MSc Thesis

Master in Environmental and Energy Management

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INTEGRATION OF AUTONOMOUS MOBILITY COMMERCE INTO THE CURRENT DUTCH INFRASTRUCTURE

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Abstract

Autonomous Mobility Commerce (AMC) entails mobile stores that can travel to consumers' homes without requiring manpower and can transform any parking lot into a possible 24-hour retail space. This study evaluates the potential of current Dutch infrastructure to accommodate autonomous mobility commerce. The research employs an inductive methodological technique to gather comprehensive information and perspectives based on literature research and participant interviews. Interview respondents from the Dutch town of Grou were overall optimistic about the concept of using AVs as transit lines to public transport, and to deliver purchases to the doorstep of customers, though some respondents stated their concerns regarding the safety of AMCs. Research establishes that the reasons for anxiety and perceived risks by some respondents surrounding AMC include fears about possible vulnerabilities, a lack of understanding of how AMC systems works, and concerns about unforeseen consequences like accidents. People perceive the benefits of using AMC to be that it may transform mobility purposes to reduce the number of accidents and injuries caused by traffic accidents, and can help with improving traffic flow to make travel more effective. However, the respondents also displayed idealized anticipations about the technological prowess of autonomous vehicles and most of them displayed a biased vision toward 2030. Overall, this thesis contributes knowledge on some of the factors which influence the social acceptance of AMCs in a specific population in the Netherlands and highlights some of the levers and barriers to the broader emergence of AMCs.

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Acronyms

AI	Artificial Intelligence
ADS	Automated Driving System
AMC	Autonomous Mobility Commerce
AMoD	Autonomous Motorized Driving
AV	Autonomous Vehicle
AVRI	Autonomous Vehicle Readiness Index
GPSD	General Product Safety Directive
ICT	Information and Communication Technologies
IoT	Internet of Things
KPMG	Klynveld Peat Marwick Goerdeler
MSR	Market Surveillance Regulation
MoD	Mobility-on-Demand
RDW	Netherlands Vehicle Authority
USDOT	US Department of Transportation

1. Introduction

1.1 Background

The way we get about has been profoundly altered by advances in communication and autonomous technology, and this is no exception when it comes to transportation. New technology is expected to turn the present transportation system into an autonomous one, regardless of the road conditions or surroundings (SAE International, 2018). Atkins provided a brief definition of Autonomous vehicle (AV) as “a car that can complete the operational service of a traditional car (e.g., driving, lane-change, parking, etc.) without the aid of a human operator” (Atkins, 2016, p 11). AV is the vehicle's capacity for information gathering and knowledge extraction from sensor data, and is essential for creating contextual awareness of the surroundings (Yang et al., 2021). Autonomous vehicle (AV) technology has emerged by advances in communication and robotics, as a result these technologies seek to minimize traffic congestion and emissions while also reducing the number of collisions, energy consumption, and pollution (Bagloee et al., 2016a). Rapid globalization depends on mobility, hence infrastructure development to meet the demands of AV technology is escalating at a fast pace (Tan & Leon-Garcia, 2018).

People's acceptance of autonomous technology may be lower than market expectations, but the reasons that influence this impression are still more psychological than technological in nature (Nastjuk et al., 2020). In addition, the introduction of autonomous vehicles varies greatly from country to country and is significantly impacted by socio-demographic aspects such as age, gender, and education level.

The concept of autonomous vehicles has been around for a long time, but the high cost of mass manufacturing and the necessary technology for implementation has prevented its widespread use. But in the past decade, research and development efforts to bring the AV to completion have accelerated. AVs have become advanced for a crucial business paradigm because of the fast growth of communication technology. However, researchers have expressed concern about the fast transformation of transportation in light of emerging new concepts and technology like social networks and smartphones (Gschwendtner et al., 2021).

1.2 Research Problem

The population of the Netherlands is expected to rise from 17.1 million to 21.6 million by 2050, resulting in a shortage of parking spots, traffic congestion, and environmental pollution in metropolitan areas (Pavone et al., 2012). AVs are being considered a solution to these problems. However, concerns around security, trust, privacy, and dependability must be addressed in the acceptance of autonomous vehicles by society. Adoption of autonomous vehicles are influenced by psychological considerations where lack of subjective knowledge, anxiety and perceived risk heavily affect the acceptance of autonomous vehicles.

Legal aspects are also involved with the circulation of autonomous vehicles, for example, policy review and rules based on General Data Protection Regulation (GDPR) (Altunyadiz, 2020). In addition to lane markers like stop signs, certain highways and streets still lack markings, making the move to fully autonomous vehicles more challenging (Alexandria Sage, 2016). Safety rules for items supplied to consumers are the primary focus of the General Product Safety Directive (GPSD), which incorporates processes and technical standards (Chatzipanagiotis & Leloudas, n.d.). Sector-specific Market Surveillance Regulation (MSR) for autonomous vehicles is the subject of EU legislation, where manufacturers must identify risk, product possession and whereby necessary technical and general information should be made publicly available and transparent with authorities (Data Sharing Framework, 2019). In order to avoid putting autonomous vehicles on Dutch roads and endangering passengers, it is necessary to conduct safety tests, traffic analysis simulations, and trials before introducing them to the public (Bridgelall & Stubbing, 2021).

The Netherlands came in second place overall for the transition to an autonomous system and third in terms of policy and legislation under the evaluation of the organization Klynveld Peat Marwick Goerdeler (KPMG)'s Autonomous Vehicle Readiness Index (AVRI)[1] (International, 2020). AV may be used to deliver items to customers who would otherwise have to travel a long distance to obtain them. Autonomous Mobility Commerce (AMC) is the name given to this service (See section 2.1 for a description). AMC are retail stores on wheels that can travel

[1] The Autonomous Vehicles Readiness Index (AVRI) is a tool to help measure the level of preparedness for autonomous vehicles across 30 countries and jurisdictions. The factors include safety, privacy, digital infrastructure, impact on transport systems, and cross-border travel. https://assets.kpmg/content/dam/kpmg/xx/pdf/2020/07/2020-autonomous-vehicles-readiness-index.pdf

to a shopper's doorstep without needing manpower, and can transform any parking lot into a potential 24-hour retail space (erply, 2017). People who live at least 10 kms from a store's sales area are most likely to utilize this service. As part of this research, a village named Grou in the province of Friesland under the municipality of Leeuwarden was chosen because of its target population and their need to utilize AMC to reduce their travel time and usage of vehicles (CBS, 2020).

1.3 Research Objective

According to a worldwide study, the Netherlands is in the best position from a technical systems perspective to deploy autonomous vehicles. The Netherland's leading position is a result of its well-maintained road network, high-quality digital infrastructure, and federal regulation that supports large-scale testing of autonomous vehicles (Gkartzonikas & Gkritza, 2019). However, the social dimension remains problematic. People's adoption of autonomous technology is still heavily influenced by psychological considerations rather than technical ones, despite the fact that social acceptance of AV technologies is lower than commercial expectations. The following are the main objectives of this research:

- Assess the social acceptance of autonomous mobility commerce into the present Dutch infrastructure.
- Develop insight into the extent to which subjective knowledge, anxiety, perceived risk, and benefits influence AV acceptance in society.

This study's research follows a qualitative approach, through which social acceptance of people are evaluated in the integration of autonomous mobility commerce into Dutch infrastructure. Therefore, the following main research question will be addressed:

- *Which policy measures promote the social acceptance of AMCs in the Netherlands?*

To be able to address the main research question, the following sub-question was formulated?

- *Which behavioral factors, attitudes and perceptions influence people's willingness to adopt AMCs in the Netherlands?*

1.4 Thesis Outline

This thesis follows an IMRaD-inspired outline: the first chapter is the introduction, which includes the empirical background, research problem, research objectives, and research questions. The second chapter presents the theoretical background, which starts the empirical background, and continues with the identification of key features related to autonomous technology and, more specifically, the applicability of AMCs. The third methodology chapter presents the research design, ethical considerations, and the overall data gathering process. In the fourth chapter, an analysis of the gathered results is conducted. Chapter five discusses the results of the data analyzed. In the last conclusion chapter, the research questions are answered, and practical recommendations and further research recommendations based on the findings of this thesis are given.

2. Definitions and Literature Review

2.1 Autonomous Mobility Commerce (AMC)

The term Autonomous Mobility Commerce (AMC) can be understood as stores-on-wheels that can travel to a shopper's doorstep without needing manpower, and can transform any parking lot into a potential 24-hour retail space. The AMC is equipped with a computer and sensors to gather data about the road ahead (Geonovum, n.d.). AMC's present commercial possibilities due to the wide range of uses it possesses. Major technology giants and e-commerce companies such as Amazon Go, Nike's speed shop and Hema's QR codes have ventured into convenience goods, fashion retail and so on (Rahul, 2021). The technology behind AMCs has existed for a decade, with a startup based in San Francisco manufacturing "The Robomart Vehicle," which was introduced as a temperature-controlled AV, which contained a variety of fresh produce, where shoppers could access the products digitally and purchase from robomart and charge them automatically while emailing them the receipts (Ben, 2019).

An autonomous driving system might revolutionize urban and extra-urban transportation systems and change the everyday lives of individuals who need to travel substantial distances to purchase commodities (Othman, 2021). Artificial Intelligence (AI) in automobiles has advanced the development of autonomous driving technologies during the last decade. Vehicles are becoming more "intelligent" as AI is integrated into their driving systems, allowing them to park themselves, adjust their speed or direction of travel, and anticipate and respond to potential hazards as they drive (Manivasakan et al., 2021).

According to the provisions, completely automated vehicles would need new perception making, mapping, and decision-making functions, or an autonomous driving intelligence (ADI). When considering architectural instances for these functions, Rama Mohan(2016) looks into how ADIs interface with existing platforms. The scenarios vary from a driverless car with a robot in place of the human, fully reusing the current vehicle components, to a completely new design evaluating these situations from the angles of business, safety, reliability, verification, and implementation with an emphasis on heavy commercial vehicles.

According to their study, even though complete platform reuse for vehicles is desirable, doing so would necessitate explicitly addressing the unintentional complexity of the older systems, which include giving the autonomous driving intelligence matching diagnostics and error management (Rama Mohan, 2016).

According to research conducted by Kirschbaum et al.(2015), on AV for commercial vehicles, this type of driving is yet another essential step towards accident-free driving centered on the intelligent interplay of driving aid systems, which would ultimately boost road safety along with economy and efficiency. AVs give more productivity and comfort for drivers in tedious traffic circumstances, and support sustainability of the environment. It will also lessen the stress that drivers experience.

Othman(2021), examines how autonomous cars may affect safety, land use, social norms, the environment and society, the economy, public health, and pandemic preparedness. Shared AVs have the capability to give top-notch service to the general public because they can drastically cut average waiting times and travel costs. However, this could also cause people to make more trips and thus increase transit, which would increase vehicle kilometers traveled, emissions, as well as energy consumption. By cutting parking demand by 80 to 90 percent, AVs have the potential to drastically lessen traffic caused by automobiles looking for parking spaces.

2.1.1 Road Safety

Road safety is a crucial concern for the transition of human drivers to networked and autonomous drivers. Based on data collected by the U.S. Department of Transportation,(USDOT), most automotive accidents are the result of human error (USDOT, n.d.). USDOT information sheets revealed around 80 percent of fatal collisions are related to the poor connection between cars. Autonomous driving with connection may lessen the drivers' stress, and it is projected that AVs will dramatically reduce road accidents linked to human error. However, until today, the commercialization of AVs has been hindered by a major safety issue. The European Commission has revealed the degradation of traffic safety in the mixed mode of non-AVs cars and AVs. It was discovered by (Wang et al, 2016) that many AVs from various manufacturers had been subjected to statistical analysis.

2.1.2 Mobility Benefits

Improvement in mobility is the outcome of the Connected and Autonomous Vehicles (CAV) and this improvement leads to a decrease in traffic congestion and pollution. The presence of AVs on the road seems to improve the mobility of the elderly and handicapped. Passengers' propensity for ride-sharing will rise as CAVs are put into service, and this trend seems to be both practical and profitable. Bennett et al. (2018), examined users with impairments in the adoption of this new technology, whereby the authors show through questionnaires and surveys that two-thirds of them had unfavorable attitudes about the usage of AVs.

There are few existing studies in the area of autonomous mobility commerce, hence this study is addressing an important literature gap in a rapidly emerging field. AMCs have been on the research and development agenda for almost a decade because of high investments and the difficulty in policy regulations, as well as societal applicability.

Figure 1. AMC e-palette concept platforms released by Toyota (Toyota, 2018)

2.2 Connected and Autonomous Vehicles (CAV)

Understanding the distinction between a connected *autonomous* vehicle (CAV) and a connected *automated* vehicle is crucial, with this research oriented around the former. The degree to which human interaction is required is, in most cases, what differentiates automated (or automatic) systems from autonomous ones (Maurer et al., 2016, p 2). A vehicle that is just automated does not possess the same degree of intelligence or autonomy as a car that is fully autonomous. Therefore, the terms “driverless” and “autonomous” are closer to being synonymous with one another, as are “self-driving” and “automated”.

The future envisioning of CAV has undergone various technological implications in the field of transportation and communication where V2X (Vehicle to Everything) refers to the process of exchanging data between vehicles. For example, geostationary dynamic, non-geostationary dynamic, and static data from Internet of Things (IoT) devices and maps may be divided into three categories: V2V (vehicle-to-vehicle) communication in addition to V2X is necessary because of physical barriers of device processing systems, such as non-optimal lighting or decreased range (Viktorović et al., 2019).

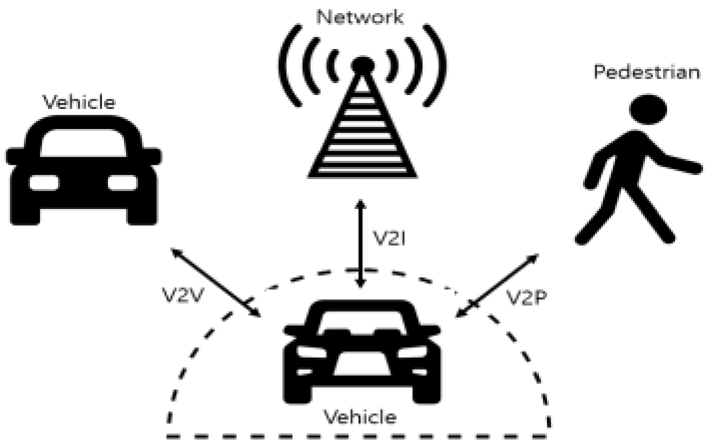

Figure 2. Types of V2X Communications (Kim et al., 2020)

Advanced sensor technologies, on board and off board processing power, GPS and telecommunication network are collectively utilized to achieve communication (Brake, 2021). CAVs are common, as people's transportation will always be a mix of private and public usage. Vehicles designed for public use, will allow passengers to travel as they like without having to worry about driving and incurring the fees associated with owning a private car. A reduction in the value of time (VOT) of autonomous driving to the level of collective transportation is estimated at 30% compared to manual driving (Steck et al., 2017). Due to an uncertainty in traffic reduction, it is vital to take into consideration that those who spend time in their vehicle doing work or other activities would no longer be significant if they did so at home or at work. The issue of congestion on the road would be put on the back burner as a result of vehicle queuing. Nonetheless, this issue is currently of minor importance since it will be several years before the widespread use of CAVs occurs (Yi & Smart, 2021).

Drivers and pedestrians are likely to benefit from CAVs, which are predicted to improve road safety and reduce environmental impact (Anagnostopoulos & Kehagia, 2020). To get to this point, there are still a lot of obstacles to overcome, and it is not without consequences. In addition, there is the risk of not reducing traffic congestion but instead promoting it. Millions and millions of test miles in harsh weather conditions, such as heavy rain, snowfall, and other weather events, are required for self-driving vehicles to properly manage any traffic condition and any uncontrolled actions of other road users, such as automobiles, pedestrians, and bicycles.

In a world where CAVs may interact with other AVs, if detection systems cannot ensure efficient functioning (Reyes-Muñoz & Guerrero-Ibáñez, 2022), or if AVs are not implemented in a realistic way, the time it takes to construct a smart city will increase. Aside from not having defined manufacturing or modeling requirements, the makers and researchers of AVs have little recourse. CAVs will be operating in a smart city, thus it is essential to conduct microsimulation analyses to predict possible fuel consumption and conflicts, taking into account an initial phase in which CAVs would operate alongside traditional vehicles (Campisi et al., 2021). A smart city aims to be more effective, environmentally friendly, and digitally connected, and as a result, more intelligent. A city that is considered "smart" is one that uses resources wisely in an effort to become both economically and energy self-sufficient (Vilathgamuwa et al., 2022). (See section 2.4 for a brief overview on smart cities).

2.3 Safety and Level of Automations

Regulations for the use of autonomous vehicles (AVs) on public roads in the Netherlands have been released by the country's vehicle authority (RDW). The RDW has devised a procedure to ensure their safety of operation via intake, desk research, testing and evaluation to avoid any adversity in the future (RDW Netherlands Vehicle Authority ,2021). Technical experts in the aerospace, automotive, and commercial vehicle sectors have produced recommendations on the capabilities of autonomous cars under the six-class taxonomy of AVs, which are defined by the Society of Automotive Engineers (SAE). Automated cars are automobiles with varying degrees of automation to help or replace human control. SAE has established several degrees of automated functioning, ranging from non-automated features

(Level 0) to complete automation (Level 5), often known as autonomous, self-driving, or driverless cars.

The literature has contradictory uses for the word 'autonomous.' Some state laws, however, have applied the term to highly automated driving systems, i.e., those at or above level 3 (SAE International, 2018). Since the word "automated" may apply to even lower degrees of automation, and since this study focuses on automation levels 4 and 5, the term "autonomous" has been used throughout the thesis to prevent confusion. It is anticipated that autonomous vehicles will drive the next paradigm change in the transportation industry.

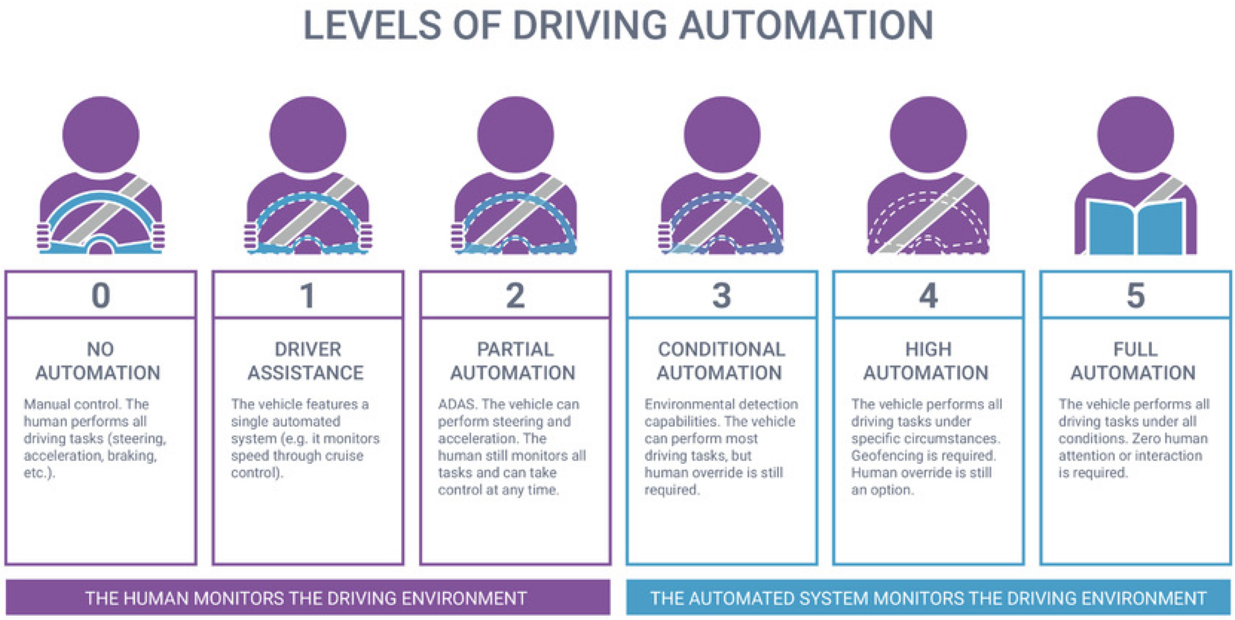

Figure 3. Six Levels of Automation (CEMS, 2021)

2.4 Smart City Integration in the Netherlands

The notion of a "smart city" was born as a result of its technological implementation in cities. A smart city may be defined in a variety of ways, but in general, it refers to an area in which ICT (Information and Communication Technologies) devices have been used to integrate old infrastructures as shown in figure 4. A key aspect of "smart cities" is their ability to automate and regular functions to better serve their residents and serve as a tool for monitoring city infrastructure. Since cities have been exposed to severe urbanization, the notion of a "smart city" has started to gain traction. Because of this, new tools and methodologies are needed that will help enhance transportation, civil infrastructure, or energy and healthcare management systems. Big data and linked gadgets have made previously inaccessible information available to municipalities and they are able to quickly and effectively obtain relevant insights from vast amounts of data, particularly while working under pressure. With the introduction of big data and the Internet of Things (IoT), there are many opportunities to enhance decision-making and, therefore, the quality of life for people (Yi & Smart, 2021).

In addition, because of the range and quality of services provided, a smart city pays close attention to the general well-being of its residents. In a nutshell, a "smart city" is a livable, innovative, and technologically advanced urban area (Bibri & Krogstie, 2020). From economics to urban planning, from energy to transportation, transforming a city into a smart one requires investments and interventions across several disciplines in order to maximize resources and outcomes (Vilathgamuwa et al., 2022). When we talk about a "smart city," we are talking about ways to save energy and lessen pollution, as well as improved transportation systems, digital infrastructures that make it easier for residents to interact with government institutions, and more secure and useful public places. Because of this, the notion of smart mobility is in accordance with the 'green shift' and the smart city (parking, charging networks, cycle paths, electric cars, car-sharing, traffic reduction, creation of intelligent flows, to name a few).

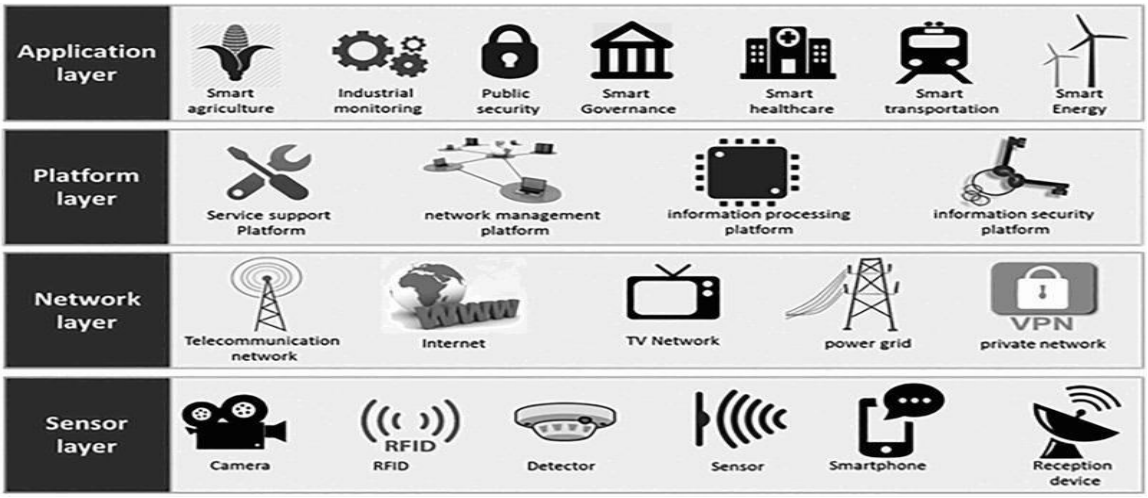

Figure 4. Layers of smart ICT Infrastructure (de Wijs et al., 2016)

2.4.1 Autonomous technology and uncertainty

AV sensor technology, localization theory, and mapping procedures for automation levels one to five were introduced. As a result, the advancement of AV technology will place an emphasis on enhancing safety, driving safety, sustainability, and mobility, while also reducing uncertainty in perception, reducing the cost of perception systems, and ensuring the operational safety of algorithms and sensors (Bagloee et al., 2016 b). However, as technology advances, data security and privacy issues are raised as potential roadblocks. A shared problem-solving approach proposed by automotive manufacturers, equipment manufacturers, data aggregators, and data processors would involve an integrated management framework for AV cyber security (Gavanas,2019). This framework would secure positioning vision, sensing, and network technologies in driverless vehicles. Sensory technologies, location technologies, vehicle networks, and vision technology are all examples of data privacy concerns. However, there are technological and socio-economic problems, such as data consistency, latency control, and high mobility, which must be overcome. Based on the findings from (Gavanas, 2019) Automated Driving System (ADS) to be commercially ready in a decade, the implications of ADS as well as current state-of-the-art variables in this sector were explored. In terms of traffic management, there are various benefits to using ADS, including decreased congestion owing to fewer accidents, improved navigation and more accessibility, fewer cars on the road due to an increase in ride-sharing, and reduced parking space. Users of vehicles will benefit from a less stressful driving experience, fewer accidents, and more efficiency. Low-speed and light-weight shuttle vehicles will be brought to chosen areas, and autonomous cars will be deployed on the highway under technologically feasible circumstances (Ng, 2021).

2.5 Empirical Research

By 2050, it is predicted that more than half of the world's population will be living, commuting, and working in cities. The rapid growth of big cities over the past few decades is another evidence of the speeding up of urbanization (Vilathgamuwa et al., 2022). Because of this, urban people have had to deal with issues relating to pollution and general well-being. More than half of the world's oil consumption and greenhouse gas emissions are attributed to road traffic. According to Sadowski (2021), even worse, as the population of cities and metropolitan regions continues to rise, the average commute distance increases, resulting in additional traffic as a result of the increasing demand for personal transport. Thus, urban dwellers, city government officials, and other relevant urban stakeholders are faced with increasingly serious air pollution, traffic congestion, and parking space shortages (Manders et al., 2020). The above-mentioned issues have prompted major changes in modern transportation systems. When compared to gasoline-powered cars, electric vehicles (EVs) offer increased energy efficiency and zero emissions capabilities (Ke et al., 2017). Transportation electrification is thus considered a viable approach to fight oil reliance and climate change. Second, the existing car ownership model is commonly regarded to be unsustainable for personal mobility in the future because of the high percentage of time that privately-owned cars are left parked. As a new business model for personal mobility, Mobility-on-Demand (MoD) is taking the world by storm with its user-centric, smartphone-based on-demand system (Matyas & Kamargianni, 2019). As stated by the (USDOT), it is a cutting-edge transportation concept that enables customers to dispatch or use shared mobility to get mobility, commodities, and services on demand. AMoD (Autonomous Motorized Driving) is a technology that has the potential to profoundly alter the vehicle industry and how people travel in cities (Manders et al., 2020).

2.6 The Netherland’s Perspective on Autonomous Vehicles

The boost in autonomous cars has the potential to transform not just personal mobility but also how people live and work throughout the globe. KPMG evaluated the market circumstances in twenty countries, including the United States, the United Kingdom, Japan, China, and Germany, as part of an examination of the nations most positioned to capitalize on the autonomous car boom (International, 2020). The following four important impacting elements were examined by the researchers: government policy and regulation; infrastructure quality; the degree to which the new technology is prevalent in the nation; and consumer acceptance of AV technology (International, 2020).

The Netherlands excels in all four pillars of research and has substantial business and public sector participation on the subject. It is already a major user of electric cars and has outstanding infrastructure as illustrated in figure 5 as well as government commitment in policy and legislation to autonomous driving as shown in figure 6 (International, 2020). The other two Benelux nations— Belgium and Luxembourg—lead KPMG's AVRI by a significant margin. It is listed in the top four for each of the four pillars and first for infrastructure, most likely owing to its heavily-traveled and well-maintained road network, which the World Economic Forum and the World Bank consider to be among the most efficient in the world. According to the International Energy Agency's Global EV Outlook, the Netherlands has by far the largest density of electric vehicle charging stations, with 26,789 publicly accessible outlets in 2016 – more than Japan has for a road network over eight times the length (O’Kane, 2018).

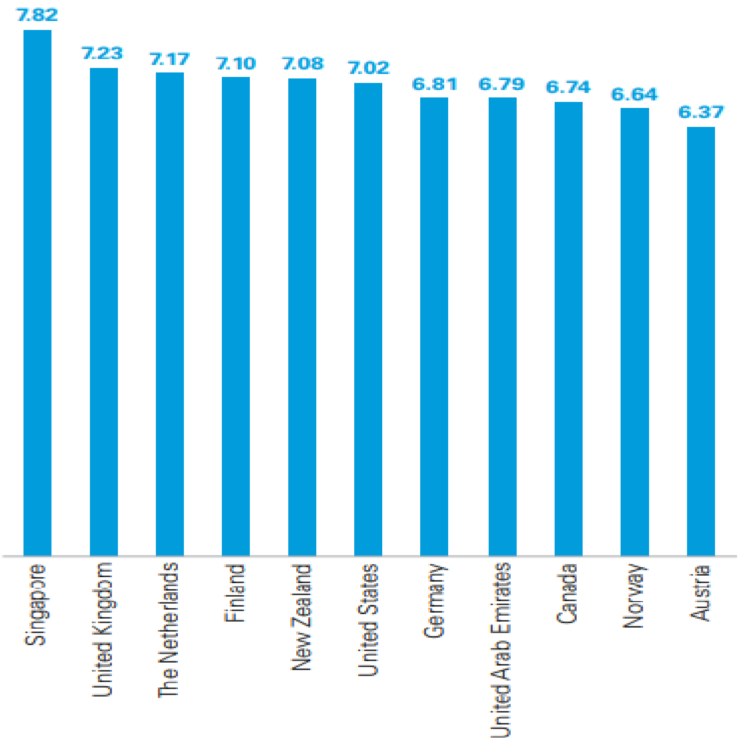

Figure 5. Infrastructural development (International, 2020)

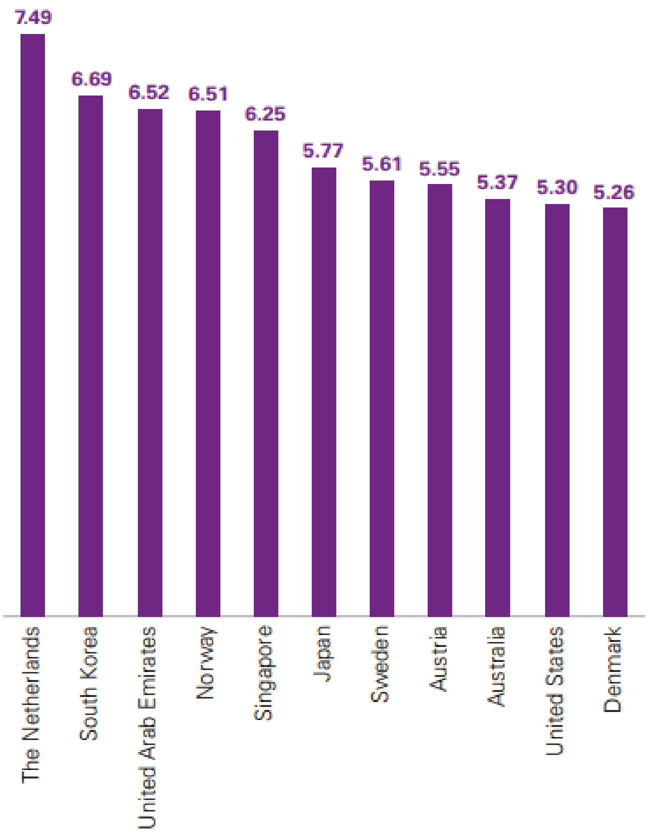

Figure 6. : Policy and Legislation (International, 2020)

In the research's consumer acceptance component, only Singapore ranks higher than the Netherlands as shown by figure 7. The Netherlands achieved the highest possible grade for rules and public investment in AV infrastructure. Its council of ministers allowed AV testing in 2015 and took the lead in the field by signing the declaration of Amsterdam, in which EU member states pledged to expedite the development of autonomous cars. In addition, the government passed a measure allowing driverless AV experiments in February 2017 (O'Kane, 2018). In addition, the Dutch government is spending €90 million to upgrade more than 1,000 traffic signals around the nation so that they can interact with cars and is supporting a proposal to have autonomous trucks operating between Rotterdam and other cities. As per the International Energy Agency, the country has the highest rate of electric vehicle use among the 20 countries in the index, at 6.39 percent - more than twice the percentage of Sweden, which is in second place. Although the Netherlands scored badly on patents and investments linked to autonomous vehicles, there has been a recent increase in public-private collaborations that are speeding the development of automotive knowledge and innovative capability. Instances include the automotive high tech campus in the Eindhoven region and the affiliated TU Eindhoven university, which includes a department specializing in smart mobility.

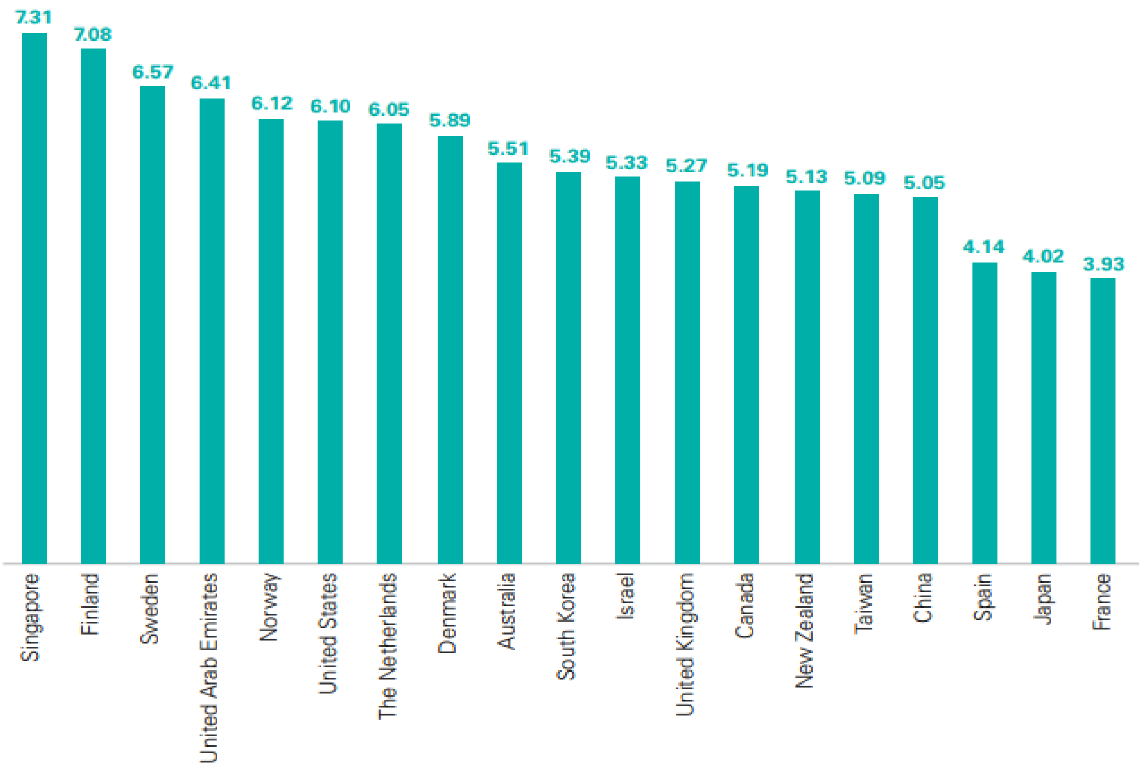

Figure 7. Consumer Acceptance (International, 2020)

The Dutch ecosystem for autonomous cars surpasses the competition. The roads in the Netherlands are very well-developed and maintained, and other indicators such as the communications infrastructure are also rather robust (OECD, 2009). In addition, the Dutch Ministry of Infrastructure has authorized extensive testing of autonomous passenger vehicles and trucks on public highways (RDW Netherlands Vehicle Authority ,2021). However, consumer survey results indicate that the Dutch are less receptive to AV technology than the majority of other nations (International, 2020). The Dutch Ministry of Infrastructure are concerned about the decisions made by the self-driving car in traffic and the issue of liability when the vehicle causes an accident. Attitudes are expected to undergo significant shifts as self-driving vehicles begin to show that they cause fewer accidents. In such a scenario, half of the Dutch participants polled said they would choose an autonomous vehicle (International, 2020).

3. Methodology

3.1 Overall Methodology

In this study, an inductive methodological approach has been employed, which is often used in qualitative research to get in-depth information and viewpoints based on literature studies or interviews with respondents (Woo et al., 2017). One of the most significant advantages of inductive research is that it simplifies the processes of data collection and interpretation. As a consequence of this, the whole investigation is conducted based on qualitative reasoning. Because of this, one of the fundamental characteristics of the inductive method is that it significantly depends on secondary data to offer a strong foundation for establishing the primary purpose of the research, which is drawing conclusions and doing analysis based on observations and hypotheses (Thomann & Maggetti, 2020).

3.2 Theoretical Framework

From the viewpoints of the economic sciences, sociotechnical transitions refers to the interactions and interferences of technical artifacts with social organizations, structures, actors, and activities that jointly accomplish social purposes (Geels, 2005). Thus, it is useful to use the analytical concept "sociotechnical system" to illustrate how social functions are dynamically generated in activities where societal groups engage in systemic interactions. Along with this notion comes the idea that a sociotechnical system cannot be transformed by technology only, such as autonomous driving technology, but rather, by a variety of intricate interactions between various socioeconomic groups, actors, and the coordination of many aspects (Fraedrich et al., 2015). A society's existing practices, beliefs, conventions, and values will then be significantly altered by such a transformation, or "transformed." Thus, sociotechnical transformation modifies the manner in which a system responds to certain social requirements (Haan & Rotmans, 2011)

Geels (2010) uses the multi-level perspective (MLP), a middle-range theory that has three analytical stages: landscape, regime, and niche, to show change processes. The term "regime" refers to the level in which customs, social conventions, and beliefs are continuously put into practice, forming rules, routines, institutional structures, social circles, norms of behavior, and cultural significance, which stabilizes the system's operation and creates its "underlying structure" (Geels, 2005: 27). When something is concurrently "stabilizing," technological innovations will have great difficulty breaking through if they include changed interests, call for new regulations, or produce different routines. Landscape and niche are notions that are both developed from the regime stage and have a strong correlation with it (Geels, 2011:26). The term "niches" refers to safe areas inside the sociotechnical system. Without too much stress from the society, market and politics, technical advances can be generated with a lot of speculation (Geels, 2005:450). The cultures, resources, and social networks that niches often offer let them create their own sociotechnical systems. When establishing alternatives to the current system, individual actors, specialized technology, and local behavior are especially crucial (Haan & Rotmans, 2011).

Landscape refers to certain properties and features of a structure that cannot be readily or purposefully modified, such as environmental or geographical features, like a dependence on nonrenewable resources, population shifts, or constructs of globalization and personalization. Frequently, it is said that the landscape stage creates an "exogenous setting" for the other stages (Andela & Willems, n.d.). Figure 8 depicts a sample level structure for the sociotechnical system of automobility founded on the MLP. However, it only focuses on the various levels and sample analytical components, not the dynamic processes that take place both inside and across the categories (Geels, 2005; Geels & Schot, 2007).

When placing emphasis on potential changes in sociotechnical systems, the analytical tripartition of the MLP is a useful strategy because it offers a long-term viewpoint that seems suitable to sociotechnical alteration, and that are less probable to appear suddenly than as the result of a process that results in progressive and evolving changes. The many stages, individuals, groups, and sectors that are engaged in this transformation are also recognized. Additionally, by offering the "niche" conception, it gives a systemic level that is crucial when it comes to the introduction of fresh breakthroughs or cutting-edge technology.

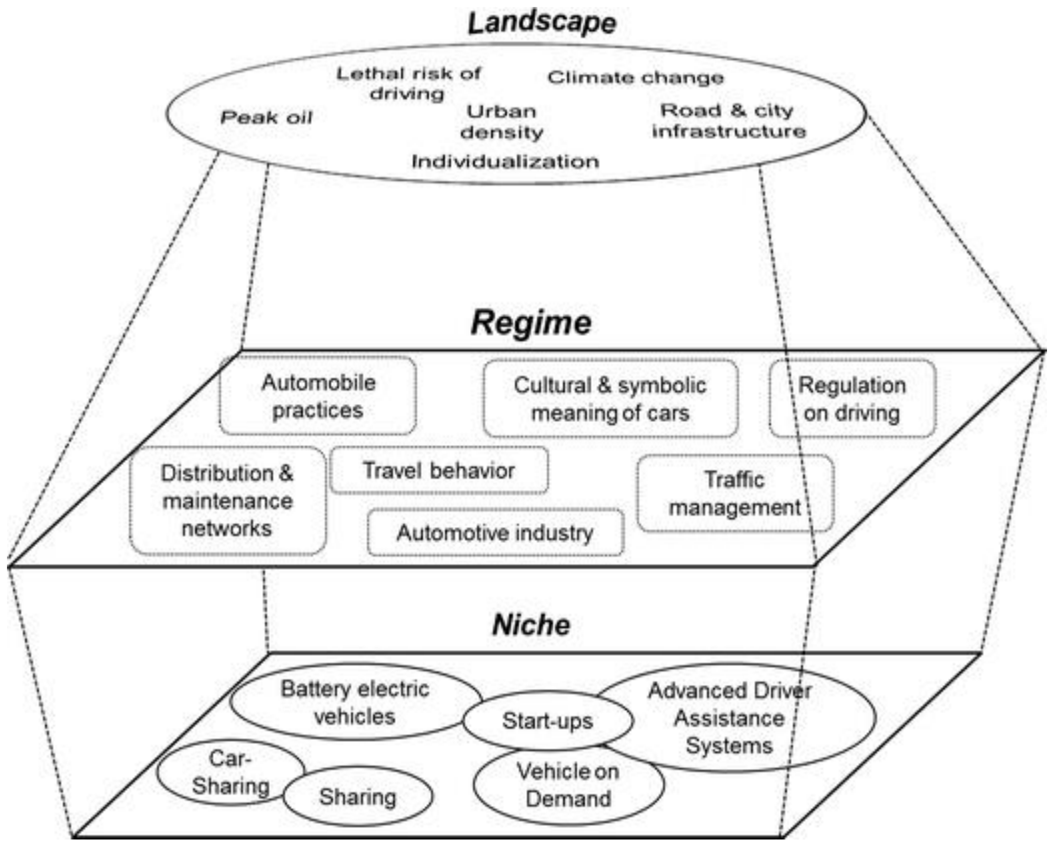

Figure 8. Multi-level perspective on automobility Geels (2010).

AVs have been a hot topic of study for decades, but only in the last five years have they really taken off. Because of the recent cooperative efforts of academics and industry, AVs are now almost ready. It is predicted that AVs will significantly reduce transportation expenses. Crash savings, travel time savings, fuel efficiency gains, and parking cost reductions from social AVs have been estimated at up to $2000 per year per AV, and as high as $4000 when all crash costs are taken into consideration. Although the AV is still in its infancy, it seems to have a bright future. There will, however, be a lengthy road to go before maturity, implementation, and mass-market release are attained.

3.3 Data Source and collection methods

For this research, a combination of primary and secondary data are used to answer the research questions. The secondary data acquired from desk study consists of academic literature primarily found via the search engines, Scopus, web of science and gray literature, such as policy documents and relevant data. The primary data was gathered via interviews and related data. This is summarized in Table 1.

	Research Question	Type of question	Data needed to answer the question
RQ 1	Which policy measures promote the social acceptance of AMCs in the Netherlands?	Exploratory	Interview + Gray Literature
Sub RQ	Which behavioral factors, attitudes and perceptions influence people's willingness to adopt AMC in the Netherlands?	Exploratory/ Evaluative	Interview + Gray Literature

Table 1. Research Material Matrix

3.3.1 Respondents

Based on snowball sampling, 12 English-speaking residents of Grou acted as participants, whereby five respondents were identified and interviewed via the social media platform of Facebook and the remaining seven respondents were identified and interviewed on a random basis between the ages of 22 and 55 were questioned M = 7 (58.3), F = 5 (41.7)). Although the number of respondents in qualitative studies vary, a small sample size is sufficient to perform analysis (Qu & Dumay, 2011). Interviews were performed through face-to-face interviews over different locations within the village of Grou, in the municipality of Leeuwarden between 6th June 2022 – 12th June 2022. The respondents were given a graphic and a video depiction of the prototype in order to give them an understanding of the product, and the interview then delved deeper into the following three aspects: In the socio-demographic section of the survey, participants were asked to provide information about themselves, including their age, gender, occupation and place of work. The capacity of individuals to use smart phone technologies was explored via the use of tech-savvy questions and the general public's opinion of audiovisual technology as part of the social acceptance section. In the AV Acceptance test, scenario-based questions were used to determine whether or not respondents are willing to make use of AMC.

ID	Gender	Age	Organization	Occupation	Approached Method
1	Male	50	Stienstra Keukens	Indoor kitchen supplier	Facebook
2	Male	38	Herberg Oer’t hostel	Hostel Owner	Random
3	Male	42	Snoek Puur Groen	Garden Landscaping Service	Facebook
4	Female	54	-	Homemaker	Random
5	Female	33	Beslag Restaurant	Manager	Random
6	Male	28	Mo Fiets	Fiets shop Owner	Random
7	Female	41	Belasdingtien, Leeuwarden	Administrator	Random
8	Male	22	Student	NHL Stenden	Random
9	Male	45	Woons Friesland	Housing Agency	Facebook
10	Female	28	UNIS Groups	Industrial electronics company	Random
11	Male	36	Jachtservice Jepma	Ship Building company	Facebook
12	Female	23	Student	Friesland College	Facebook

Table 2. List of Respondents

3.4 Ethical Consideration

The BMS Faculty's ethics committee had been approached and given the approval before any empirical data from actual persons was gathered. The survey was optional, and the informed consent statement that was included at the start of the survey allowed respondents to contact the researcher if they had any questions or concerns about the use of the data for the thesis. Additionally, the data was anonymized so that it cannot be linked to a specific respondent.

3.5 Research Area and Boundary

In this section, we will look at the research scope. The project's area of study is Grou, a village in the province of Friesland, located 15 km from Leeuwarden. The village has 5500 residents with a demographic which is highly characterized by older residents of 50+ years. Despite Grou having shops for basic goods and services, they have no provision for other commodities like fashion stores, spare parts and solar equipment, forcing the residents to rely on Leeuwarden and major towns and cities for purchases, resulting in travel time and financial resources by the residents. Due to these factors the village was chosen as a feasible research area to perform interviews with the residents. An aim of 12 interviews were targeted to understand participant mobility and behavioral aspects and further analyze people's perspectives in regards to AMC usage and identify underlying behavioral factors associated with autonomous vehicles in general.

3.6 Data Analysis Method

The primary data sources in the form of interviews and secondary data from the desk research were combined to analyze the data by cross-referencing it to the interview results. Specific subjects generated from the desk research and the interview questions guided and formulated in line with subjects identified. Interview responses were transcribed, analyzed and organized through a spreadsheet. These inputs generated from interviews were complemented by the desk research to build on the results.

3.7 Research Limitations

The societal shift toward the use of autonomous technology is now well under way. There are several compelling arguments in favor of doing so, and the process of formulating an idea such as AMC's acts as a niche where various sectors are involved i.e.; economic, social, technical and geographical (Raven et al., 2010). Addressing dimensions of a socio-technical regime involving market user preference, science and technology, appropriate policy and culture requires extensive study in collaboration with municipalities. Given the limitations in time and available resources, the scope of this research was participants from the village of Grou.

3.8 Ethical Issues

The perspective of the participants on autonomous vehicles comprises sociological, technological, legal, and economic obstacles (Schreurs & Steuwer, 2016). This is regardless of the fact that autonomous vehicles have the potential to be beneficial. Concerns about personal privacy and an absence of social justice are examples of societal elements that contribute to the problem. In general, the respondents did not accept or have enough subjective knowledge about autonomous vehicles. The majority of the research that has been done up to this point supports these results. According to the findings of a research conducted by Pettigrew et al.(2018), sixty percent of respondents reported that they had at least some level of concern over the topic of safety. The implementation of autonomous vehicles might result in consumers experiencing more constraints on their data privacy, and concerns about security issues, such as hacking, have been expressed by respondents (Fagnant & Kockelman, 2015). A significant part is also played by more technical considerations, such as the dependability of the autonomous system. The majority of individuals are worried about software being hacked and misused, in addition to concerns over legal and safety problems (Kyriakidis et al., 2015).

4. Results

Social Acceptance of Autonomous Mobility Commerce (AMC)

It has been argued that risk perception and fear about safety and security hazards are crucial variables for the societal acceptability of autonomous mobility (Kummeneje & Rundmo, 2020). The anticipatory fear that leads individuals to feel anxious while contemplating AMC, and which is the outcome of the cognitive appraisal of risk, is what is measured by perceived benefit, perceived risk, and anxiety (Kyriakidis et al., 2015; Nordhoff et al., 2018). The findings of this most recent study, which were very similar to those of earlier research (Madigan & Nordhoff, 2017) showed that people are worried about the security and safety of autonomous vehicles, and also that women, in general, are more concerned than men about the security and safety of various means of transportation (Rundmo et al., 2011).

When asked to rate their level of concern on several aspects of safety and security linked to autonomous cars, in comparison to traditional vehicles with a driver, respondents were given the opportunity to share their thoughts. Table 3 presents interview respondents' behavioral attitudes. Three respondents lacked subjective knowledge about the AI technology, while four respondents perceived risks of using autonomous vehicles including the possibility of accidents. The following are some examples from respondents.

Respondent 1: "I do not know anything about AI technology, I do not have anything like that in my home"
Respondent 2: "Yes, I love AI technology, especially the Google nest which I use every day at home"

Three respondents were anxious about autonomous mobility commerce and had concerns that the technology would break down. Five out of the total 12 interviewed respondents perceived benefits about the autonomous mobility commerce, and did not perceive any dangers associated with using the roads with autonomous vehicles and instead focused exclusively on the perceived advantages, while the remaining seven respondents shared concerns:

Respondent 1: I am afraid of equipment failure in those types of cars leading to accidents. They don't even have a driver! I wouldn't want to share the road with automated cars out of concern for accidents."

Respondent 3: “I think automated cars are great, they just make sense and are so functional. I am eager to get an automated car one day as I think they are the future.”

	Lack of subjective knowledge	Anxiety	Perceived risk	Perceived benefit
Respondents	3	4	4	4

Table 3.: Interview Respondent’s Behavioral attitude towards AMC

4.1 Current mobility behavior

Mobility plays a significant part in the social lives of all the respondents. All of those interviewed relied on their automobiles to go to and from work and for errands, apart from two students who relied on public transport.

Respondent 3: “I have a Tesla, which is an automated vehicle, so my preferred driving mode is obviously automated which is where everyone should go.”
Respondent 8: “I don't actually have a car, I prefer to use the bus and metro to get me from A to B.”
Respondent 7: “I go to Leeuwarden mostly on the weekends for work, and while I am there I buy what I need for the week.”

It was noted that participants' patterns of movement varied depending on whether they resided and worked in Grou, or unlike one respondent who worked in Leeuwarden and mostly commuted back and forth.

4.2 Private car

A vehicle is essential for getting to work and shopping in rural locations, as shown by these findings. People depend on private automobiles in rural locations because of comfort and flexibility. By contrast, between conventional use of a vehicle and smart vehicle, eight respondents out of 12 owned gasoline powered cars and only two respondents owned automatic cars.

4.3 Transportation of goods

Respondents replied that AMC transportation of products and services has more potential in the future. However, a few individuals showed interest to utilize AMC to transport products and services.

Respondent 11: “I am enthusiastic about the functionality of automated cars and in the future, I will be willing to make use of such cars so that I may transfer materials without any hassle.”
Respondent 5: “I think automated cars are the future and I’m willing to adapt to the technology which I think will make my life easier”

According to survey participants, rail transportation of products and services is challenging due to a shortage in manpower and fluctuating rules and regulations and high cost. In the long term, AMC would be a cheaper option compared to the existing transportation. Intercompany transportation, especially carrying items from manufacturers to warehouses, may be accomplished with AMCs.

4.4 General Attitude towards AMC

Concerns regarding potential vulnerabilities, a lack of comprehension as to how the autonomous mobility commerce system operates, and worries about unforeseen effects like identity theft are among the causes of anxiety and the perceived risks around AMC. As depicted in table 4, three respondents lacked subjective knowledge about how the AMC system operates, four respondents were anxious about using the AMC system mostly due to unforeseen effects of the AMC, whereas four respondents also perceived risks around the operations of AMC. On the other hand, five respondents, as shown in table 4, perceived benefits around the operations of AMC. The respondents perceived benefits in AMC mostly because it could help lessen the number of collisions and injuries brought on by traffic accidents. AMC could also aid in enhancing traffic flow to facilitate more efficient travel.

This research revealed that the respondents of Grou are optimistic about the concept of using the vehicles as transit lines to public transport. However, the respondents also have idealized anticipations about the technological prowess of the autonomous vehicles and most of them are biased towards the vision 2030. As shown in table 4, seven out of twelve total respondents had a positive vision about 2030 whereas only five respondents had a biased vision 2030.

ID	Lack of Subjective Knowledge	Anxiety	Perceived Risk	Perceived Benefit	Positive vision 2030	Biased vision 2030	Gender	Age
1	x		x			x	Male	50
2				x	x		Male	38
3						x	Male	42
4	x	x	x			x	Female	54
5		x			x		Female	33
6					x		Male	28
7			x			x	Female	41
8				x	x		Male	22
9				x	x		Male	45
10		x		x	x		Female	28
11				x	x		Male	36
12	x	x	x			x	Female	23

Table 4. General Attitude towards AMC

4.5 Purchasing Patterns and behavior

Two respondents (5, female and 12, female) carried out their monthly shopping online.
Respondent 5: “I place orders for products online at least twice a month, and I'm willing to pay more for delivery of items to my door.”
Respondent 12: “I look at various products online and place orders around three times a month.”

Other respondents in this group rarely do online shopping, although four respondents do online shopping at moderate and high levels, often once a month. When it comes to shopping, only two respondents did not make use of the various online platforms and technologies. Four respondents made more than five trips to Leeuwarden to purchase commodities in a month and these individuals rarely used the online platforms to do their shopping. Three respondents made trips to Leeuwarden for purchases less than five times in a month and these respondents also highly utilized online shopping platforms to make their purchases each month. This indicates that the majority of the people who responded regularly go to Leeuwarden for the purpose of doing their shopping. Four out of five people in the population who are considered utilizing AMC for an extra delivery fee were optimistic about the idea.

Therefore, autonomous shops could be highly embraced by these individuals. Many experts, not only in the automotive sector, have argued that the usage of autonomous vehicles has the potential to provide many advantages to society and the economy as a whole. In regard to the first category, particular emphasis is made to the fact that AVs have the capacity to increase the efficiency of delivery of products by reducing the need to undertake certain duties associated with driving. The autonomous stores for instance would be of great convenience because the stores could be restocked at warehouses and customers would be able to order from the stores and have the products delivered to their address. For some individuals, not having to physically go to existing stores for purchases would mean more time to work, which benefits the economy.

ID	No of trips to purchase commodities in a month	Frequency of online shopping in a month	Willingness to use AMC at an additional delivery fee	Gender	Age
1	>5	Rarely	Positive	Male	50
2				Male	38
3	<5	Moderately		Male	42
4	>5	Rarely	Positive	Female	54
5	<5	Highly		Female	33
6	>5	Moderately	Positive	Male	28
7				Female	41
8				Male	22
9	>5	Rarely	Negative	Male	45
10				Female	28
11				Male	36
12	<5	Highly	Positive	Female	23

Table 5. Purchasing Pattern of participants

4.6 Dutch Road Infrastructure Capability

According to studies conducted across the world, the Netherlands is the nation that is now in the greatest position to implement fully autonomous vehicles. The Dutch are proud of their high-quality infrastructure and their government's commitment to maximizing the benefits of autonomous vehicles. According to a study conducted by the International Energy Agency, out of the top 20 countries in Europe in terms of innovation and technology, the Netherlands has by far the greatest percentage utilization of electric vehicles, with a share of 6.39 percent.

When the responses from the interviews about the competence of the Dutch road infrastructure were analyzed, it was found that only four respondents out 12 felt it is safe to share the road with AMCs. On the other hand, eight respondents were concerned that they would be in danger if they had to share the road with AMCs. Additionally, the respondents were positive about Dutch road infrastructure being compatible with AI vehicle circulation and believe the Netherlands has a good policy and regulation.

Respondent 3: “I am optimistic about the capabilities of the Dutch road infrastructure to support the circulation of AI vehicles.”
Respondent 4: “I think Dutch policy and regulation have been competent overall, with really good work on roads which are safe and well organised.”

ID	Comfortable sharing the road with AMC	Anxious sharing road with AMC	Gender	Age
1		x	Male	50
2	x		Male	38
3			Male	42
4		x	Female	54
5			Female	33
6	x		Male	28
7		x	Female	41
8	x		Male	22
9	x		Male	45
10			Female	28
11			Male	36
12		x	Female	23

Table 6. Dutch Road Infrastructure Capability

5. Discussion

This research was conducted with the objectives of determining social acceptance for autonomous mobility commerce in the Netherlands, contributing to the travel patterns, purchasing patterns, and behavioral patterns. The results were based on a qualitative analysis of interviews, which explored the adoption of AMC with residents of the Dutch town of Grou. Twelve residents were recruited to participate in this study, which elicited perceptions towards AMCs and the mobility behavior of current passengers, as well as the perceived challenges of integrating AMC into existing traffic systems.

This section will now discuss the results using the multi-level perspective (MLP), which acts as the theoretical backbone of this research. In terms of MLP, the mechanisms for the evolution of the automobile, which imply that the vehicle would be enhanced by technology assisting and completely replacing the driver, may be outlined as either transforming or rearranging the current regime, especially from inside the regime itself, rather than from the landscape, niche, or outside forces (Geels & Schot, 2007). We can consider AMCs to be a niche area - a locus for radical innovations (Geels, 2011) - though it is clear that many of the lock-in mechanisms, which prevent the niche from expanding, are loosening. We will now discuss two of these aspects; first, policy measures to promote social acceptance of AMCs, and second, subjective knowledge, anxiety and perceived risk, and benefits influence AV acceptance in society.

5.1. Policy measures promote the social acceptance of AMCs in the Netherlands

A major barrier to sustainability transformations can be institutional actors and policies. However, as an exploratory part of this research, the results for the policy measures show that the Dutch government has made substantial public investment in AV infrastructure and made good policies to promote AV in the Netherlands. The country is already well organised with good public planning for roads and transport, and highly ranked internationally in terms of electric car use. Furthermore, document analysis in this thesis shows that the Netherlands are also prioritizing AV, for example, by signing the declaration of Amsterdam, in which EU member states pledged to expedite the development of autonomous cars. In addition, the Dutch government's emphasis on business and public sector participation allows critical issues to be discussed, and contributes to the high consumer acceptance of AV (see figure 7).

These results are supported by the interview data, whereby participants, although concerned about AV itself, state that they were "...optimistic about the capabilities of the Dutch road infrastructure to support the circulation of AI vehicles" (respondent 3).

5.2. How subjective knowledge, anxiety and perceived risk, and benefits influence AV acceptance in society

Subjective knowledge refers to knowledge about how much an individual thinks he or she knows about a product, in this case, automated vehicles and the possibilities for AMC. Results showed that after learning more about the technology and gaining first-hand experience with it, most respondents replied positively towards the acceptance of AMC. It was also clear that interviewees who had first-hand experience with electric cars (such as the two respondents that owned electric cars) had more positive views and purchasing intentions with AMCs than those who had never had any prior interaction with them.

An interesting aspect of the research, which represents a substantial challenge for the social elements of socio-technical transitions, is that when it comes to autonomous vehicle-related aspects, prospective customers place a relatively higher value on vehicle safety than on any other feature or expense connected to the vehicle. On the one hand, this may suggest that as the overall safety of self-driving cars improves, so will consumer interest in buying one. On the other hand, research showing that people are still concerned about the safety of autonomous vehicles despite the fact that they would remove human mistakes which are a significant source of traffic accidents, demonstrates that there is a strong element of subjectivity in how people perceive safety.

This shows the vital importance of public perception on how fast new technology is accepted and utilized. Perspectives gathered from the interviewees showed that a niche innovation such as AMC, has already prompted more efforts towards the positive implementation of AV technology. Findings show that future development trajectories for AMC in the Dutch town Grou were positive, with this initial research determining that the critical elements for the social acceptance of autonomous mobility are lowering risk perception and anxiety about security and safety risks.

The reasons provided by respondents in this research for anxiety and insecurity surrounding AMC include fears about possible risks, a lack of understanding of how the AMC works, and worries about unanticipated consequences like system failure leading to accidents. Though the majority of participants demonstrated positive perceptions towards AMCs, the anxiety and fear that some of the respondents demonstrated represent real reservations people have in driverless cars and the perceived dangers towards AMCs in Dutch society, that must be continually addressed for AV and AMCs to move out of a niche and into a mainstream socio-technical regime. The issue that has to be answered is how autonomous cars should be seen, and whether or not they should be seen as having a lower risk profile than conventional automobiles. It is also essential to make progress on the legal framework and to provide clarity about the duties of all involved parties, particularly in the event that accidents occur. It is essential to take into account the public's viewpoint in order for autonomous vehicles to achieve commercial success.

This research revealed that the respondents of Grou were overall optimistic about the concept of using AVs as transit lines to public transport, and to deliver purchases to the doorstep of customers. However, the respondents also displayed idealized anticipations about the technological prowess of the autonomous vehicles and most of them displayed biased towards the vision 2030. Half of the respondents travel regularly to Leeuwarden to purchase commodities, so by reducing the number of trips that individuals make to retail stores the AMC has the potential to improve the efficiency of product distribution. .

People place a significant amount of importance on their ability to move freely due to the impact that this has on their engagement in social life (Hilgarter & Granig, 2020). The potential that lies in the utilization of AMC is brought into focus by the generally favorable perception of people towards AVs. Integration of autonomous vehicles into current traffic infrastructure plays an essential role not just for safety but also for the economy since it creates chances for new business models which have not yet been created or assessed. However, other considerations such as the cost of goods through AMCs need to be taken into account, as well as selection on offer, which will also affect how positively residents view the AMCs.

To conclude this discussion, regarding the adoption of AMC technology, despite the mostly positive perceptions to AMCs by respondents, some people's lack of awareness and acceptance of AMCs, based on fears over safety and privacy, act as barriers to the social acceptance of AMCs. As noted by the MLP framework, sociotechnical systems cannot be transformed solely by technology (Fraedrich et al., 2015), but rely on other factors such as social elements for transformations to take place. Therefore, although the practices of driving and traveling in vehicles to go and purchase items will most likely continue to evolve as vehicles advance to be much less human-operated and AMC is incorporated, social issues will have to be continually addressed. As a result, the adaptive scenario is conceivable for a progressive adjustment at the regime stage, whereby a profound transformation of the system is currently underway.

6. Conclusion

The objective of the thesis was to assess the social acceptance of autonomous mobility commerce into the present Dutch infrastructure and understand the underlying policy measures towards awareness rising along with behavioral factors. The following section will conclude this thesis by summarizing the answers to the research questions, followed by some notes on the limitations of the study (section 6.1.) and avenues for future research (section 6.2.).

In answering the main research question, *“Which policy measures promote the social acceptance of AMCs in the Netherlands?"* It appears that the Dutch government's focus on encouraging public and business participation in its decision making has led to an open environment where people feel comfortable sharing their views on AMCs. Furthermore, as illustrated by the interviews, government policies to invest in transport infrastructure and promote AVs demonstrates that in addition to favorable institutional arrangements and regulations, government policy is contributing significantly to AMC acceptance in the Netherlands.

In regards to the sub research question, “*Which behavioral factors, attitudes and perceptions influence people’s willingness to adopt AMC in the Netherlands?”* It is clear that anxiety and fear are behavioral factors that continue to represent an obstacle to potential AMC adaption, especially linked to the issue of security and accidents with AMCs. However, there is an overall positive perception to AMCs, perhaps due to presence of AI and technology already being in peoples' lives (such as the respondent noting their Google Nest), so it is an idea which is not so distant from peoples' daily lives.

As a final note, it is important to remember that the issue of AVs and AMCs make up the field of sustainability transitions, which are naturally full of debates about the relative importance and dangers of various environmental solutions and problems. Beyond technological developments, such as developing technologies to reduce the risk of crashes, such debates entail deep-seated values and beliefs, which will entail significant public awareness raising and engagement as to the benefits and limitations of AVs.

6.1 Limitations

A shortcoming of this research is the absence in usage of AMCs, whereby the findings of this research are interpreted in light of the current conditions of the autonomous vehicle industry. As no completely autonomous vehicles are accessible to the general public, it means that most people do not yet have firsthand experience with AMCs and instead depend on circumstantial and secondary information from the media. In addition, the interviews failed to take into account the possibly uneven understanding of AMCs by participants, although each participant was given a presentation before the interview to learn about AMCs. Furthermore, the continual growth in knowledge about the AMCs products and its usage changes the preferences which were examined in the interviews. However, despite the fact that pricing and restrictions may have had a significant influence on the adoption of AMCs, these specifics were not taken into account. This infers that the assumptions employed in the research may not incorporate all the significant variables since this is hard to achieve until AMCs reach the personal automobile market and thus to a wider societal level.

Manufacturers, legislators, and other interested parties should use the social influence and performance capabilities of autonomous vehicles to influence purchase intentions as a way of further promoting the uptake and acceptability of AMC. On the basis of thesis findings, it is recommended that deploying AMC would benefit people through general safety, reduction of crashes, cost efficiency, time saving, and less greenhouse gas emissions.

6.2 Future Research

Markets for autonomous mobility commerce are piloted and tested mostly in big cities such as Amsterdam, Utrecht or Rotterdam for the acceptance in technology and active recommendations from the users to represent the demographic spread and exposure towards technology in these big centers. Due to the small sample size and scope area, a wider research scope is necessary in order to convey to people the advantages of AMC to the ecosystem and to the safety of traffic, as well as to build profitable business models and robust collaborations between the public and the private sectors.

It is also essential to make progress on the legal frameworks surrounding AVs and AMCs and to provide clarity about the duties of all involved parties, particularly in the event of accidents and personal data. It is essential to take into account the public's viewpoint in order for AMC to achieve its intended commercial success. To enable viable AMC usage in daily situations, there is a need for increased awareness as well as training and public awareness. AMC has the potential to reduce the number of traffic-related accidents and injuries, and could also help with improving traffic flow and make shopping more efficient by providing products that people want to purchase delivered directly to their address.

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Appendix

Opening Statement before the Interview

You are being invited to participate in a research study titled Integration of Autonomous Mobility Commerce into the Current Dutch Infrastructure. This study is being done by Aswin Raj Sivaprakash from the Faculty of Behavioural, Management and Social Sciences at the University of Twente.

The purpose of this research study is to analyse factors involved in the Integration of Autonomous Mobility Commerce into the Current Dutch Infrastructure and will take you approximately **30-45** minutes to complete the interview discussion. The data will be used to understand participants' perspectives on social acceptance of autonomous mobility commerce.

Your participation in this study is entirely voluntary and you can withdraw at any time. You are free to omit any question.

We believe there are no known risks associated with this research study; however, as with any online-related activity, the risk of a breach is always possible. To the best of our ability, your answers in this study will remain confidential. We will minimize any risks by collecting and evaluating the data through a hard disk which will be deleted once the evaluation is done. No respondent's information will be retained.

Aswin Raj Sivaprakash +31 657589084

Interview Questionnaire

Section 1

What is your Gender?
- Male
- Female
- Other

What is your Age
- 15-25
- 25-35
- 35-45
- 45-55

Type of Occupation

Place of work

- Grou
- Leeuwarden
- Other

Section 2

Ownership of Vehicle

- Conventional
- Hybrid
- Smart
- No Applicable

Type of Vehicle

- Manual
- Automatic

Usage of Mobility Services

- Bus
- Metro

Section 3

Usage of AI Equipment at Home

- Alexa
- Google Nest
- Other

Familiarity with AI Technology

- Yes
- No

Considering Behavioral factors

- Subjective Knowledge
- Perceived Benefit
- Perceived Risk
- Anxiety

Infrastructural Capability of Dutch road system

- Comfortable sharing the road with AMC
- Anxious sharing the road with AMC

Section 4

Number of trips per month

- >5 or <5 to Leeuwarden for purchase of products

Frequency of online purchases in a month

- Rarely, Moderately, Highly

Would you be willing to pay more for the same-day delivery of products?

Circulation of Autonomous Vehicle in 2030

- Positive Vision
- Biased Vision

List of Respondents

ID	Gender	Age	Organization	Occupation	Approached Method
1	Male	50	Stienstra Keukens	Indoor kitchen supplier	Facebook
2	Male	38	Herberg Oer't hostel	Hostel Owner	Random
3	Male	42	Snoek Puur Groen	Garden Landscaping Service	Facebook
4	Female	54	-	Homemaker	Random
5	Female	33	Beslag Restaurant	Manager	Random
6	Male	28	Mo Fiets	Fiets shop Owner	Random
7	Female	41	Belasdingtien, Leeuwarden	Administrator	Random
8	Male	22	Student	NHL Stenden	Random
9	Male	45	Woonfriesland	Housing Agency	Facebook
10	Female	28	UNIS Groups	Industrial electronics company	Random
11	Male	36	Jachtservice Jepma	Ship Building company	Facebook
12	Female	23	Student	Friesland College	Facebook