to be very high and take it for granted. For example, some informants argued that the passengers of their pilot project were satisfied and wanted to have it as a permanent transportation service. Or that passengers are not interested in whether there is a bus driver or not. One of the representatives (N) of a public authority pointed out: *“I don't think users care if it's a driver or not. They are more interested in the service itself, as long as it works. People are a bit unfamiliar when they use it for the first time, but they don't take the bus because it's fun, they need a transport service.”*

In addition, this aspect is difficult to test and evaluate for practitioners. Because the data from fulfilled pilots shows, it was challenging to involve different focus groups of passengers to reflect on their experiences with APT. As in Bodø-case, the route was adopted for people who will travel from the central terminal at the speedboat pier to the hospital. So, the passengers were predominantly elderly people, that took these buses occasionally.

5.3.1 Professionals' acceptance: local public administration and public transport departments

The perception of professionals is formed by public sector organizations, in the frame of this study those are: local public administration and public transport departments. Some of the professional environment seems to be skeptical and conservative towards new technologies. The first argument is that implementing APT is *too early and many actors see them as science fiction*. Informant K from public service reflected: *“I think those who work with traditional bus operations think that this is a bit early, they do not see it as such a big development.*

Because when we started with a big self-driving bus, we had 3 operators instead of 1 bus driver. We are not exactly there where we can earn money on this. So, it will take time when we start earning.”

The second emerging issue related to public actors is an unwillingness to accept and incorporate new transformative and challenging routines into their work. Informant L from the public sector stated: *“Many people in these Public Transport Companies are relatively conservative. Who are not very positive about driverless buses. And this creates obstacles and challenges.”* In addition, another public informant M pointed out: *“The public sector is still a bit on the fence (sitter på gjerdet). The Country Municipalities that own it do not order transformation quickly enough. And then that part of the market doesn't invest, and those who are behind the technology and vehicle side either, because they see the market hasn't arrived yet, and when will there be fewer risks. Then we don't get the green shift fast enough that we really need.”*

With respect to this point, a parallel with the energy sector can be drawn. Those who worked with traditional fossil fuels were exceptionally critical when technology for renewable energy was introduced. The IEA underestimated continuously the investments and outcomes of these notions. Or the same related to electric cars, in 2021, two out of three new passenger cars are electric cars in Norway (SBB, 2022).

Last but not least, there is an issue on a political level, that is related to *willingness and readiness to support and implement autonomous public transport* in the future. This element is essential because policies and programs adopted by the governance have a big impact on how APT will develop in the future. Incentives for more environmentally friendly transportation can be provided by the governance, and it also has the power to ban private vehicles from the roads by implementing regulations. Both private and public actors agreed on this point. An informant I from the private sector explained: *“The technology is actually mature enough, but the industry is conservative, and the authorities are conservative.”* And a public actor M claimed: *“I understand that there is no political will to move forward faster in development to take out the operator. We have done this in closed areas, but not in open traffic. The Department of Transport is very careful, they do not give clear signals about what applies and what needs to be done. We have been trying for 6 months now but have not progressed, it is not easy. There is little political will.”*

Another barrier is the *tension between public transport companies and state politicians regarding their priorities*. Those who deliver transportation offers to citizens are more interested in having more possible passengers because it creates their revenue. But state politicians prioritize accessibility for different passenger groups, even though this means that buses will operate at a reduced capacity in rural areas. A public actor L gave an example: *“Public Transport Company owned by the County Municipality, so it is the County Municipality that decides what to do or not. There is often conflict between Public Transport Companies and state politicians regarding what is important. For example, for state politicians, it is important to drive in districts even if we get few passengers. But Public Transport Company focuses on driving in urban areas, because there we get better economy, the more passengers, the lower the cost of passengers per kilometer, etc.”*

Additionally, some municipalities in Norway, such as Bodø, offer internships to master students who are technology-optimistic to work with autonomous technology. Experiencing APT results in shaping their future carrier and research and promoting a positive perception of autonomous technology.

5.3.2 User acceptance

To cover this aspect holistically, I used supplementing data from documentary analysis on user acceptance of APT where interviews were conducted with citizens. The reason for this is that in this study the informants are strictly professional actors, and the aspect of user acceptance is unpacked from their point of view. The opinions of actual passengers must be clarified, though. Overall, this aspect seems to be marginalized in the eyes of professional public and private actors.

My informants were asked to reflect on their experiences and assumptions of the current and future that influence passengers' perceptions of APT. The majority of informants do not see user acceptance as a barrier at all. A representative of the public sector (C) stated: *“It's a whip and a carrot (pisk og gulrot). It's very easy with people. If there are cheaper offers, they will use autonomous transport. On the other hand, it will become more expensive to drive a car. I believe that those who deliver the service have more responsibility for good communication with users, and trust is then created.”* A private actor (A) pointed out: *“What is repeated is that the elderly and the young experience self-driving transport very well. Whereas those who fall in the category between these two are quite negative. If the public transport system improves, it is positive for the residents. As long as the most critical questions regarding bus drivers and safety are answered, self-driving transport is better embraced.”* In addition,

another public informant (D) stated: *“There won't be any particular issue. I think that for the users it will not play any role whether there is a driver on board or not. It must be safe and predictable. The users would be very happy if we can use fewer roads and offer faster roads, a much larger and more flexible offer. In other words, all the things that users want, and this is possible, and much more possible with autonomy than with today's technology. We are also becoming more digital worldwide.”*

On the other hand, one of the central barriers according to the finding is the *culture of private car driving*. In modern society, a car is a synonym for independence and freedom. A privately owned car opens access to having a job, additional income, and flexibility. Moreover, cars give us privacy and even the pleasure of experiencing driving. People still want to be able to drive and use private vehicles, which means that cities still require infrastructure geared toward individual vehicles before collective transportation. This creates barriers for the transition to autonomous technology. In the case of Norway, the figures are significant because 83% of all registered vehicles are privately owned automobiles. Regarding this, informant A from a private company reflected: *“The biggest challenge is the culture of private cars. A private car is a synonym for freedom. To solve this, we have to create such a good offer so that the private car is not experienced as a loss. I believe that people must change their behavior and culture if they are to have good alternatives to the private car. But if you don't get good alternatives, people will continue to drive private cars. We can achieve this by implementing good ordering solutions.”*

Finally, one of the barriers to the acceptance of APT is related to human behavior. *People are afraid of technology* by their nature.

On this issue an informant I from a private company reflected *“Every normal human being is afraid of autonomous vehicles. Nobody trusts technology 100%. Everyone thinks they are the best drivers. “Slow and not reliable”, they think. I think people need to sit there and try to see that it works quite fine.”*

Based on my own experience of working with autonomous busses in Bodø, people seemed to be curious and to new technology and thought that it was interesting and important to test them. Some people read articles about new technology in the transportation sector, but most

of them do not have any particular opinion about it. Based on an analysis of citizens' perception of APT the main issues are related to knowledge and safety.

6. Analysis and discussion

The most of previous research addresses barriers related to safety and technology (Straub & Schaefer, 2019; Tan & Taeihagh, 2021), user acceptance (Nastjuk et al., 2020; Yuen, et al., 2022), and infrastructure (Lengyel et al., 2020, Liu et al., 2019), however, there is still a call to explore governance aspect, that is a challenge in itself, because the technology is not established yet, and the current knowledge is based on experiments. That is why the idea of the thesis is to investigate the challenges and opportunities of governance of APT. The future orientation of this topic serves as a background for creating new knowledge about barriers and uncertainties of the implementation of APT from the institutional perspective. In particular, the research question is: *How governance of autonomous transport may be implemented in practice?* Utilizing institutional theory, namely three pillars of institutions (Scott, 2008), three main topics for analysis are framed. These topics are regulative, normative, and cultural-cognitive that integrate the main elements of governance aspects of the future institution.

Empirically, I conducted a case study of Smartere Transport Bodø project and the interviewed network of people both nationally and internationally. It gave me the possibility to reflect on the phenomena of APT more holistically. Further, I analyze and link to the research question the empirical findings from self-ethnography, documentary analysis, and qualitative interviews with 16 professionals.

The findings illustrate that there are multiple ways we need to address the governance of APT in practice. My analysis consists of revealing three different essential elements of institutions to consider and categorizes them as barriers to regulations, barriers to professionalization, and barriers to social acceptance of APT. Regarding these aspects, the literature has addressed the issues of the regulations gap (Lund-Tønnesen, 2022), professional risks of losing driving skills and jobs in the transportation sector (Anderson et al., 2014; Taiebat et al., 2018), and not least, the behavioral factors of passengers as a key to technological transition (Paulsson & Hedegaard Sørensen, 2020).

The findings reflect both the current state, barriers, and uncertainties related to the implementation of APT. The discussion is divided into three sub-chapters and organized as unpacking the main points from the analytical model from chapter 3 in this research.

6.1 Regulative pillar: policy-related barriers

The regulative pillar unpacks the policy-related barriers to the formation of a future institution. My findings illustrate not only the state of the art of current regulations but also assumptions and uncertainties for the future. What I found out is that the main barriers to regulations are related to *policy design, safety, and interpretation*. In particular, there are several *different flaws and tensions in regulations, as well as uncertainties related to prioritizing strategies, understanding, and management*.

Previous literature indicates that the regulations are an important element (Aoyama & Alvarez Leon, 2021), however, it is also essential to unpack the details and understand in what way the regulations are an issue from the practical perspective. Many researchers recognize different problems of regulations related to the governance of APT, such as policy-related issues (Straub & Schaefer, 2019), safety (Maldonado Silveira Alonso Munhoz et al., 2020; Giffinger, 2010), privacy (Tan & Taeihagh, 2021; Lee & Hess, 2022), data related issues and emerging of prosumers (Marsden & Reardon, 2018), insufficient regulation design (Lund-Tønnesen, 2022; Abbot, 2012), economy (Scurt et al., 2021), and political will (Mordue et al., 2020).

The thesis findings are in line with this previous literature. However besides serving as a confirmation, my empirical data provides a deep analysis of those challenges in practice. The literature shows the regulation of autonomous transport is a barrier to its future implementation (Lund-Tønnesen, 2022). My study discloses the previous literature on a deeper level in the form of concrete practical matters such as tensions and uncertainties of regulations.

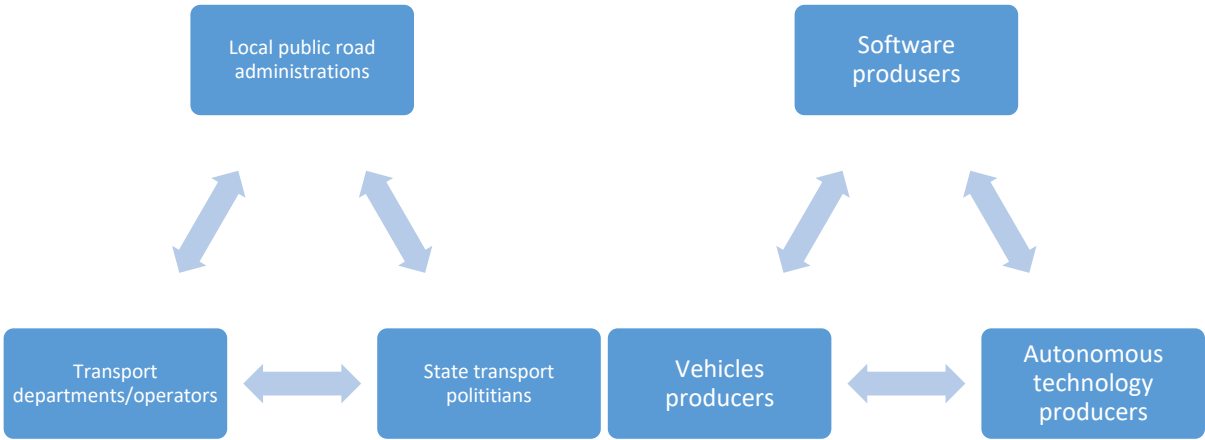
My findings are in line with several points from the literature such as the gap between regulatory and technological development (Lund-Tønnesen, 2022). Besides, I provide several practical examples of this. Surprisingly, my findings show that there are unrealistic expectations regarding how fast the technology will advance, therefore the regulations are not updated appropriately. In fact, the regulations restrict technological development, rather than technology is not ready for loosening the restrictions. Because the more pilots are conducted, the better technology will be advanced.

According to the literature, almost all of the projects related to APT involve at least one public actor (Ainsalu et al., 2018). Generally, my empirical findings are in line with these statements, but also highlight the importance and even necessity of interdisciplinary

collaboration when working with APT. It is important to note that there are different perspectives on regulations depending on who expresses their opinion, whether it is the public or private sector. In addition, even how different the public sector and the private sector is within city level, more detailed see Figure 3 and Figure 4. This creates a barrier to policymaking itself because the priorities of different actors may not be in line. In practice, it manifested as the tensions between public and private interpretation of regulations.

Figure 3. Actors of the public sector

Figure 4. Actors of the private sectors



Furthermore, my findings are in line with the fact that financing is an important factor, and in fact an issue for the future implementation of APT (Anderson et al., 2014). The literature suggests that economic barriers, such as the cost and economic impact of APT implementation, must be addressed. For example, 5G technology is still not widely available and is prohibitively expensive. Or the autonomous vehicles’ hardware is costly and requires skilled workers to maintain (Scurt et al., 2021). What I found out is that there is a link between funding sources and their influence on regulations. Practically, I found a need to involve external financing in projects that are further connected to internal factors such as political will and prioritizing.

In terms of uncertainties related to the safety and prioritizing strategies, practically, I found out that there are several tensions between experimenting and safety regulations, past-oriented regulations and future-oriented business models, and technology focus and citizens focus regulations. These aspects are in line with the findings of Straub & Schaefer (2019), Abbot

(2012), and Ruhlandt (2018), however, there are some additional uncertainties related to how the inner complexity of regulations will keep up with the connection of several systems and how they will be used by private actors.

Finally, on the aspect of interpretation and management, Lewallen (2020) expressed that the regulators and regulated entities of APT lack clarity when linking new technology to current regulations and laws. The empirical finding of this study is generally in line with these findings. Moreover, the finding revealed practical issues in regulation administration and how it is related to enabling and constraining factors, as well as flexibility. In practice, it means that it is difficult to track how regulations are created, how and by whom they are managed, and not least how to apply them.

6.2 Normative pillar: barriers for public and private actors

The normative aspect is related to the professional environment of APT. Generally, these actors are public and private actors involved in the projects of APT, in particular: bus manufacturers, the cars industry, technology producers, transport service departments on a regional level, public road administrations, and bus drivers.

There is little qualitative research that reflects on this aspect holistically. It seems that the previous research has more focus on the professionalization of drivers, arguing that the loss of driving skills is experienced as fear, hence a barrier for APT (Anderson et al., 2014; Taiebat et al., 2018).

My findings link professionalization in a broader sense to various actors, including bus drivers, and create meaning for professionals on different levels and sectors. In particular, there is a link between the development of other hardware manufacturers and the development of autonomous technology. In practice, bus manufacturers are lagging behind in professionalization since the incentives from municipalities are insufficient. In addition, current economic incentives (cheap buses) focus makes car manufacturers limit the professionalization of the field.

The previous literature identified that the new technology is indeed a disruption for the public sector (Abbot, 2012), and that the governance of the transportation sector must change Marsden & Reardon, (2018), which are basically in line with the empirics of this study. Though, in addition to it, my research went deeper and showed the practical issues of

transport service departments on a regional level. I found several contracts and competence-related challenges for the professionals. In terms of contracts, the time and geographical dimensions of transport contracts are challenging for adding autonomous technology. Because the current regulations are based on long-term contracts with fixed geographical zones. However, APT requires more flexibility both in terms of time and geography.

Regarding competence challenges, my finding is in line with the literature regarding the professionalization of bus drivers could be a problem (Anderson et al., 2014; Taiebat et al., (2018). Moreover, my study showed that the professionalization change of bus drivers is a principal domain linking APT to social sustainability, because of the existing gap of lacking professionals in this area.

Furthermore, in my empirical findings, I broaden the issue of competence to several actors and found that practically there is a demand for future-oriented professionals, which creates tensions with currently established manpower. Additionally, there is a tension between openness and reluctance for competence exchange.

Surprisingly, I discovered in my study that the challenges of local public administrations represent bureaucratic documentation approval processes for APT. My findings highlight specific barriers such as silo-based focused thinking, a lack of competence and resources to process experiments, and, last but not least, a narrow focus on private cars and their future as a basis for future strategies. There is a particular problem with bureaucratic thinking and a lack of openness to joint competence.

6.3 Cultural-cognitive pillar: barriers of professional and user acceptance

The cultural-cognitive aspect of institutions reflects the perceptions of society as “taken for granted” services (Scott, 2013). In the context of this study, the social actors are professionals and passengers.

First, the professional acceptance of autonomous technology is important, especially for public actors, as they have a lot of power of influence on the implementation of APT. The empirical findings of this study identified a need for more political will to support APT, which is in line with the previous research by (Mordue et al., 2020). Furthermore, I found that public actors are quite skeptical towards autonomous technology and showed unwillingness to accept changes in their established working routines.

Unlike the two previous aspects of institutions, there is much qualitative research and documents that studied the social acceptance of APT. Several studies pointed out that APT is a concern of social acceptance to a greater extent than technological (Marsden & Reardon, 2018; Pigeon et al., 2021). According to Camps-Aragó, et al. (2022), the main barrier to the adoption of autonomous shuttles is citizen acceptance.

Surprisingly, if the literature was arguing that citizen acceptance is the main barrier, my findings showed that there is much more complexity regarding this aspect. User acceptance could be a barrier, according to previous research Camps-Aragó, et al. (2022) and Marsden & Reardon (2018), but in my case, I learned that there are much more issues of public practitioners from the different fields of the public sector (see Figure 3), rather than the issue of citizen acceptance.

Furthermore, according to my findings, the main barrier to the implementation of APT is related to the culture around driving private cars. There is uncertainty related to knowledge and safety, as well as behavioral factors because human beings are afraid of technology. Generally, user acceptance may not be an issue in the future.

On the other hand, in the empirical finding of this study, the aspect of user acceptance seems to be marginalized. Both data from qualitative interviews and documentary analyses indicate that it does not serve as an issue for the future implementation of APT. In addition, people seem to be much more positive about technology after experiencing it. A significant number of pilot projects received positive feedback, and participants were reported to be more open to the technology as a result (Mahmoodi Nesheli et al., 2021).

However, it seems challenging to understand this issue from a practical perspective. For example, in Norway, the main focus is on the regulative aspect of APT. And the cultural-cognitive aspect seems to be “taken for granted” and easy to cope with. Overall, the regulative and normative aspects were much more emphasized in practice, compared to the cultural-cognitive.

To sum up, it seems that the previous literature has not been devoted much to the aspects of governance as an institution (Scott, 2008). I discovered the complexity, in particular, that the three institutional elements seem to be interconnected, but have their own pace of development. The conducted study shows that depending on the context of the subject, the three pillars of the institution are not aligned in their understanding of what is important for

the formation of future institutions. On the table below, I sum up the main finding of this study (Table 2).

Table 2. The main finding of the study

Regulative	Normative	Socio-Cognitive
<p>Policy design: There are different flows of regulation as barriers and uncertainty for APT future.</p> <p>Risk and safety: Future-focused business models or “business-as-usual” secure regulations.</p> <p>Interpretation and management: Regulation is not a problem in itself, but an issue of how it is interpreted and administrated.</p>	<p>Private sector:</p> <p>Development of the other technology producers</p> <p>Insufficient project management</p> <p>Lack of incentives from the public sector, both in the form of demand for innovation and funding</p> <p>Public sector: Conservatism of the industry.</p> <p>Lack of competence.</p> <p>Irrelevance of existing contracts with operators for autonomous public transport.</p> <p>Silo-based thinking.</p> <p>Bureaucratism.</p>	<p>Political level: Political will and readiness to support autonomous public transport.</p> <p>Professional group: Skepticism toward new technology.</p> <p>Unwillingness to accept new working routines.</p> <p>Passengers: Private car driving culture.</p> <p>User acceptance uncertainty related to knowledge and safety.</p> <p>Fear of technology.</p>

Firstly, the central barriers of regulations related to *policy design, risk and safety, and interpretations*. Those are manifested as the different flaws of regulation, tensions between safe and sound regulations and future-oriented business models, and inconsistencies between public and private interpretations. Overall, the regulations were of a bigger concern for private actors, rather than for the public sector.

On the normative side, this thesis concludes that the main barriers to professionalization are different for the public and private sectors. For the private actors, this is more a concern of the

development of the other technology producers, the project management, and the lack of incentives from the public sector, both in the form of demand for innovation and funding. For the public actors, such as public transport departments and local public road administrations, the barriers to APT penetration are related to the conservatism of the industry, lack of competence, and irrelevance of existing contracts with operators to autonomous public transport. Furthermore, on a deeper level, it is an issue of silo-based thinking and bureaucratism.

Finally, the social aspect seems to be more controversial compared to the regulative and professional one. This aspect has inner complexity in the form of several lairs of actors whose perception of APT influences its future implementation. There are three groups of social actors in the frames of this study: political, professional, and passengers. Even though this study reports several barriers to user acceptance, this aspect was marginalized and even taken for granted by the majority of participants. On the political level, this thesis concludes that political will and readiness to support APT is an important element that plays a crucial role in the future of APT. From the professional perspective, the unwillingness to change usual working routines and skepticism towards new autonomous driving are the main barriers. The main barriers to the passenger's acceptance of APT are the *culture of private car driving*, followed by *uncertainty related to knowledge and safety*, and *humans' fear of technology*.

7. Conclusion

The goal of this study was to understand APT governance and how it would be in practice. The particular emphasis in this study is on the barriers and consequences for the various actors involved, as well as the acceptance of the society. Furthermore, the topic's future orientation served as a backdrop for several uncertainties related to the implementation of APT. The research question was: *How governance of autonomous transport may be implemented in practice?*

I found out that, in the Norwegian context, there is a bigger focus on the regulative side of the implementation of APT rather than the social. Overall, the understanding of the future institution will be different depending on who is asked whether it is a private or a public actor. And even inside the sector, there are several variations that should be considered (see Figure 4 and Figure 5 in the previous chapter).

This thesis concludes that regulative, normative, and social dimensions (Scott, 2008), are important for understanding how APT can be implemented in the future. In particular, I found

several barriers and uncertainties that help to understand this issue in practice. Furthermore, this kind of study requires multidisciplinary and multisectoral investigation, which is complex in itself. In relation to the research question, it means the future institution should focus more on single actors and their interrelations regarding professionalization. As APT is technology-driven innovation that demands cross-organizational, cross-sectoral, and even international collaboration.

The governance of APT is characterized by inner complexity and combinations of several aspects of an institution. The central barriers of regulations related to *policy design, risk and safety*, and *interpretations*. On the normative side, this thesis concludes that the main barriers to professionalization are different for the public and private sectors. For the private actors, this is more a concern of the *development of the other technology producers*, the *project management*, and the *lack of incentives from the public sector*. Whereas, for the public actors, the barriers are related to the *conservatism of the industry*, *lack of competence*, and *irrelevance of existing contracts with operators to autonomous public transport*. Furthermore, on a deeper level, it is an issue of *silo-based thinking* and *bureaucratism*. Finally, the social aspect addresses several layers of actors whose perception of APT influences its future implementation. Those are concerns of political will, overcoming professional conservatism of industry, and moving away from the culture of driving private cars by the passengers.

By this means, with these findings my thesis has several important contributions to literature and to practice. Firstly, when it comes to literature, the main contributions relate to APT and its challenges from a governance perspective (Aoyama & Alvarez Leon, 2021; Marsden & Reardon, 2018; Lund-Tønnesen, 2022; Straub & Schaefer, 2019; Ruhlandt, 2018; Scurt et al., 2021; Seuwou et al., 2020;). In particular, I revealed different tensions of complexities on how the governance mechanism can function in practice, based on the three pillars of institutions (Scott, 2008). In one way, my study serves as a bridge between research and practice. Secondly, I bring new knowledge about Norway and the development of Norwegian public transport development. Moreover, my contribution is to pay more critical concern to different tensions that are important to consider when implementing APT and addressing sustainability through autonomous technology (Giffinger, 2010; Flügge, 2017; Campisi, et al., 2021).

Last but not least, I also have an important practical insight for practitioners and policymakers, specifically when developing APT systems and also developing guidelines for cities. It is important to address several aspects:

Firstly, the *interpretation of regulations by different sectors*. An example from the findings showed that some of the private actors had difficulties understanding what should be done in order to comply with regulations and receive approvals for their project, whereas the voices of public actors reflected that the regulations have broad frames and facilitate well for the project of APT. Therefore, there is a need for more dialogue between public and private actors related to the APT.

Secondly, the *significance of time and geographical dimensions when integrating APT* in usual long-term public transport contracts. Since the technology is developing rapidly and requires more flexibility, the existing way of contracting characterized by permanent contracts and locked geographical zones may not be as efficient for ATP as for ordinary public transport with human drivers.

Finally, the *demand for competence and complexity and how it is distributed around actors*. This point reflects the importance to consider that the competence circulates unevenly around the actors related to APT. The findings showed that private actors are used to having more competence and understanding of complex autonomous technology, whereas the public traditional organizations are characterized as having a lack of expertise and resources to handle APT. Moreover, multisectoral local cooperation is required for APT to succeed.

This research has several limitations that also serve as an opening for further research. Firstly, this thesis is narrowed to a single case study where the main qualitative data is highly contextual in these frames. Since there is no functioning institution that governs APT, this study is limited to operating the data received from experiments. Future research needs more empirical examples to make this kind of investigation. Secondly, there is a limitation regarding the theory use, this research is limited because I applied only one theory of three pillars of institutions. Future research may consider utilizing several theories to investigate the governance of APT. Overall, my suggestion for future research is to put more emphasis on the complexity of different actors involved in the governance of APT within the context of smart cities. Furthermore, in this field technology is developing rapidly, so this kind of study can be repeated after a couple of years, however with consideration of the mentioned adjustments.

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Appendix

Appendix 1. Interview guide

Section	Questions
Introduction	<ol style="list-style-type: none">1. Do you consent to being recorded in this interview?2. What is your relationship to autonomous public transport, and how long have you been working with it?
Regulation and governing	<ol style="list-style-type: none">3. How do you perceive the current state of regulations of autonomous public transport?4. How the governance of autonomous public transport will look like?5. What will be the scenario for regulations and how it will play out as a building block in the future institution that governs autonomous vehicles?
Professional area	<ol style="list-style-type: none">6. How do you perceive the consequences of autonomous public transport for different professionals?7. What will be the scenario of professionalization?8. In what way will autonomous public transport affect both public and private sectors?<ul style="list-style-type: none">• How these changes could be implemented in the future institution that governs autonomous public transport?
Humans' perception	<ol style="list-style-type: none">9. How do citizens and professionals perceive autonomous public transport?10. What will be the scenario for user acceptance in the future?11. In what way the future institution could be framed by people's attitude to the new technology?
Concluding	<ol style="list-style-type: none">12. Do you want to add something regarding my research question?

Appendix 2 Informants

Informant	Title	Organization/ project	Sector	Form	Date
A	Chief Growth Officer (CGO)	AA	Private	Digital	09.03.2023
B	Project Manager	SINTEF	Private	Digital	15.03.2023
C	Project Manager	NFK	Public	Physical	15.03.2023
D	Head of mobility services	Skyss	Public	Digital	17.03.2023
E	CEO	AA	Private	Physical	22.03.2023
F	Head of International Sales and Business Development	Ioki	Private	Physical	22.03.2023
J	Marketing Manager France	Bolt	Private	Physical	22.03.2023
H	VP Global Sales Manager spec. Transportation, Logistic and New Mobility	DEKRA	Private	Physical	22.03.2023
I	Team Lead Autonomous Mobility	P3	Private	Physical	23.03.2023
J	Project Manager	EasyMile	Private	Physical	23.03.2023
K	Head of Strategy and Development	Kolumbus	Public	Digital	27.03.2023
L	Project Manager - Autonomous buses	Kolumbus	Public	Digital	27.03.2023
M	Business Manager	Kongsberg Municipality	Public	Digital	29.03.2023
N	Project Manager and Strategic Logistics Planner	Brakar	Public	Digital	31.03.2023
O	Bus driver	Nordland Buss	Private	Physical	26.04.2023
P	Business Developer	Mobility Forus	Private	Digital	02.05.2023