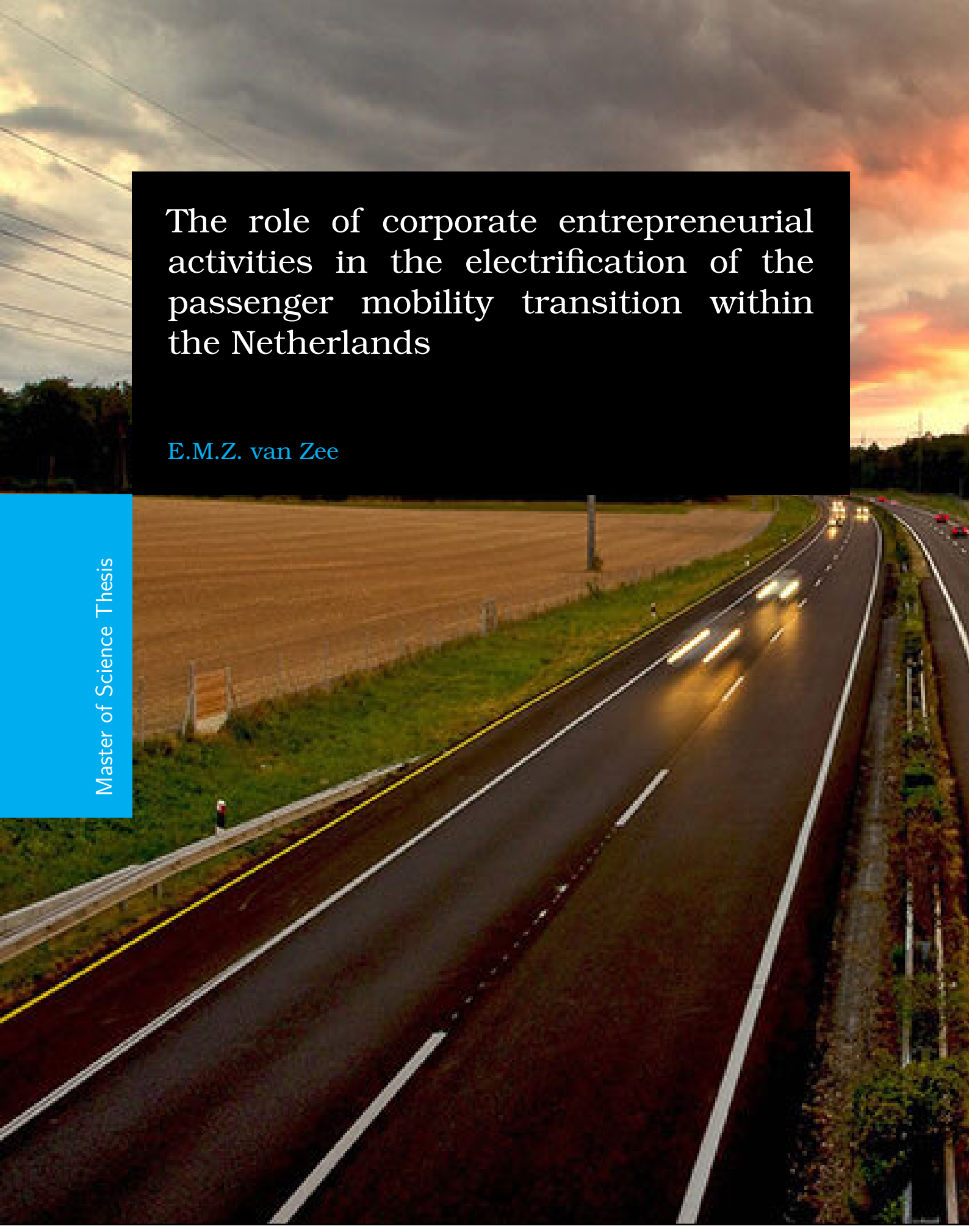

The role of corporate entrepreneurial activities in the electrification of the passenger mobility transition within the Netherlands

E.M.Z. van Zee

Master of Science Thesis

TU Delft Delft University of Technology

Sustainable Energy Technology

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November 24, 2024

Student number:	4727231	
Project duration:	May 01, 2024 – Dec 02, 2024	
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The work in this Master thesis was supported by Pon. Their cooperation is gratefully acknowledged.

"To my grandmother, who always tried to understand every angle and nuance. Her curiosity and way of considering different perspectives have inspired me throughout the writing of this report. It is never black and white but filled with color."

Acknowledgements

Over the past six months, I have enthusiastically submerged myself in the automotive world. I enjoyed learning about the different perspectives on the transition to sustainable mobility, especially the contrasting ones. I am very grateful for this unique opportunity, and this experience would not have been the same without the people I worked with during this project.

First, I thank Jan Anne Annema for his supportive guidance. Our discussions on the disconnect between theory and real-world application were particularly insightful. I am also thankful to Jan Anne for connecting me with my supervisors at Pon, which shaped my experience during this thesis.

Second, I thank Paul Sauerbier for the endless discussions about the ever-changing political landscape. Paul also helped me find the right interviewees, and I greatly appreciate his willingness to share his passion for cars with me.

Third, I thank Raymond Gense. Through his stories, an entirely new world opened up to me. Raymond's deep understanding of complex systems and his detailed explanations were invaluable. I am grateful for his openness and insightful guidance.

Fourth, I thank Linda Kamp and Bert van Wee for providing feedback, hosting the meetings, and keeping me on track with deadlines.

Fifth, I thank all the interviewees for their honesty and openness during the interviews, for spontaneous test drives in electric vehicles, for offering tours, and for introducing colleagues in the workshops. Their enthusiasm greatly contributed to the production of a well-rounded and nuanced study.

Last, I thank my friends and family for their inexhaustible support throughout this journey. Whether visiting me at Move to see my workspace or listening to my stories and brainstorming ideas, their encouragement has been invaluable.

Amsterdam,
November 24, 2024

Emma van Zee

Summary

The uptake of electric and plug-in hybrid vehicles in the Netherlands progresses slowly despite their importance for sustainable mobility. With 2030 zero-emission targets approaching, this thesis offers a unique perspective from within the Dutch automotive sector. It analyzes how companies view and address the challenges of this transition, providing an in-depth look at corporate strategies.

This study uses a mixed-method approach, combining a literature review, desk research, formal interviews, informal meetings, and observations during an internship at Pon, a leading automotive importer. Insights from this unique position offer a direct view of how companies adapt their strategies to a complex and evolving environment. Interviews with mobility experts, sustainability specialists, dealers, and vehicle brand representatives highlighted market trends, barriers, and strategies. The Technological Innovation Systems framework was applied to offer a broader understanding of systemic interactions and feedback loops that shape the electrification process.

The analysis shows that inconsistent government policies create uncertainty for companies and consumers. This uncertainty drives companies to adopt reactive, short-term strategies, prioritizing sales volumes over long-term planning. Dealers face reduced margins and limited customization options for electric vehicles, disrupting traditional business models. Meanwhile, rising vehicle costs have shifted the focus toward business-to-business solutions like fleet management and mobility solutions. For private buyers, the increasing cost of new cars has turned vehicle ownership into a luxury, further narrowing the consumer market.

Public skepticism, fueled by misinformation and negative media, amplifies the uncertainty and further slows the uptake of electric mobility. Infrastructure challenges, such as grid congestion and limited charging options for households without driveways, deepen consumer hesitation. In the sector, skepticism toward electric vehicles also lives, with interviewees expressing a preference for internal combustion engine vehicles. This sentiment influences the transition, as companies remain cautious about electrification.

The Technological Innovation Systems framework highlights weakening feedback loops, particularly between market formation and legitimization. While financial incentives initially stimulated demand and public support, the phase-out of subsidies has reduced societal acceptance and confidence in long-term electrification goals. Companies face additional barriers in resource mobilization, as they must divide investments between internal combustion engines and electric technologies. This division boosts skepticism both within the sector and among consumers. Together, these challenges form a cycle of doubt that slows progress.

To address these challenges, companies must shift from reactive strategies to long-term ones, prioritizing sustainable mobility. These strategies include advocating for consistent policies, building consumer trust through practical measures such as test drives, and facilitating a robust second-hand electric vehicle market. Diversifying business models with mobility solutions can stabilize revenues while enhancing consumer relationships. Moreover, lobbying for plug-in hybrid vehicles and e-fuels as transitional technologies provides a practical pathway for broader participation in the electrification process.

List of Acronyms

Acronym	Definition
ACEA	Association de Constructeurs Européens d'Automobiles
ANWB	Algemene Nederlandsche Wielrijders Bond
B2B	Business-to-Business
BOVAG	Bond van Automobielhandelaren en Garagehouders
CBS	Centraal Bureau voor Statistiek
CSRD	Corporate Sustainability Reporting Directive
D	Dealer interview
(B)EV	(Battery) Electric Vehicle
FCEV	Fuel Cell Electric Vehicle
FI	Formal Interview
ICE	Internal Combustion Engine
IEA	International Energy Agency
IM	Informal Meeting
NMA	Nederlandse Maatschappij voor Automobielbedrijf
Ob	Observation
OEM	Original Equipment Manufacturers
PHEV	Plug-in Hybrid Electric Vehicle
RAI	Rijwiel en Automobiel Industrie
R&D	Research and Development
RVO	Rijksdienst voor Ondernemend Nederland
SEPP	Subsidieregeling Elektrische Personenauto's Particulieren
TIS	Technological Innovation System
TNO	Nederlandse organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek
V2G	Vehicle-to-Grid
VER	Vereniging Elektrische Rijders
VNA	Vereniging van Nederlandse Autoleasemaatschappijen
ZEV	Zero-Emission Vehicle

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Chapter 1

Introduction

The Netherlands aims to reduce greenhouse gas emissions by 55% by 2030 relative to 1990 levels and achieve climate neutrality by 2050 [Rijksoverheid, 2024]. In addition to these environmental targets, the Dutch government aims to create a well-functioning mobility system that stimulates the economy and minimizes casualties by 2040 [Rijksoverheid, 2022]. So, the government pursues three objectives: achieving CO_2 reduction targets, ensuring mobility for all, and securing state revenue.

In 2022, the transportation sector accounted for 29.6 million tons of greenhouse gas emissions in the Netherlands, representing 18.7% of national emissions [Dashboard Klimaatbeleid, 2024]. The sector includes inland shipping, aviation, mobile equipment, rail traffic, recreational boating, fisheries, and road traffic. So, there is a need to reduce emissions in this sector to meet the climate goals. High energy density and fuel efficiency requirements make emissions reductions in non-road sectors challenging. Moreover, as shown in Figure 1-1, light-duty vehicles represent 46% of transport emissions, making it the most significant contributor. As a result, reductions in road traffic emissions will be essential [Bakker et al., 2014; Rijksoverheid, 2022].

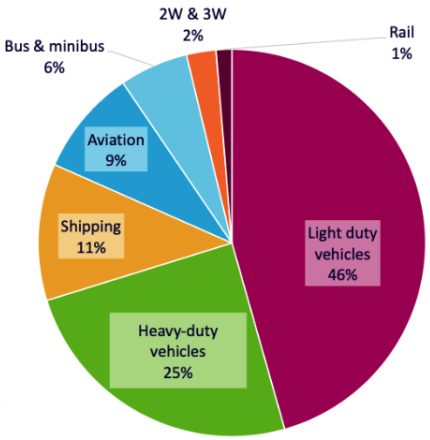

Figure 1-1: Transport emission 2020 [IEA, 2021]; 2W & 3W refers to two- and three-wheeled vehicles

This research explores the role of corporate entrepreneurial activities in electrifying the passenger mobility transition within the Netherlands, only including corporate and private vehicles. The focus on the perspective of the Dutch automotive sector connects technical, economic, and policy challenges involved, highlighting how these factors shape corporate strategies and system integration efforts to drive sustainable mobility. The electrification of passenger mobility through electric and plug-in hybrid vehicles (EVs and PHEVs) is essential for sustainability.

Both EVs and PHEVs can help lower emissions and support sustainable mobility. High costs and limited range make battery electric vehicles (BEVs), referred to as EVs in this report, more difficult to sell. In addition, EVs face rising energy consumption per kilometer, driven by the need for larger batteries to meet range demands [Steinmetz et al., 2024]. In contrast, PHEVs are cheaper, can run on electricity for daily commutes, and are suitable for longer trips. Moreover, PHEVs require smaller batteries and, therefore, use scarce resources more efficiently.

The uniqueness of this report lies in its business-oriented perspective, developed during an internship at Pon, a Dutch auto importer. This research is the first detailed investigation to map how a company views the transition to electrification. It provides a distinct perspective on the electrification process, highlighting the role and viewpoint of automotive companies in shaping and navigating the transition. The automotive sector includes importers, dealers, vehicle brands, safety experts, and charging operators. Each stakeholder offers unique perspectives, responsibilities, and influences, which creates complex dynamics for the electrification in the passenger mobility sector. Automotive companies must balance cash flow, competition, and regulations pressures while navigating the shifting landscape, consumer behavior, and evolving policies. To address these challenges, gaining insights into the interplay between corporate activities and the broader transition landscape is essential.

1-1 Research objectives

This thesis examines the Dutch automotive sector and addresses two research gaps related to electrification. While corporate entrepreneurial activities are recognized as drivers of technological innovation, their perspective and role in the transition to electric mobility remain underexplored. Studies such as those by Tol (2016) and Köhler et al. (2013) highlight the importance of corporate entrepreneurial activities but do not specifically examine how businesses support EV and PHEV uptake. Consequently, the first research gap focuses on the limited exploration of these activities within the context of mobility electrification, particularly among established companies. This thesis aims to broaden the understanding of how corporate entrepreneurial activities interact with broader technological innovation systems.

The second research gap concerns the role of intermediaries and stakeholder interactions in supporting corporate entrepreneurial activities. While intermediaries such as government agencies, suppliers, and technology firms play a critical role in facilitating knowledge exchange and supporting innovation, the literature has not thoroughly examined how these relationships

evolve and contribute to the broader electrification process [Hansen et al., 2015; Markard et al., 2015; Kivimaa et al., 2019]. Understanding how intermediaries and stakeholder interactions shape corporate strategies is essential for creating an innovation ecosystem that drives the uptake of sustainable mobility solutions. The study's empirical objective is to investigate how these relationships are reflected in practice, particularly in the Dutch automotive sector.

Moreover, this report examines broader system dynamics by analyzing the strategic role of automotive companies in the transition to electric mobility, using the Technological Innovation Systems (TIS) framework [Hekkert et al., 2007]. The TIS framework is widely used for studying technological innovation development, diffusion, and adoption. To understand how an innovation system functions, researchers identified seven functions of innovations. These functions serve as analytical tools to map out the activities and interactions that facilitate the development and diffusion of new technologies across industries and markets.

By linking theoretical insight with practical application, this study explicitly explores how corporate entrepreneurial activities contribute to the systemic change needed for the electrification of the mobility sector. This thesis adopts the term "corporate entrepreneurial activities" to highlight the role of established businesses in driving innovation. It examines how companies navigate market barriers, develop strategies, and collaborate to support EV and PHEV uptake. Ultimately, the study aims to show how businesses can create effective strategies to drive this transition in the Netherlands.

Therefore, the following four research objectives from a business perspective are formulated.

1. Understanding barriers and drivers
   This objective aims to identify the barriers (blocking mechanisms) and drivers (motors of innovation) that influence the uptake of EVs and PHEVs in the Dutch automotive sector, with a specific focus on how businesses navigate these barriers and drivers.

2. Analyzing policy measures
   This objective focuses on examining how government policies and regulations shape the strategic decisions of Dutch automotive companies.

3. Exploring corporate entrepreneurial activities
   This objective investigates how corporate entrepreneurial activities within the automotive sector contribute to the uptake of EVs and PHEVs.

4. Accessing the dynamics between the seven functions of the TIS framework
   This objective zooms out from corporate entrepreneurial activities to examine the broader system dynamics within the Dutch mobility sector. The dynamics are still from a business perspective.

1-2 Research questions

The main research question and sub-questions guiding this study are framed as follows. The first three sub-questions focus on corporate entrepreneurial activities, and the fourth question zooms out to assess the dynamics of the broader system.

How can the broader uptake of electric and plug-in hybrid vehicles be driven in the Netherlands up to 2030, focusing on the strategic role of companies in this transition within the passenger mobility sector?

1. What barriers and drivers do Dutch automotive companies, primarily involved in import and sales, identify in the development and market introduction of electric and plug-in hybrid vehicles?
   This sub-question focuses on identifying the barriers and drivers that Dutch automotive companies face in the development and market introduction of EVs and PHEVs. It examines both internal challenges and external factors.

2. How do government policies influence the strategic decisions of Dutch automotive companies regarding the uptake of electric and plug-in hybrid vehicles up to 2025?
   This sub-question examines how government measurements influence the strategic decisions of Dutch automotive companies, particularly up to 2025. The analysis focuses on how companies navigate the regulatory framework and respond to market pressures.

3. What strategies are Dutch automotive companies expected to adopt, and how are they positioning themselves in the changing vehicle landscape leading up to 2030?
   This sub-question studies how Dutch automotive companies adapt their strategies to the changing vehicle landscape leading up to 2030. It takes into account both domestic and European political shifts.

4. How do corporate entrepreneurial activities within the Dutch automotive sector interact with the functions of the Technological Innovation Systems framework to drive the electrification of passenger vehicles by 2030?
   This sub-question zooms out to explore the feedback loops between the seven TIS functions. It uses observed data to assess how innovation dynamics drive or slow the electrification of passenger vehicles in the Dutch automotive sector.

This research aims to provide insights into the Dutch automotive sector and to drive the electrification of the passenger mobility sector, focusing on both corporate and private vehicles. The time frame of this study extends up to 2030, aligning with the Dutch government's target for zero-emission sales of new cars. The methodology consists of a literature review, desk research, and qualitative data collection through formal semi-structured interviews, informal meetings, and observations. Formal interviews were conducted with two mobility experts, two sustainability experts, two coworkers from vehicle brands, five dealers, a safety expert, and a coworker from a charging platform. Additionally, informal meetings and observations during

the internship offered further context and understanding of companies' day-to-day challenges, enriching the data collected from formal interviews. Each formal interview, informal meeting, and observation has a code name, detailed in Appendix A. These code names function as citations throughout the report and are employed to safeguard the anonymity of participants.

1-3 Report structure

This report is structured as follows. Chapter 2 outlines the research approach, including desk research, literature review, interviews, and observations. Chapter 3 reviews existing research on mobility sector electrification, focusing on gaps in understanding corporate entrepreneurial activities within the TIS framework. Chapter 4 introduces the TIS framework as the basis for analyzing system dynamics.

Chapter 5 presents identified themes and statistics from interviews and observations. Chapters 6, 7, and 8 focus on corporate entrepreneurial activities. Chapter 6 identifies barriers and drivers in electrification. Chapter 7 examines how government policies shape strategies up to 2025, while Chapter 8 explores company strategies for 2030.

Chapter 9 zooms out to assess how corporate entrepreneurial activities interact with the functions of innovation, analyzing feedback loops and system dynamics. The discussion (Chapter 10) reflects on findings, linking short-term strategies, policies, and broader dynamics. Finally, Chapter 11 provides conclusions on driving electrification in the Dutch passenger mobility sector and suggestions for future studies.

Chapter 2

Methodology

This chapter outlines the methodology used to study the role of corporate entrepreneurial activities in electrifying the Dutch passenger mobility sector. Empirical data was collected through desk research, semi-structured interviews, informal meetings, and observations. These methods provided insights into real-world practices and addressed sub-questions related to the sector's transition toward EVs and PHEVs.

Section 2-1 details the methodological approach, ensuring consistency and reliability. Section 2-2 explains the literature review as the theoretical foundation, while Section 2-4 outlines the required data and thematic areas guiding collection. Desk research is described in Section 2-3, while Section 2-5 focuses on interviews and observations, formal and informal.

Given that this study took place at an importer, observations and informal discussions helped to gain insights into daily practices and uncover undocumented perspectives and experiences that might not arise in formal interviews. This approach to data collection allows for a detailed analysis of the underlying motivations and resistance to change within the sector.

2-1 Methodological approach

This section illustrates how the different methodologies answer the research questions and how they integrate. The process started with formulating the report's aim and defining the research question. Sub-questions 1, 2, and 3 focus on a more zoomed-in perspective, examining corporate entrepreneurial activities, while sub-question four zooms out to explore the broader dynamics of the entire innovation system.

Second, the literature review provided the theoretical foundation for this thesis by mapping the broader context of electrification and examining how corporate entrepreneurial activities and the TIS framework influence the transition to sustainable mobility. The TIS framework analyzes the systemic processes involved in the development, diffusion, and application of innovations like EVs and PHEVs [Ortt et al., 2022]. This literature review identified research gaps and formulated the sub-questions and system dynamics.

Third, desk research provided contextual and empirical data that contributed to answering sub-questions 1, 2, and 3. By analyzing government reports, statistical databases, and corporate documents, this method revealed the current state of electrification in the Netherlands.

Fourth, the formal interviews conducted offered in-depth stakeholder insights. These interviews provided data to answer sub-questions 1, 2, 3 and 4. The study conducted 13 interviews, which is sufficient for this research due to data saturation. By the eighth interview, no new information relevant to the research objectives had emerged, as respondents had begun to repeat or confirm findings from earlier conducted interviews. Although occasional new insights surfaced, these were secondary and did not impact the study's primary focus.

Fifth, informal meetings and observations during the internship provided insights that added depth to the findings. These interactions, which took place in casual settings such as coffee breaks or lunch meetings, helped uncover nuanced perspectives and day-to-day challenges that formal interviews might not have captured.

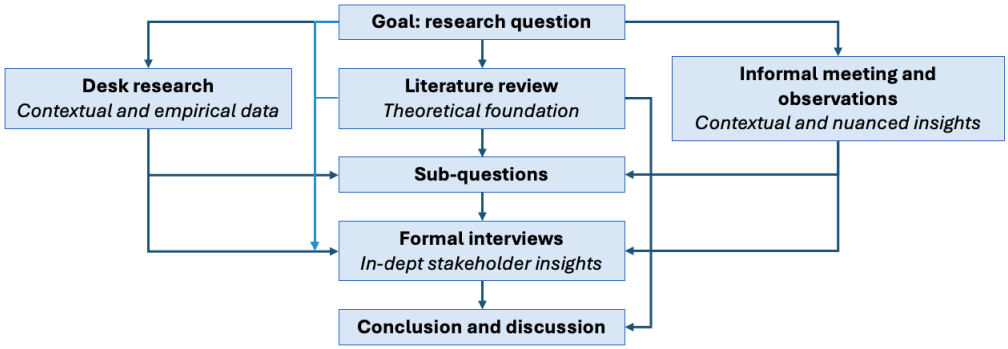

Figure 2-1: Methodology approach - how the different methodologies contribute to the study

The interaction between the different methodological approaches is visualized, as shown in Figure 2-1. The integration of these methodologies delivered both theoretical and empirical perspectives. It enhanced the reliability of findings and ensured that the conclusions drawn were well-rounded and based on multiple perspectives. Moreover, the interview protocol reflected the seven functions of innovation from the TIS framework, with each interview question linked to a specific function. This helped capture the framework's dynamics from the perspective of the Dutch automotive sector and laid the foundation for a visual representation of the TIS framework itself. Together, these methods form the foundation for answering the main research question, offering detailed interpretations and verifiable results that contribute to understanding the Dutch automotive sector's transition towards electrification.

2-1-1 Consistency and reliability

The study uses data from trusted sources such as governments and unions, including regulatory data and market trends, to ensure consistency and reliability. The results of each part of the study are regularly examined to ensure they align with the study's main goals and maintain relevance. Additionally, a mixed-methods approach, incorporating a literature review, qualitative interviews, and desk research, alongside regular consultations with the supervisor from a Dutch importer, supports its consistency and reliability. He validates the data and provides essential context regarding the current state of the automotive sector, ensuring that the analysis is grounded in real-world applications and enhancing the study's relevance. The research methodology is adaptive, incorporating feedback from the interviews and technological or regulatory changes within the automotive sector. This dynamic approach ensures the study's relevance and reflects the most current understanding of the sector and its nuances.

2-2 Literature review

The literature review shows the theoretical foundation for this study by first exploring the broader landscape of electrification in the mobility sector. The literature search consists of three phases. The initial phase focused on understanding the context of transitioning to sustainable mobility through EVs and PHEVs. This phase aimed to map the broader field of electrification and identify studies that highlighted perspectives in the transition to sustainable mobility.

Second, as the review progressed, the scope narrowed to focus on entrepreneurial activities and the TIS framework. This phase focused on literature exploring how companies engage in innovation, collaborate with stakeholders, and respond to market and policy changes in the mobility sector. The TIS framework analyzes systems' development, application, and innovation, which is central to understanding how corporate entrepreneurial activities contribute to technological transitions.

Finally, the third phase combined search terms to identify literature at the intersection of electrification, TIS, and entrepreneurial activities. This approach helped align the literature's findings with the study on the uptake of EVs and PHEVs in the Netherlands. The literature review also identifies research gaps.

- TITLE: "Electric Vehicle" OR "EV" OR "Electrification"
- TITLE: ("Electric Vehicle" OR "EV") AND ("Mobility" OR "E-mobility" OR "Adoption")
- TITLE: ("Electrification" OR "Charging Infrastructure") AND ("Dutch" OR "Netherlands")
- TITLE: ("Electric Vehicle" OR "EV") AND ("Dutch" OR "Netherlands")
- TITLE: "Entrepreneurial Experimentation" OR "Entrepreneurial Activities"
- TITLE: "Technological Innovation System" OR "TIS" OR "Innovation System"

- TITLE: ("Technological Innovation System" OR "TIS" OR "Innovation System") AND "Dynamics"
- TITLE: ("Technological Innovation System" OR "TIS" OR "Innovation System") AND ("Entrepreneurial Experimentation" OR "Entrepreneurial Activities")
- TITLE: ("Technological Innovation System" OR "TIS" OR "Innovation System") AND ("Vehicle Owners" OR "Electric Vehicle" OR "EV")
- TITLE: ("Technological Innovation System" OR "TIS" OR "Innovation System") AND "Electrification"
- TITLE: ("Technological Innovation System" OR "TIS" OR "Innovation System") AND "Mobility"

This study conducted multiple sources to collect relevant scientific papers and articles. These included TU Delft course material from TPM0931SET Sustainable Energy Innovations and Transition by Dr. L.M. Kamp, materials provided by Dr. J.A. Annema, the TU Delft repository, Science Direct, and Google Scholar.

The search results were screened by reviewing the abstract and conclusion of each paper to assess its relevance. If necessary, essential sections such as the methodology and discussion were also analyzed to verify their contribution to the research focus. Mendeley is a tool that helps researchers manage their references. It managed and organized the literature, enabling efficient tagging, annotating, and grouping relevant papers.

After determining the relevance of each paper, the study assessed its reliability using the following four criteria.

1. Author qualification
   The qualifications of the authors are evaluated to determine their expertise. Authors who established reputations in the area are prioritized, such as Hekkert and Wieczorek.
2. Publication platforms
   The study assessed the credibility and impact of the journals and conferences where the articles were published, ensuring the inclusion of only high-quality, peer-reviewed sources.
3. Citation analysis
   The study checked the number of citations for each article, considering those cited more than 50 times as more reliable. This threshold reflected common citation practices in the field, where articles with over 50 citations within five years of publication were regarded as impactful. The assessment relied on intuition and experience with academic sources. Citation counts were evaluated in relation to the publication year, recognizing that more recent articles or those written in Dutch required fewer citations to be considered impactful.
4. Cross-verification
   Information from one source is cross-verified with other sources to ensure consistency and to understand the reasoning within the article better.

Papers that did not fully meet all criteria were not immediately excluded. Instead, they were considered within the broader context of the study's objectives, using each criterion as part of a comprehensive evaluation to assess their relevance and reliability.

In addition, both backward and forward snowballing techniques were employed using the articles provided by Technological University of Delft supervisors. This method involves reviewing the references cited in the initial articles (backward snowballing) and identifying the following articles that cite the initial articles (forward snowballing). Table 2-1 summarizes the results of the snowballing process. This method helped identify a broader range of literature relevant to the electrification of mobility, entrepreneurial activities, and TIS dynamics.

Initial reference	**Snowballed reference**	**Snowballing**
Kamp, 2002	Freeman (1987)	Backward
Ortt et al. (2022)	Bakhuis et al. (2024)	Forward
Bakhuis et al. (2024)	Bergek et al. (2015)	Backward
Van Wee et al. (2022)	Hekkert et al. (2007)	Backward
Van Wee et al. (2022)	Suurs et al. (2009)	Backward

Table 2-1: Snowballing references and their direction

This phased search and selection process, which started broadly with electrification and then focused on entrepreneurial activities and TIS dynamics, resulted in a complete collection of literature. This literature offers valuable insights into the role of businesses and innovation systems in electrification. Therefore, it forms the basis for analyzing the Dutch automotive sector's transition to EVs and PHEVs.

2-3 Desk research

The study employed desk research to understand the current state of electrification in the Dutch automotive sector. This method involved collecting and analyzing existing data and documents to gain a broad overview of developments and challenges within the sector. Sources consulted included government reports, industry publications, news articles, and statistical databases.

Government reports from agencies such as Rijksdienst voor Ondernemend Nederland (RVO), Rijksoverheid, and the Ministerie van Infrastructuur en Waterstaat provided data on policies, subsidies, and statistics related to electrification and mobility. Statistical databases like Centraal Bureau voor Statistiek (CBS) and the International Energy Agency (IEA) supplied quantitative data on the growth of EVs and PHEVs. At the same time, corporate reports from Pon delivered practical insights into industry-specific challenges. The Rijwiel en Automobiel Industrie (RAI) Vereniging, Nederlandse Maatschappij voor Automobielbedrijf (NMA), Algemene Nederlandse Wielrijders Bond (ANWB), Bond van Automobielhandelaren en Garagehouders (BOVAG), and Stichting Natuur & Milieu collectively form the societal coalition, working together to influence and support sustainable mobility initiatives in the Netherlands.

This desk research contributed to answering sub-questions 1, 2, and 3. For sub-question 1 (barriers and opportunities), desk research helped identify barriers to EV and PHEV uptake, including consumer behavior. Publications from organizations like the ANWB, Opwegnaarzes, Vereniging Elektrisch Rijders (VER), and Nederland Elektrisch offered insights into market trends. For sub-question 2 (influences of government measures), government reports, and statistical databases showed the influence of government measures and economic factors. These findings helped explain the impact of fluctuating incentives and emission targets on EV and PHEV uptake. For sub-question 3 (strategic decisions up to 2030), desk research provided background on alternative technologies like e-fuels and hybrid solutions.

These diverse and reliable sources provided a complete understanding of the electrification landscape in the Netherlands. The study used government agencies, respected industry organizations, and statistical databases for their authoritative information and data accuracy. Cross-verification techniques were applied to enhance the reliability of the results, ensuring consistent validation of the data from multiple sources. These steps strengthened the credibility of conclusions drawn from the desk research.

2-4 Required data

This study required data to address the research questions and sub-questions effectively. The literature review, desk research, and informal meetings shaped the sub-questions. As shown in Figure 2-2, five themes were used to gather the required information: market and economy, consumer behavior, technological development, business perspective, and policy and government.

Sub-question 1 analyzes the barriers and opportunities associated with EVs and PHEVs uptake within the Dutch automotive sector. It required both quantitative and qualitative data. Desk research gathered market trends, policy developments, and technological barriers by analyzing government reports, industry publications, and corporate documents. These sources provided essential background information on the market dynamics and regulatory environment. In addition to desk research, the interviews offered qualitative insights into the daily challenges of the automotive sector. These discussions provided first-hand perspectives on barriers such as consumer hesitation, infrastructure readiness, technological innovation, and policy support opportunities.

Sub-question 2 focuses on the influence of government policies and economic trends on the strategic decisions of companies in the Dutch automotive sector. Interviews revealed how companies interpret and respond to the measures. The study collected real-time insights into how economic and policy shifts affect strategic decision-making by examining the influence of fluctuating government incentives and emission targets. Desk research completes this with data on financial trends.

		Corporate entrepreneurial activities within the Dutch automotive sector			Feedback loops
		SQ1: Barriers and drivers	**SQ2: Influence of government measures up to 2025**	**SQ3: Strategies up to 2030**	**SQ4: Dynamics within the automotive sector**
Themes	**Market and economy**	EVs versus ICEs - Market barriers - Market drives	Influence of - economic trends and market dynamics - government	- (Pricing) strategies	- Market formation - Legitimization - Market dynamics
	Consumer behavior	Consumer hesitations and motivations	- How government policies influence consumers - Difference B2B and private consumers	Mobility needs	- Legitimization - Consumer behaviors role in the dynamics
	Technological development	- Technological barriers - Opportunities in innovation		- Alternative technologies like e-fuels	- Knowledge development and diffusion - Resource mobilization
	Business perspective	- Decision-making processes - Success factors for new models	- Market expectations - Strategies up to 2025	- Corporate strategies up to 2030	- Resource mobilization - Knowledge diffusion - Market formation
	Policy and government	- Influence on uptake of EVs and decision-making - Government treasury	- Impact of existing and future policies on corporate decisions - Sustainability goals	- Lobbying - Political shifts	- Guidance of the search - Market formation

Figure 2-2: Required information: per sub-question and themes

Sub-question 3 focuses on the strategic decisions automotive companies are adopting through 2030. It includes alternative technologies (such as e-fuels) and the evolving role of mobility solutions. Desk research gathered data on these alternative technologies, with insights into innovations' economic and technological viability. Interviews and observations provide perspectives on how companies navigate market uncertainties, balancing short-term consumer demand and the need to invest in electric and hybrid technologies.

Sub-question 4 examines how corporate entrepreneurial activities interact with the six other functions of the TIS framework to shape the electrification process. The study also discusses feedback loops within the sector.

2-5 Interviews and observations

This section provides the methodology for the interviews and observations. Subsection 2-5-1 describes the formal semi-structured interviews conducted. Subsection 2-5-2 outlines the informal meetings and observations during the internship and relevant events. The study analyzes these findings using qualitative thematic analysis, thoroughly interpreting the data and identifying patterns across different sources (Subsection 2-5-3).

2-5-1 Formal semi-structured interviews

The objective of conducting formal interviews is to gain insights into the perspectives and experiences of stakeholders within the Dutch automotive sector. In total, 13 formal interviews are conducted, including two mobility experts, two sustainability experts, two coworkers of vehicle brands, five dealers, a safety expert, and a coworker charging platform. The interviewees are selected in consultation with Public Affairs at Pon. The participants are chosen for their essential insights into the current landscape and future direction of EV and PHEV uptake in the Netherlands. The selection of participants also ensured a diversity of perspectives by including dealers representing different brands and from across the country, each with unique regional challenges. Moreover, two coworkers from different vehicle brands were interviewed. A point of consideration is that the participants are linked to the importer Pon, meaning the perspective primarily reflects their brand portfolio.

The interview protocol was designed as a flexible checklist to ensure that each area was consistently addressed while allowing room for adaptation based on the participants' roles and expertise. Some questions were asked in every interview to gain an overall view, while others were specified per interviewee. Initially, general information was collected by introducing the attendees, including their position and background information on their expertise. Open questions were used initially to encourage the discussion. These general open-ended questions aimed to gather broad insights related to the study's objectives. As the interview progressed, more specific questions were asked. Room was left for follow-up questions that arose from the interviewee's responses, allowing a deeper dive into relevant topics. In addition, in developing the protocol, attention was also given to ensuring that all functions of the TIS framework were addressed. It ensured the analysis of the sector's transition dynamics for sub-question 4.

Semi-structured interviews are used as they provide in-depth understanding, flexibility, and nuances in questioning the interviewee. According to Seidman (2006), semi-structured interviews are helpful in qualitative research because they allow for an in-depth exploration of the interviewee's experiences while allowing the interviewer to follow up on interesting points as they arise. This format stimulates a smooth conversational flow, encouraging detailed and insightful responses from the interviewee. Additionally, semi-structured interviews offer a balance between the structured approach of surveys and the open-ended nature of unstructured interviews, making them suitable for gathering qualitative data [Wilson, 2014; McCracken, 1988]. The interviews need to take place in a comfortable and familiar location to ensure that participants feel relaxed and can share information freely [Wilson, 2014]. Therefore, the interviews are conducted at a location of the interviewee's choice to encourage a natural and open conversation between interviewer and interviewee. During the interview, the interviewer moves on from each question once satisfactory data has been collected [Cannell et al., 1968].

The interview protocol included five themes (Figure 2-2). Specific questions were used for auto dealers and brand representatives, focusing on demand trends, sales strategies, and vehicle servicing challenges. Similarly, the charging platform operator participant had specific questions about the charging infrastructure. Moreover, questions about risks were asked of the safety expert. Despite these particular questions, the interviews followed a uniform approach to maintain consistency across discussions. Participants also shared their sources

of information and methods for staying updated on developments in the sector, providing a complete view. This approach allowed for a diverse set of perspectives, ensuring the data collected reflects the dynamics of the sector from multiple angles. The full interview protocol can be found in Appendix B, providing an overview of the structured approach taken to ensure consistency and coverage across all interviews.

2-5-1-1 Interview process

Interviews were conducted face-to-face, each lasting approximately 60-90 minutes. With the consent of the participants, the interviews were audio-recorded and transcribed verbatim for later analysis. Field notes were also taken to capture non-verbal cues and contextual information. The interview started with an introduction to the study and its objectives. Before conducting the interview, the interviewee signed the informed consent document (Appendix C). This form is part of the Human Research Ethics Committee's approval to ensure ethical standards during the interview process. The form explained the interviewee's rights and informed them about the interview process.

During the interview, transcription was used for "reproducing spoken words, such as those from an audiotape interview, into written text" [Halcomb et al., 2006]. Transcribing interviews is the first step in qualitative research, ensuring spoken language is transformed into written text for analysis and reference [Azevedo et al., 2017]. The denaturalized type of transcription was used [Bucholtz, 2000] to produce cleaner and more readable text, focusing more on the exactness of the information [Stuckey, 2014]. During transcription, abbreviations were used to save time, and speakers were clearly labeled. After the interview, the conversation was summarized and checked with the interviewee. Later, essential information from the recording was added to capture the essence of the conversation.

2-5-2 Informal meetings and observations

Conducting informal meetings provided additional insights and context through observations and casual conversations. This method complemented the formal interviews by offering a broader understanding of sector dynamics, particularly the nuances that might not be captured through structured questions. The informal meetings and observations occurred during the internship at Pon and at relevant events within the automotive sector. The internship facilitated spontaneous conversations during everyday interactions, such as at the coffee machine or lunch breaks. Attending relevant networking events further enriched these informal interactions. These informal conversations and observations were precious for capturing real-time reactions and behaviors that might not have surfaced in formal settings. These less structured conversations allowed for a natural flow of dialogue and the opportunity to observe real-time reactions and behaviors. Field notes were taken immediately after each interaction to ensure an accurate recollection of the points discussed. This method allowed for a broader view of professional relationships and the overall atmosphere within the sector.

Anonymity and confidentiality were strictly maintained, and any sensitive information revealed was not directly used in the research. Instead, this information informed the researcher's perspective without being explicitly included. The informal insights gathered were analyzed with the formal interview data, providing a richer, more nuanced understanding of the Dutch automotive sector. By integrating informal meetings with formal data collection methods, the research achieved a more thorough perspective on the Dutch automotive sector, enhancing the depth of the findings.

2-5-3 Qualitative thematic analysis

The interview data, informal meetings, and observations were analyzed using qualitative thematic analysis, a method chosen for its ability to identify patterns in the data and provide detailed insights into themes [Braun et al., 2013]. This method is not bound to a specific theoretical perspective, offering flexibility within the analysis. The technique is further developed by Maguire et al. (2017) and consists of six steps, where moving back and forth between the steps is allowed.

1. Data familiarization: transcribing interviews and highlighting important parts
   The initial step involved thoroughly understanding the content of the data by repeatedly reading through the transcripts and listening to the audio recordings. During this process, notes were taken regarding potential codes or themes, ensuring a comprehensive understanding of the material.

2. Generating codes
   After data familiarization, the process of coding notable characteristics throughout the data started. This structured approach ensured that all details were relevant to the research question. The generated codes were documented in an Excel file, providing a clear and organized foundation for further analysis.

3. Searching themes
   Following the generation of codes, broader patterns among the codes were identified and organized into distinct themes. This theme-based organization helped group-related codes, making the data analysis more structured.

4. Reviewing themes
   Once the themes were identified, a review was conducted to evaluate their consistency and coherence. Where necessary, overlapping themes were merged, and more specific themes were created to capture details within the data. This examination ensured that the thematic structure reflected the data's nuances.

5. Defining themes
   During this stage, the themes were changed to ensure they were relevant and made sense together, focusing on how they helped answer the research question.

6. Writing analysis
   The final stage involved writing the analysis. The study selected clear and explicit citations to illustrate important findings. Each interviewee was assigned a code name to ensure anonymity in the report.

Appendix A includes the code names, data summary, and identified themes. The codes are defined as follows: 'FI' for formal interviews, 'D' for formal interviews with dealers, 'IM' for informal meetings, and 'Ob' for observations. For observations, there is a distinction between 'a' for formal settings and 'b' for informal settings. These code names function as citations throughout the report and have been used to protect participant anonymity. This appendix is not publicly available to further ensure confidentiality, as Pon provided the researcher with a unique and highly transparent view of their operations, making anonymity essential. Additionally, verification methods, such as cross-referencing insights from multiple interviews, were applied to ensure the accuracy and credibility of the results. These techniques enhanced the reliability of the conclusions drawn from the interviews.

Chapter 3

Literature review

The electrification of the passenger mobility sector represents a central strategy to address the environmental and energy challenges. This transition involves the interaction of technological advancements, policy measures, and market dynamics. The review explores existing literature on the broader electrification of mobility to build a foundation for this research. From these findings, it became apparent that businesses play an essential role in supporting the uptake of EVs and PHEVs.

As the review progressed, the focus narrowed to the business aspect of electrification, as businesses were recognized as central in the uptake of new technologies. The TIS framework analyzes these processes, as it offers a means to understand how actors, including businesses, contribute to technological innovation and diffusion. The TIS framework identifies "entrepreneurial activities" or "entrepreneurial experimentation" as a fundamental component. This thesis adopts the term "corporate entrepreneurial activities" to specifically link entrepreneurial actions with established businesses, highlighting both the entrepreneurial aspect and the involvement of incumbent companies.

The chapter is structured as follows: Section 3-1 reviews the literature on passenger mobility electrification. Section 3-2 discusses corporate strategies and collaborations addressing electrification challenges. Section 3-3 examines entrepreneurial activities within the TIS framework, highlighting the role of established businesses in technological transitions. Section 3-4 identifies research gaps and outlines this study's contribution to understanding corporate entrepreneurial activities. It highlights the study's impact on academic and practical perspectives.

3-1 Electrification of the passenger mobility sector

EVs are seen as a solution to reduce emissions and support the transition towards sustainable mobility [Tang et al., 2023; Abd Alla et al., 2021]. However, despite the increasing necessity of electrification, the broader uptake of EVs and PHEVs remains limited. Developing a sustainable EV market presents challenges due to high costs and performance limitations compared to internal combustion engines (ICE) [Statharas et al., 2019]. Given these challenges, government policies and corporate actions must address these barriers.

Research has shown that structured government policies can drive mobility electrification by creating a stable environment for innovation and investment. For example, Abd Alla et al. (2021) illustrates how well-designed policies in Italy's automotive sector contribute to long-term energy savings. This study highlights how structured support, including targeted incentives and regulations, is essential for reducing emissions and energy use across the transport sector. These findings suggest that similar policies across the European Union could drive the transition to electric mobility [Abd Alla et al., 2021]. While government intervention is essential, the role of corporate initiatives becomes apparent when comparing approaches in different countries.

A comparison between Norway and Sweden highlights how the broader range of entrepreneurial activities in Norway has accelerated EV adoption, contrasting with Sweden's approach, which has focused more on specific government programs [Tol, 2016]. In Norway, the government actively supported EV organizations, encouraging corporate systems to engage in entrepreneurial activities that support market growth. Additionally, incentives such as toll exemptions, access to bus lanes, and the development of charging infrastructure have been implemented to promote EV use. In Sweden, the focus has been on specific programs rather than promoting a broad entrepreneurial base. This difference underscores the importance of corporate entrepreneurship in driving market transformation. Thus, policies that support entrepreneurial activities can drive a sustainable vehicle market.

Government policies in Ontario offer another example of how measures can support corporate entrepreneurship in EV markets [Sawajneh, 2022]. Sawajneh (2022) argues that supportive policies for entrepreneurial activities are necessary to boost the EV market, as they enhance the development of the EV technological innovation system.

In the Netherlands, the early phase of the transition to sustainable vehicles was marked by high stakeholder expectations and a relatively carefree attitude towards short-term returns [Bakker et al., 2014]. Here, too, the role of structured government policies is apparent in the urban mobility strategies of Dutch municipalities, which underscore the importance of structured support and market incentives for ensuring long-term success, not only in the Netherlands but across Europe [Koogh et al., 2021]. Deuten et al. (2020) supports the importance of regulatory frameworks, arguing that emission targets for manufacturers and strong incentives are necessary to achieve shifts towards zero-emission vehicles (ZEVs). Analyzing both the Dutch and Norwegian markets, Deuten et al. (2020) shows that without these incentives, EV uptake stagnates. Despite mentioning the role of businesses, all these studies do not analyze how corporate strategies are aligned with sustainability targets.

3-2 The role of corporate strategies

While these structured policies have supported EV uptake, critics argue that Dutch incentives primarily sustain the current auto mobility structure rather than driving a broader socio-technical transition, limiting long-term systemic change [Waas, 2021]. Feng et al. (2020) also questions the sustainability of subsidies. Consequently, the challenges include creating a feasible business model for EVs and ensuring long-term market stability without reliance on government support. While research has focused on government policies and consumer behavior [Liao; 2019; Statharas et al., 2019; Leal Filho et al., 2015; Schot et al., 2018], there is limited research on how companies navigate these challenges.

Taken together, existing literature often highlights government incentives and infrastructure development but tends to overlook the corporate perspective and collaboration [Mazzucato, 2018]. Research shows that strategic collaborations with other stakeholders in the industry support the success of entrepreneurial activities. Partnerships with vehicle manufacturers, suppliers, and technology firms are essential to combine the resources and expertise needed for the uptake of EVs and PHEVs [Köhler et al., 2013]. These collaborations facilitate the exchange of knowledge and skills to promote a dynamic innovation environment [Hekkert et al., 2007].

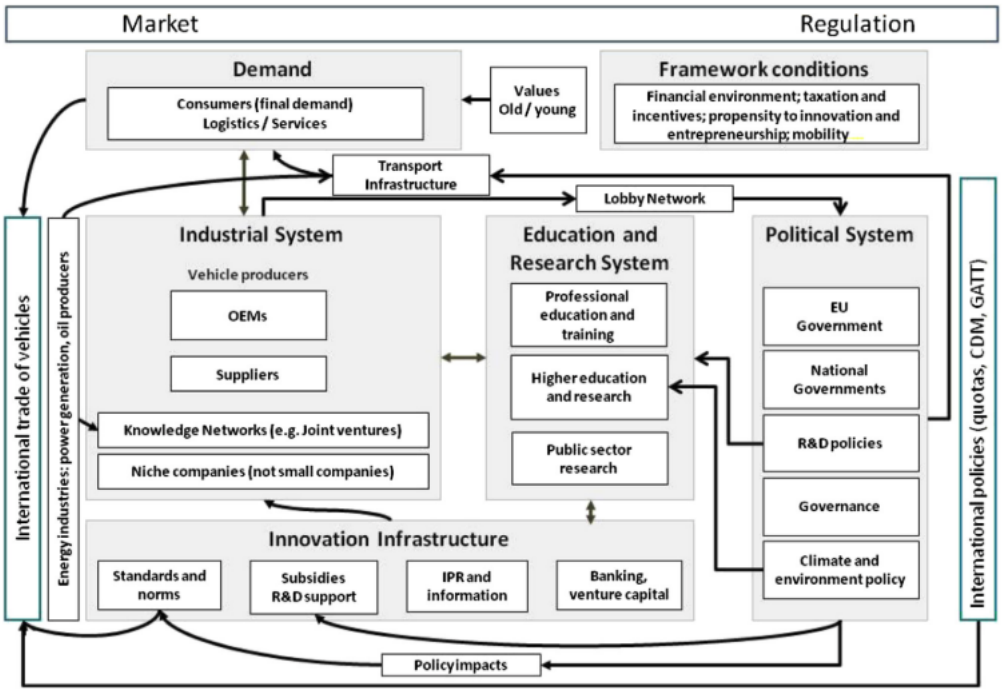

Figure 3-1: The innovation system for automobiles [Köhler et al., 2013]

The complexity of the dynamics between different stakeholders is illustrated by Köhler et al. (2013), as shown in Figure 3-1. It illustrates how market demands shape the focus of Original Equipment Manufacturers (OEMs) and suppliers, which are influenced by consumer needs and logistical demands [Liao, 2019]. This visual representation underscores the dynamic and

interconnected nature of the innovation ecosystem, where various stakeholders, including government bodies, research institutions, and corporate entrepreneurs, interact to drive the uptake of new technologies. The figure illustrates how these relationships contribute to developing the EV and PHEV markets. These studies highlight the complexity of transitioning towards sustainable mobility, which involves strategic stakeholder interactions and corporate entrepreneurial activities.

There is limited literature on the electrification of the mobility sector, with most studies focusing on policies and consumer behavior [Liao, 2019; Leal Filho et al., 2015; Statharas et al., 2019]. In contrast, Feng et al. (2020) adopts a more technical approach, focusing on specific technological advancements such as battery innovations, electric motor improvements, and charging infrastructure development. Feng et al. (2020) highlights that previous studies have often approached the electrification of the mobility sector from a broad perspective, examining the system as a whole. Therefore, as the review progressed, it became apparent that research on the role of businesses in contributing to technological innovation remains under-explored [Mazzucato, 2018; Schot et al., 2018]. While the literature often underscores the importance of entrepreneurial activities [Tol, 2016; Köhler et al., 2013], there is still a need for further examination. The TIS framework frequently applied to analyze transitions, is identified as a tool to explore how entrepreneurial activities influence the electrification of the passenger mobility sector [Hekkert et al., 2007; Bergek et al., 2008; Van Wee et al., 2022]. The following section will examine these activities within the TIS framework, addressing this gap in the literature.

3-3 Entrepreneurial activities in the TIS framework

As discussed in the previous section, the existing literature on the electrification of the passenger mobility sector primarily focuses on government policies and consumer behavior. In addressing the challenges of electrification, literature showed entrepreneurial activities are important [Köhler et al., 2013; Tol, 2016; Sawajneh, 2022]. However, studies rarely examine the role of established businesses in directly contributing to and shaping this transition. This gap in the literature suggests that the role of companies in technological innovation remains under-explored. The focus shifts to corporate entrepreneurial activities within the TIS framework to address this gap.

The TIS framework frequently applied in studies on technological transitions, provides a structured approach to studying the development, diffusion, and adoption of innovations by mapping the barriers, opportunities, and interactions between technology, policy, and businesses [Weiss et al., 2022; Sawajneh, 2022]. It identifies seven functions that support technological progress: (1) corporate entrepreneurial activities, (2) knowledge development, (3) knowledge diffusion, (4) market formation, (5) guidance of the search, (6) legitimization, and (7) resource mobilization. Together, these functions create feedback loops that either support or restrict technological progress, making the TIS framework a valuable tool for analyzing corporate entrepreneurial activities in the EV market [Suurs et al., 2009]. A detailed explanation of each function within the TIS framework is provided in Chapter 4 of this thesis.

Hekkert et al. (2007) highlights that entrepreneurs are essential for a well-functioning innovation system, as they drive the development and diffusion of technologies. Entrepreneurial experimentation enables businesses to test new ideas, products, and processes in uncertain markets [Jacobsson et al., 2011]. Pillai (2024) highlights the importance of technological innovation and government policies in improving the international competitiveness of the EV sector, highlighting the need for companies to innovate continually to maintain their competitive edge in the global market. The TIS framework views entrepreneurial activities as integral to mobilizing resources, challenging existing institutions, and creating new networks [Bergek et al., 2008].

Entrepreneurial activities involve actions by individuals or companies, new or existing, that transform the potential of new technologies into practical applications [Hekkert et al., 2007]. These actions range from developing innovative products, establishing new markets, and creating business models that address challenges. According to Hekkert et al. (2007, p. 421), "Entrepreneurs are essential for a well-functioning innovation system", and therefore important for the development and diffusion of technological change. Moreover, an increase in number of entrepreneurial activities suggests a well-functioning innovation system [Hekkert et al., 2007; M. Hekkert et al., 2009]. Lindholm-Dahlstrand et al. (2019, p. 591) stated: ".. entrepreneurial experimentation is central in driving both the supply- and the demand-side dynamics of innovation systems, hence linking both innovation systems and entrepreneurship to economic growth."

According to Jacobsson et al. (2011, p. 48), "From a social perspective, a fundamental way to handle uncertainty is to ensure that many entrepreneurial experiments take place." Entrepreneurs take risks in unexplored areas to achieve technological breakthroughs [Bergek et al., 2008]. Within the TIS framework, entrepreneurial activities contribute to technological development through three main mechanisms. First, they mobilize resources by securing financial investments, forming strategic partnerships, and attracting skilled talent essential for innovation. They also identify potential applications of technologies and create new supply chains, which stimulate the commercialization of innovation [Markard et al., 2015]. Second, entrepreneurs challenge existing regulations and institutions to support new technologies, including lobbying for favorable policies and standards [Bergek et al., 2008]. Third, they join collaborative networks and knowledge-sharing platforms to promote educational processes among different stakeholders [Planko et al., 2017]. Therefore, entrepreneurial activities enhance the spread and adoption of innovation [Lindholm-Dahlstrand et al., 2019]. By building strategic networks and partnerships, they gather the necessary resources, raise awareness, and build trust among potential users. "A TIS without vibrant experimentation will stagnate", according to Bergek et al. (2008, p. 416). Entrepreneurs adapt their innovations to meet market needs through continuous feedback and improvement processes.

For electrification, corporate entrepreneurs collaborate with suppliers, governments, and technology firms to develop solutions that address market barriers like high costs, limited infrastructure, and consumer hesitation [Lindeboom et al., 2024]. While the literature recognizes the importance of collaboration in overcoming electrification challenges [Köhler et al., 2013], there has been limited research on how corporate entrepreneurs use these collaborations to create business models and strategies for market sustainability.

3-4 Research gaps

Although the literature on mobility sector electrification exists, several essential areas remain unaddressed. Specifically, research has overlooked the role of automotive companies in shaping and adapting to this transition. While government policies, technological developments, and consumer behavior have been well-studied [Liao; 2019; Statharas et al., 2019; Leal Filho et al., 2015; [Schot et al., 2018], the strategies and actions of automotive businesses in this shift have received limited attention. This section highlights the under-explored areas and, therefore, the two research gaps of this study: (1) the limited exploration of corporate entrepreneurial activities within the electrification of mobility and (2) the under-researched influence of intermediaries and stakeholder interactions on these activities.

The first research gap lies in the limited exploration of corporate entrepreneurial activities in the electrification in the mobility sector. Entrepreneurial activities, which refer to entrepreneurs' specific roles in testing and implementing new ideas within the innovation system, are essential in driving technological transitions. However, most studies focus on the system as a whole, while the entrepreneurial strategies of companies remain under-examined. The dynamic interactions and feedback loops are limited addressed [Bergek, 2019]. This gap addresses the activities of corporate entrepreneurs and how these activities directly contribute to and shape the electrification of the mobility sector over time. This thesis focuses on how Dutch automotive companies overcome barriers associated with the uptake of EVs and PHEVs.

The second research gap concerns the combined influence of intermediaries and stakeholder interactions in the electrification of the mobility sector [Hansen et al., 2015; Markard et al., 2015; Kivimaa et al., 2019]. Intermediaries are individuals or organizations that mediate innovation processes by connecting businesses, research institutions, governments, and other stakeholders. Effective intermediaries facilitate knowledge exchange and support the entrepreneurial actions necessary for technological adoption. Moreover, while multiple studies highlight the importance of strategic stakeholder interactions, a deeper analysis of how these interactions enable broader entrepreneurial activities is still missing [Köhler et al., 2013; Feng et al., 2020; Bakker et al., 2014; Tol, 2016]. However, the current literature does not explore how intermediaries adapt to and influence innovation processes over time. There is a gap in understanding how these actors, intermediaries, and stakeholders develop and strategically support entrepreneurial activities and influence the innovation system as a whole [Kivimaa et al., 2019].

Chapter 4

Theoretical framework

This chapter provides a detailed explanation of the TIS framework, which serves as the theoretical foundation for the analysis in this thesis. The TIS framework studies technological innovation development, diffusion, and adoption. In the context of this research, it is applied to analyze the electrification of the passenger mobility sector in the Netherlands, with a specific focus on corporate entrepreneurial activities.

The chapter is structured as follows: First, the development of the TIS framework is discussed (Section 4-1). This is followed by an overview of the seven functions of innovation systems (Section 4-2), essential to understanding how technological systems evolve.

4-1 Development of the TIS framework

Innovations require time to achieve social acceptance and economic interest before they can be widely diffused and scaled up [Kemp et al., 1998]. The TIS framework looks at innovation as a systemic process to understand the development and implementation of innovations, as well as for advising the decision-making process [Ortt et al., 2022].

Freeman (1987) highlights the interactions between networks of institutions, public and private, which play an essential role in innovation processes. Carlsson et al. (1991) additionally develop the concept of 'technological systems' within dynamic networks. Institutional factors, such as legal frameworks, policy initiatives, and regional traditions, shape the networks involved.

The TIS framework was further developed by Hekkert et al. (2007), who introduced the 'functions of innovation systems' to provide a more systematic approach to understanding the dynamics involved. These functions are essential in capturing positive and negative feedback loops that shape technological transitions [Suurs et al., 2009]. In addition, both Wieczorek et al. (2012) and Bergek et al. (2008) deliver frameworks to improve the TIS framework in robustness and real-world situations.

In later years, the framework has been refined to include more contextual elements, such as geographic factors, to understand better how the TIS framework functions in different environments [Bergek et al., 2015]. The introduction of the TIS Life Cycle by Markard (2020) highlights the dynamic nature of technological innovation, describing four key phases: formation, growth, maturity, and decline. Formation involves few participants, minimal sales, uncertainty, and control over production steps like research, development, experiments, and prototyping. Growth sees numerous new entrants, rapidly increasing sales, standardization, and declining technological variation. Maturity is marked by widespread technology use across sectors, high sales, low growth rates, and superior technological performance. Decline sets in with introducing superior technologies, leading to falling sales, company exits and transitions to innovations. These phases reflect the evolution of technology from early development to widespread adoption, followed by eventual displacement by newer innovations.

4-2 Functions of the TIS framework

The TIS framework analyzes the development, diffusion, and application of technological innovations, taking the interactions between actors, institutions, and processes into account [Van Wee et al., 2022]. Actors include the organizations and individuals involved in the system, such as companies, universities, governments, and users. Networks include the interactions between these actors, facilitating the exchange of knowledge and resources. Institutions include formal and informal standards and policies. To understand how an innovation system functions, Hekkert et al. (2007) identified seven key processes, referred to as the 'functions of innovation systems.' These functions serve as analytical tools to map out the activities and interactions that facilitate the development and diffusion of new technologies across industries and markets.

The seven functions of the TIS framework are as follows.

1. Entrepreneurial activities
   This function represents the innovation system's key players, including new entrants and exciting companies that initiate ventures or projects. Entrepreneurs, whether startups or incumbent firms, accept risks by introducing new technologies and solutions to the market and, therefore, drive the evolution of innovation.

2. Knowledge development
   This function includes all activities related to the creation and diffusion of both technological and non-technological knowledge. It includes formal research and development and informal knowledge exchanges through networks and collaborations. Moreover, it includes the development of external economies, where networks and resources help businesses scale the ecosystem. Indicators of these activities include the number of R&D projects and patents.

3. Knowledge diffusion
   This function highlights the spread of information through networks, coalitions, and external linkages. It is essential for circulating ideas and innovations across the system. The number of conferences, seminars, and collaborative platforms within the innovation ecosystem often measures knowledge diffusion.

4. Market formation
   It creates a supportive framework and secure environment for the adoption of technologies, including creating demand, setting up market standards, and securing investments. It also involves promoting adoption through marketing and education. Overall, it is essential for transitioning innovations from development to commercialization.

5. Guidance of the search
   This function shapes the understanding of technological possibilities and market opportunities by identifying specific needs such as regulatory requirements, consumer preferences, and industry standards. It helps innovators and businesses focus on areas with the most potential for growth and success. It directs the learning and exploration process by considering these factors.

6. Legitimization
   This builds social and political acceptance of the innovation. It is essential for technological adoption and is achieved through societal norms, regulations, and public understanding. Examples of legitimization include government initiatives to promote technology and educational campaigns to raise awareness.

7. Resource mobilization
   This function is about acquiring the necessary resources such as money, investments, and skilled employees. Therefore, it includes allocating financial, human, and material resources to support innovation development, scaling, and diffusion.

Figure 4-1 provides an overview of the TIS framework, showing all elements that impact the innovation process, including actors, institutions, and technologies. The figure is reproduced from Bergek et al. (2015) but differs from the original in block 3a. This modification was made to ensure clarity and consistency in this report. The framework begins with defining the focus (block 1), which sets the context for the research. Structural components (block 2) are then analyzed, including the actors, networks, and institutions that form the organizational and social structure within which the innovation operates. In block 3a, the 'functions of innovation' are central to the model, representing the activities driving innovation. These functions are interconnected through feedback loops, demonstrating continuous interactions among them and emphasizing the dynamic nature of the innovation system. Moreover, the

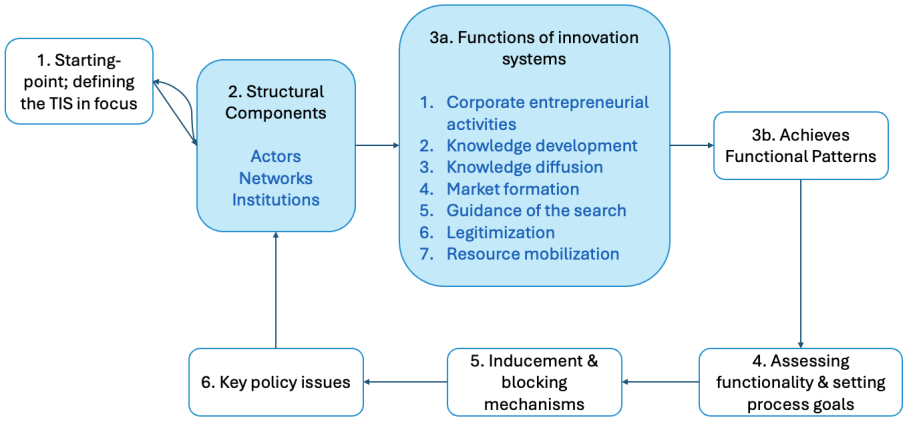

Figure 4-1: Technological Innovation System framework, reproduced from Bergek et al. (2015)

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framework assesses how well the innovation system functions and sets goals to guide the innovation process (block 4). It also explores factors facilitating or obstructing innovation (block 5). Lastly, block 6 highlights key policy issues that must be addressed to improve the system. This structure helps explain how technological innovation is developed, scaled, and adapted to changing conditions.

Chapter 5

Interview statistics

The analysis presented in this thesis captures internal challenges and external factors influencing the uptake of electric mobility. The qualitative thematic analysis identified nine themes across formal interviews, informal conversations, and observations. These themes reflect the different perspectives gathered from the stakeholders within the Dutch automotive sector. It is noteworthy that occasional participants expressed concerns about battery degradation or competition from Chinese manufacturers.

The data identified the following themes.

1. Long-term versus short-term focus
2. Skepticism toward EVs
3. Petrol head culture
4. Cost and accessibility
5. Government policy and uncertainty
6. Technological and infrastructure challenges
7. Media perception
8. Transition strategies
9. Business-to-business (B2B) solutions

To reflect the different types of expertise, two separate tables with rates are provided for analysis (Tables 5-1 and 5-2). Dealers, vehicle brand representatives, and mobility experts have more detailed knowledge about vehicles' sales and technical aspects. By separating these responses, the analysis avoids misrepresenting the data rates.

Theme/ proposition	Rate
Skeptical attitude towards EVs	9 out of 13
EVs have a great driving experience	12 out of 13
EVs are too expensive; New cars are too expensive for private owners and/or broader uptake	13 out of 13
EVs cause charging stress and range anxiety; Long trips like vacations are impractical, especially with a caravan	12 out of 13
Policy and economic uncertainty; Uncertainty leads to hesitation	13 out of 13
Government is responsible; Absence of clear government direction is a barrier	12 out of 13
Dutch targets for 2030 are **not** feasible	12 out of 13
European target for 2035 are **not** feasible	7 out of 13
Charging infrastructure is not sufficient or still too complex for broader uptake	11 out of 13
Complete mobility (or charging) solutions are the future	12 out of 13
(Unjustified) negative perception of EVs in the media; Demand for clearer information on EVs	9 out of 13
Fear of battery degradation	1 out of 13
Does fear Chinese brands	1 out of 13

Table 5-1: Statistics of the formal interviews.

Theme	Rate
Focus on selling cars, ICE or EV; Not responsible for promoting EVs; Consumer chooses	9 out of 9
Focus is short-term and reactive; Strategies are promotions and discounts; Consumer chooses	9 out of 9
Personal preference for ICE; Consumer chooses	6 out of 9
EVs are not profitable: high sales volumes and affordable models for mass uptake; Worried about revenue model	9 out of 9
No availability of suitable models; (Fully) dependent on OEMs	9 out of 9
The second-hand market is needed	4 out of 9
Past EV sales were tax driven	9 out of 9
EVs mainly for B2B; Mandatory CO_2 reporting for companies	9 out of 9
Warranties on EVs are beneficial	2 out of 9
PHEVs are the transitional solution	7 out of 9
Alternative technologies like E-fuels as a solution	8 out of 9
Uncertainty due to OEM who follows a double strategy	1 out of 9
Consumer behavior is changing	7 out of 9

Table 5-2: Statistics of formal interviews with mobility experts, representatives of vehicle brands, and coworkers' dealers.

Chapter 6

Results: Current landscape of barriers and drivers

The electrification of the Dutch passenger mobility sector presents a complex environment for businesses, shaped by their intermediary positions between stakeholders. For example, importers and dealers navigate the demands of OEMs, government regulations, and consumer expectations, all while staying aligned with sector developments and competitor actions. Therefor, this chapter focuses on sub-question 1: *What barriers and drivers do Dutch automotive companies, primarily involved in import and sales, identify in the development and market introduction of EVs and PHEVs?* By identifying these barriers and drivers, the chapter illustrates the current state of electrification within the Dutch automotive sector. This analysis is a foundation for subsequent chapters, which explore the sector's future perspective on electrification and analyze the Dutch landscape using the TIS framework.

The chapter is structured as follows. Section 6-1 discusses six barriers slowing the uptake of EVs and PHEVs. It is followed by Section 6-2, which examines five drivers, referred to as motors of innovation, supporting the transition.

6-1 Barriers

Six barriers have been identified in this research, highlighting internal challenges, and external factors. The following sections provide a detailed discussion of these barriers: loss of business model, skepticism and petrol heads, absence of suitable models, uncertainty, limitations in charging infrastructure and influence of media.

6-1-1 Loss of business model

The current business model in the automotive sector is primarily short-term and focused on maximizing vehicle sales, whether for ICE vehicles or EVs. As D04 noted, "Our strategy is just to sell as many cars as possible." FI07 added, "For us, it's not so much about attracting people to electric vehicles." While importers set specific EV sales targets, financial viability remains a concern for dealers [D04, FI02, FI07, FI08]. This short-term focus, noted by all dealers and brand representatives, leads to reactive sales strategies prioritizing immediate results over long-term planning. FI07 noted, "We make decisions based on what we know today. If that knowledge changes tomorrow, we will adapt tomorrow."

A challenges posed by EVs is the reduced ability to fine-tune vehicle specifications, an aspect of the current business model. While ICE vehicles allow for greater customization, EVs face stricter regulations. As FI08 explained, "With electric cars, we have less freedom in determining options and packages due to cybersecurity regulations." This shift gives OEMs greater control over vehicle design, limiting the influence of importers in adapting to local market demands.

Decreasing profit margins further strain the EV business model, with dealers and OEMs struggling to achieve profitability [FI02, FI07, FI08, D01, D03]. As D03 noted, "We're pushing many forced cars onto the market. That's going to stop at some point. The challenge is getting those cars into the market healthily, where you can profit from them. But the margins are getting thinner and thinner." While the net price of EVs is higher, the percentage margin of retailers decreased. Moreover, high production costs add to the difficulties of achieving profitability in the EV market. As FI02 explained, "The high price doesn't come from the manufacturer profiteering (woekeren). No, the manufacturer sells it almost at cost, trying to recoup production costs, but they're not earning much on it." Although absolute profits may remain reasonable due to higher gross prices, the declining margins create financial pressure [FI01].

In addition to decreasing margins, private consumers are buying fewer new cars. Contrary to predictions, price parity between EVs and ICE vehicles by 2025 has not been achieved, with price differences still noticeable, especially in the lower-cost segment where the percentage difference is more considerable [VER, 2024]. Over the past five years, prices of new ICEs and EVs have increased by 36.5%, making them less affordable for private buyers [Ob03]. As FI08 noted, "80% of our larger models are now sold to business customers, and nearly 95% of these are leased. Private customers rarely buy new cars anymore; they can't afford it."

6-1-2 Skepticism and petrol heads

Skepticism about EVs within the automotive sector arises from financial pressures and cultural attachment to ICE vehicles. This skepticism was mentioned in 9 out of 13 interviews, highlighting an emotional resistance to change. The transition to EVs threatens the traditional revenue streams, mainly through less frequent maintenance. As D02 stated, "Of course, you

would prefer to sell a petrol car to ensure returning customers for maintenance." FI07 elaborated, "Dealers now rely around 30% on sales and 70% on maintenance". With fewer moving parts and reduced maintenance requirements, EVs challenge the profitability of dealerships, further fueling skepticism within the sector.

Beyond financial concerns, a solid emotional attachment to ICE vehicles contributes to this skepticism. Informal meetings and observations revealed that employees in the sector often describe themselves as petrol heads: car enthusiasts who prefer roaring engines and mechanical complexity [Ob5, Ob11]. It seems almost paradoxical that these petrol heads, who have built their careers and passion around ICE vehicles, are now expected to sell EVs. This attachment adds to the resistance toward promoting EVs. As IM01 revealed, "I've got oil running through my veins," highlighting how deep this attachment is.

The skepticism also extends to the long-term uptake of EVs. 7 out of 13 interviewees expressed doubts about meeting the European 2035 phase-out target for ICE vehicles, citing concerns about EV sustainability. A new insight from this research is the recognition of resource limitations for battery production. As FI04 explained, "If you look at the analyses, there simply aren't enough raw materials to provide every car with a battery. (...) I think electricity may not be the solution, but part of the solution." These doubts often manifest as comments like, "Why would you want to drive an EV?" Such skepticism reflects broader concerns about the feasibility of a fully electric future, both within the sector and at a systemic level.

6-1-3 Absence of suitable models for low- and middle-income consumers

The limited availability of affordable EV models for low- and middle-income consumers remains a significant barrier to broader uptake. While automakers have announced smaller and more affordable models, only 25% of expected EV launches between 2024 and 2028 fall into the small and medium segments [IEA, 2021]. This trend highlights the focus on larger, more expensive models, which excludes a significant portion of potential buyers.

High production costs, particularly for advanced battery technology, significantly increase the price of EVs, making them less accessible to lower-income buyers. As FI06 observed, "I do think, however, that many people who switch back to a gasoline car don't do so because they had a negative experience driving electric. Instead, it's because they had a negative experience with the current costs of electric driving." According to ANWB data, 72% of Dutch consumers perceive EVs as too expensive [Nu.nl, 2024]. According to the total cost of ownership calculated by VER, EVs hold advantages in the luxury segment but remain around €9,000 more expensive in the compact segment compared to ICE vehicles [VER, 2024]. Although charging is cheaper, new vehicles overall have become more expensive [Krijgsman, 2023]. Consequently, the absence of affordable models for low and middle-income buyers remains a barrier [FI01].

The Dutch fleet is one of the oldest in Western Europe, underscoring the importance of a second-hand EV market for broader uptake [FI08]. Consumers often prefer second-hand vehicles due to their lower purchase price [FI04]. However, as FI01 pointed out, "If you want to create a second-hand market, you first have to sell new cars." D02 echoed this sentiment: "The second-hand electric cars are still far too expensive." Challenges also arise in reselling second-hand EVs at sustainable prices. D01 remarked, "In Germany, 66% of dealers prefer not to trade in second-hand electric cars because they can't market them at the prices they're received for." This hesitancy reflects broader uncertainties, complicating efforts to build a robust second-hand market.

Interviewees also highlighted practical concerns about current EV models, exceptionally high costs, and range anxiety. The fear that an EV's battery may not provide sufficient range for longer journeys, commonly referred to as "range anxiety," was mentioned by 12 interviewees. IM02 noted, "As long as I'm just driving short distances and staying within the country, it's fine." This concern is especially pronounced during holiday travel or extreme weather conditions when battery demands increase. Additionally, towing capacity remains a limitation for EVs, particularly for holidaymakers. As D01 stated, "You can't tow a caravan" due to current range and power constraints [FI01, FI03, FI06, D01, D03, D05].

6-1-4 Uncertainty in policy and the economy

Unpredictable policies and economic instability create challenges for consumers and businesses, complicating long-term planning and market confidence. Frequent adjustments to EV targets and fiscal policies contribute to a volatile environment that limits strategic clarity for companies.

In the Netherlands, changing EV targets illustrates this uncertainty. While the demissionary cabinet suggested that a 60% target for new EV sales by 2030 was more realistic, the current government remains committed to 100% EV sales [FI01]. As FI04 mentioned, "It's great that subsidies are available for innovation, but as soon as those are removed, EVs become too expensive again." Many proposed regulations are seen as ideological rather than practical, raising concerns about their feasibility [D04]. Continuous policy shifts make clear communication difficult for importers and dealers [FI01].

The feasibility of long-term European goals, such as the 2035 phase-out of ICE vehicles, remains a concern. 7 out of 13 interviewees expressed doubts about achieving this target, citing the slow pace of EV uptake and resource challenges, as discussed in previous sections [FI02].

Beyond policy, dealers have observed frequent price adjustments by car brands like Tesla, which disrupt the broader sector [FI02]. These pricing changes affect sales, residual value stability, and leasing costs, forcing dealers to focus on short-term strategies. As D05 remarked, "I just take it day by day."

6-1-5 Limitations in charging infrastructure

The availability and reliability of charging infrastructure presents a challenge to EV uptake. Grid congestion already leads to issues, particularly for business customers. As FI06 observed, "Grid congestion mainly affects business customers. Requesting a grid upgrade, if possible, can take around six months." Private buyers without a driveway rely on public charging stations, which adds further difficulties. Despite the Netherlands already having a solid charging network [FI02], the perspective of the automotive sector is that challenges continue in connecting new charging points. As FI06 explained, "If more people need to charge their cars but the installations don't keep up, we'll run into serious bottlenecks. It will have a negative impact because the grid just won't be able to handle it."

Charging infrastructure presents additional complexities [FI01, FI02, FI07, D02]. For example, when a household owns two EVs, one for business and one for personal use, charging station operators cannot distinguish between them, leading to all charging costs being billed to the business. Split billing is not always possible, making it difficult to accurately separate private and business expenses, particularly for leased vehicles.

Dealers and service providers contribute to this complexity by offering charging solutions relying on another provider's infrastructure but re-branding it with their name. This creates confusion among customers, who often contact the company listed on their card rather than the charging operator. As FI07 noted, "Unless you dig into it, it's almost impossible to keep track of which parties are involved."

Beyond these structural challenges, "charging stress" has become a growing concern. This stress derives from uncertainty surrounding charging station availability and reliability, particularly during travel. Long wait times and limited capacity increase this stress during holidays when many drivers worry about finding available stations. FI03 shared, "I'm never going on vacation with an electric car again in the next few years. It was truly awful." Concerns about sufficient charge for emergencies also add to this stress, as IM04 noted: "Recently, I woke up wondering if I could get to my parents in an emergency, as things were getting worse at the time."

6-1-6 Negative influence of media and public opinion

The negative influence of media and public opinion creates misconceptions that slow the uptake of EVs. Amplified incidents, such as rare EV fires, dominate headlines and distort public perception. As FI05 stated, "Research shows that the chances of an electric car catching fire are much lower than a combustion engine car. But when it does happen, it's hard to control, and that's what you see in the headlines. I think that's when some people start thinking, 'I told you so'". Reports like VER's myth-busting publication highlight misconceptions around EV costs, range, and reliability, underscoring the need for balanced communication [Ob07, Ob10].

A vocal minority, representing perhaps five percent of consumers, disproportionately shapes public narratives. As FI06 observed, "And those voices tend to be the loudest." This polarization forces consumers to pick sides, with discussions focusing on challenges such as range anxiety, charging infrastructure, and higher upfront costs rather than normalizing electric driving as a standard option.

Misinformation also affects decision-making within the automotive sector [FI01, FI02, FI07]. Dealers and other stakeholders risk basing their strategies on inaccurate reports. As IM05 explained, "A lot is being published. Much of it is true, but often it isn't, and before you know it, these things take on a life of their own." In this context, importers are essential in ensuring accurate information reaches stakeholders. FI01 described their function: "Essentially, it's about stripping away everything that comes along, separating what's relevant from what's not, and shaping it in a way that we can present to our stakeholders: clear, concise, and free of any unnecessary details."

6-2 Drivers

Five drivers, including technological advancements, government incentives, mobility solutions, warranties, and driving experience, are driving electrification. These motors of innovation, both technological and market-based, guide automotive companies in strategic positioning for the transition.

6-2-1 Technological advancements

Technological advancements in the automotive sector drive innovation, particularly in battery efficiency, materials, and vehicle performance. Current developments in battery chemistry, such as reducing the use of scarce materials like cobalt and the potential shift from lithium to more abundant alternatives like sodium, address concerns about resource dependency [FI02]. As FI05 noted: "Five years ago, a Tesla battery weighed 500 kilos, with around 30 kilograms of cobalt. Today, only about half a kilo of cobalt is in a battery." These advancements lower environmental impact and enable more resource-efficient production, potentially making EVs and PHEVs more accessible.

As FI01 observes, "New battery technologies are emerging that are cheaper, have better energy density, are smaller, lighter, easier to use in compact cars, and come with less risk." However, the Dutch sector remains mainly dependent on OEM-led innovations, with 9 out of 9 interviewees noting this dependency.

Expanding fast-charging networks and bidirectional charging capabilities also enhance convenience for EV drivers. Bidirectional charging innovations such as vehicle-to-grid (V2G), vehicle-to-home, and vehicle-to-device are also emerging, allowing EVs to power sources for homes and the grid [D01]. This development opens new possibilities for energy storage solutions beyond traditional transportation uses. Over-the-air software updates enable vehicles to receive maintenance and feature improvements remotely, reducing the need for service visits [Ob01].

While these advancements address range anxiety, charging convenience, and environmental concerns, new-generation PHEVs offer a transitional solution for consumers hesitant to commit to EVs fully. PHEVs provide flexibility, supporting short trips on electric power and longer journeys with fuel, making them suitable for daily commutes and long-distance travel. Obtained from IM06: "You can see the trend over the years: PHEVs have been emitting an average of 15% less CO_2."

In addition to technological improvements, Europe is increasing investment in European battery production to reduce reliance on foreign suppliers such as China. Companies like Northvolt and Varta are leading this effort. However, challenges arise due to fluctuating demand for EVs. For instance, Northvolt recently encountered financial difficulties after a significant order was canceled, and Varta narrowly avoided collapse through an intervention by Porsche [Jonge Baas, 2024]. This underscores the need for consistent demand to support large-scale investments.

6-2-2 Government incentives and coalition

Government policies decisively shape the Dutch automotive sector. D02 highlighted this influence: "If the government wants me to wear a pink polo, I'll wear a pink polo. They play a role in shaping what we have to do." Policies such as subsidies, tax breaks, investments in charging infrastructure, and CO_2 reduction mandates are influential drivers for companies in all sectors to adopt sustainable practices [ANWB, 2024]. The introduction of incentives like the Subsidieregeling Elektrische Personenauto's Particulieren (SEPP) subsidy scheme made EVs more accessible by offering financial incentives [Rijksdiens voor Ondernemend Nederland, 2023]. The spike in EV sales in 2019, following changes in government policy, illustrates the market's sensitivity to regulatory shifts: "You saw a major shift to electric driving when the government lowered the additional payments. 2019 was one of those years" D02.

Mandates like the Corporate Sustainability Reporting Directive (CSRD) and CO_2 reporting requirements push organizations toward sustainable mobility strategies. Large organizations are increasingly integrating sustainable mobility into their strategy. As FI03 noted, "With mandatory CO_2 reporting now in effect, large organizations are already incorporating sustainable mobility into their strategies." In 2022, 21 percent of corporate driving in the Netherlands was conducted using EVs, and this percentage continues to rise [Centraal Bureau voor de Statistiek, 2023; Peeters, 2023]. However, this shift is often compliance-driven rather than voluntary, as IM13 observed: "The only reason people drive electric is because they have to. Nobody wants to do it themselves. So if those incentives disappear, you're left with nothing."

Moreover, canceling netting incentives (salderingsregeling) for solar energy further encourages EV uptake by maximizing self-consumption. "People say, 'I have too many solar panels if the netting arrangement gets removed. I want something to make use of them, like an electric car or a hybrid.' But more often than not, you see hybrids" [D01].

6-2-3 Complete mobility solutions

A growing trend in the Dutch automotive sector is the shift toward complete mobility solutions, which refer to integrated packages beyond just selling vehicles. These solutions include fleet management, vehicle leasing, maintenance services, charging infrastructure, and other mobility-related offerings, allowing companies to provide a full-service approach to customers. As D04 noted, "Dealers ultimately want to offer a complete solution."

One important measure already being implemented is the inclusion of maintenance in the purchase price of EVs, providing customers with a clearer understanding of long-term ownership costs [FI01, FI07]. EVs also come with lower lifetime maintenance costs due to fewer moving parts, which means less can break down [FI01]. This results in fewer trips to service points. A dealer typically sees a customer once every two years for general servicing, regardless of whether it's an ICE vehicle or an EV. However, by offering maintenance-inclusive packages, dealers can increase customer loyalty, as these services bring customers back more frequently, creating more opportunities to strengthen relationships.

As D05 remarked, "We need to start figuring out how we can incorporate other mobility options as well." As FI07 emphasized, "I couldn't tell you where we want to participate and where we don't. What is our role?" This uncertainty reflects the growing recognition that companies must diversify their offerings to meet changing customer demands.

6-2-4 Warranty

The concept of warranties offers clear benefits for both consumers and importers in the Dutch automotive sector. While every new car comes with a factory warranty, EVs typically include additional coverage for the battery, some extending up to fifteen years [ANWB, 2024]. These warranties help ease concerns about long-term reliability, encouraging hesitant buyers to switch, knowing that expensive repairs are less likely to fall on their shoulders [FI08].

For importers, extended warranties also generate an additional revenue stream. Funds collected from warranties are pooled into a reserve, as FI07 explained: "If you set aside between 1500 and 2000 euros per electric vehicle sold, and this happens thousands of times a year, you build a substantial reserve fund that earns interest." The interest received from this fund serves as an additional income stream. While a portion of the reserve covers maintenance costs, the fund grows over time as not all vehicles require expensive repairs. This practice is already occurring, according to FI07. However, this has only been confirmed by one respondent.

6-2-5 Driving experience

The impressive driving characteristics of EVs, such as smooth acceleration, quiet operation, and minimal maintenance needs, make them appealing, especially for those seeking comfort and efficiency (observed in 12 out of 13 interviews). As D05 remarked, "It drives fantastically. That is not the issue: people must get used to it." Additionally, safety experts highlight EVs as safer in accidents, particularly regarding battery-related risks. As FI05 mentioned, "An electric car is much less of a fire hazard than a fuel-powered car." Experiencing the comfort of EVs often shifts initial skeptics toward electric mobility.

Beyond comfort, the cost-efficiency of EVs is another appealing factor. EVs require less frequent maintenance due to fewer moving parts, no need for oil changes, and regenerative braking, which reduces brake wear [FI01, D02]. However, when maintenance is needed, it can be more expensive due to specialized components like the battery and advanced electronics. Despite these occasional higher maintenance costs, the total cost of ownership of EVs tends to be lower over their lifetime [Element Energy, 2021]. As FI02 pointed out, "If you do the math optimistically, you're not losing money on driving electric. We've more or less reached that point now."

6-3 Key findings

The question *What barriers and drivers do Dutch automotive companies, primarily involved in import and sales, identify in the development and market introduction of electric and plug-in hybrid vehicles?* reveals a dynamic interplay between six barriers and five drivers.

- Short-term strategies dominate, focusing on sales volumes over long-term planning, limiting the sector's adaptability.
- The shift to EVs challenges traditional revenue models by reducing profitability from maintenance and customization, raising skepticism about their financial viability.
- The unavailability of affordable EVs for low and middle-income buyers slows progress. As FI03 stated, "Eventually, you have to win over the masses. And for them, price is the deciding factor." The challenge is to offer affordable, reliable models, after which "it will happen automatically" [D05].
- Charging infrastructure limitations continue despite a solid existing network, with concerns over whether it can meet future demand [FI02].
- Positive driving experiences drive interest, but misinformation and negative media influence public opinion. Internal resistance among employees also challenges EV promotion efforts [FI03].
- Feasibility concerns for 100% electrification by 2035 are noted, with FI04 stating, "If you look at the analyses, there simply aren't enough raw materials to provide every car with a battery." This reflects sector doubts about long-term sustainability.
- Complexity and policy uncertainty affect electrification despite subsidies and CO_2 regulations [FI04]. D01 stated that "With clarity, you have a clear end goal in sight," while FI06 noted, "Clarity from the government is essential. Affordable pricing matters, and so does the infrastructure."

Chapter 7

Results: Influences of governmental policies up to 2025

Interview results indicate that the high upfront costs of EVs remain a substantial challenge for companies that struggle to overcome this without introducing more affordable models. The previous chapter discussed barriers such as regulatory uncertainty and the limited availability of suitable models, along with drivers such as technological advancements and government incentives. Government policy and economic trends are closely linked to these barriers and drivers.

This chapter explores how government measures and economic trends influence the strategic decisions of Dutch automotive companies, focusing on the period up to 2025. Since this report was written in 2024, the analysis emphasizes companies' immediate actions and decisions within the current regulatory framework. It addresses sub-question 2: *How do government policies influence the strategic decisions of Dutch automotive companies regarding the uptake of EVs and PHEVs up to 2025?*

The following section discusses how the fluctuating nature of Dutch policies has shaped the short-term strategies of automotive companies (Section 7-1). The following section explores the broader European context (Section 7-2). Section 7-3 discusses challenges such as competition from Chinese EV manufacturers. Fourth, the role of PHEVs as a transitional solution is highlighted in Section 7-4. Lastly, Section 7-5 highlights idealists versus skepticism in the sector.

7-1 The impact of fluctuating Dutch policies

In recent years, policy promotions have demonstrated how quickly market dynamics can shift. For example, overstock issues arose after sudden changes, as FI02 explained: "We had to store excess cars in employee parking spots due to overstock. We eventually sold them with promotional deals, or they wouldn't have moved at all."

Fluctuating policies also caused spikes in sales. Respondents D01 and D02 revealed that the introduction of EV subsidies in 2019 triggered spikes in EV sales. In addition to the sales peaks driven by promotional regulations, companies experienced spikes just before regulatory changes were implemented, for example, at the end of a year [Ob03]. These spikes are illustrated in Figure 7-1, with 30.7% of newly sold cars and 5.7% in 2023 of the total Dutch passenger fleet being fully electric [Rijksdienst voor het Wegverkeer, 2024]. PHEVs account for 12.6% of newly sold cars and 3.8% of the Dutch fleet, respectively.

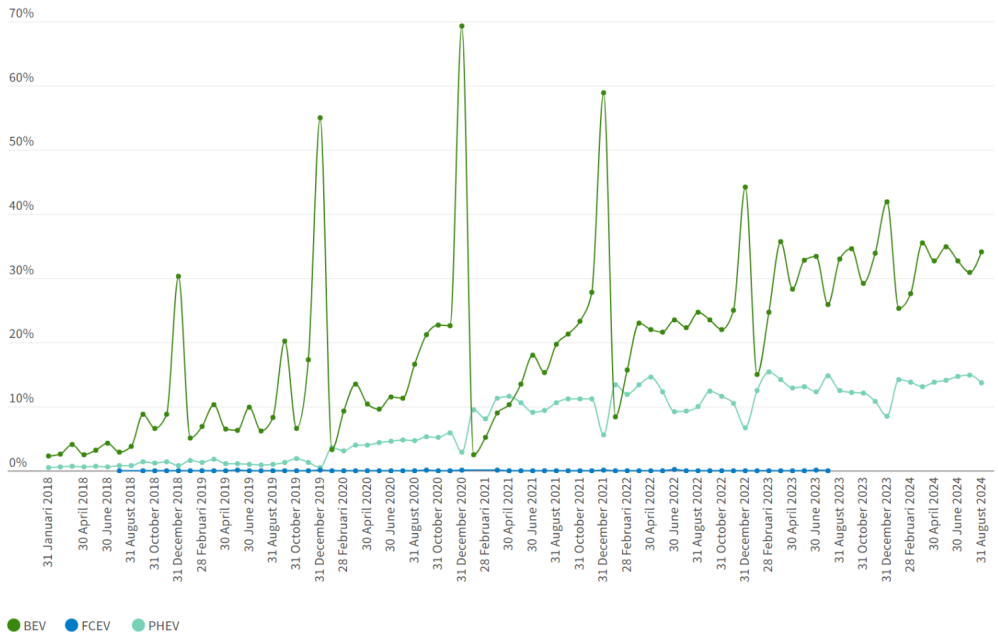

Figure 7-1: The percentage share of newly registered passenger cars by drive train per month (BEV, PHEV, and fuel cell electric vehicle (FCEV)). The FCEV drive train is hardly visible in the graph due to the low number of passenger cars with this drive train entering the market. [Rijksdienst voor het Wegverkeer, 2024]

Frequent changes to road tax (motorrijtuigenbelasting) and EV subsidies further destabilize the market [FI01, FI02, FI08; Van Helvoort et al., 2024]. Respondents FI07, FI08, and D03 indicated that fluctuating policies made businesses reactive, forcing them to prioritize short-term strategies over long-term planning. D05 summarized this challenge: "We must continually adjust to government decisions, making long-term planning nearly impossible."

The government's inconsistency is derived from the Dutch political landscape, which frequently shifts focus every four years [D03]. As interviewee IM08 noted, "The automotive sector tends to adjust strategies based on today's developments, but a more stable four-year policy would help align with long-term objectives."

The Dutch government's 'hand aan de kraan' approach exemplifies the reactive dynamic within the sector. The term translates to 'hand on the tap,' implying that the government adjusts policies based on market performance, like turning a tap on or off. This involves closely monitoring the sales of ZEVs by the government and making periodic adjustments to incentives or regulations to ensure that the sales figures align with the targets set in the Climate Agreement [Voorhout, 2023]. While this ensures flexibility, it also creates uncertainty, forcing companies to remain highly reactive.

Efforts to balance climate goals with affordable mobility and sustainable public finances further complicate decision-making. For example, zero-emission zones in cities push residents to consider EVs, but the absence of a unified national policy and delays in municipal implementation create planning uncertainties. D01 commented: "Policy developments often outpace actual market demand," creating a disconnect between governmental goals and what the market can realistically achieve.

An example of policy unpredictability is the recent amendment in the Spring Budget (Voorjaarsnota), announced just five months before Prinsjesdag, the annual event where upcoming policies and budgets are outlined. Automotive companies, which place orders a year in advance, face disrupted planning. "It completely disrupts our 2025 strategy," remarked interviewee FI02. This adjustment was followed by errors in the Dutch government's fiscal calculations, which rely on one external consultancy. As FI02 noted, "One small company in the Netherlands handles all the fiscal calculations around mobility. (...) And now, this morning, we were confronted with the fact that there was an error in the model."

A more collaborative approach between ministries and coalitions is necessary to align policy-making with market realities. The societal coalition of RAI (importers), BOVAG (dealers and garage owners), ANWB (consumers), NMA (leasing companies), and Stichting Natuur en Milieu (climate action) exemplifies efforts to prevent disruptive, thoughtless policy decisions.

7-2 Broader European challenges and market pressures

Every interviewee agreed that the government's essential involvement in electrification is crucial, particularly regarding climate targets that mandate an increased market share of EVs. However, achieving this growth is complicated. In addition to national challenges, external factors at the European level, including political and economic pressures, also influence Dutch automotive companies.

OEMs face challenges in achieving EV profitability. Respondent FI02 noted, "An electric car is much more expensive to produce than a non-electric car for an OEM." High battery production costs and reliance on external suppliers, particularly from China, complicate the situation. Recent struggles of European battery manufacturers highlight vulnerabilities in the supply chain. For example, Northvolt faced financial difficulties after BMW canceled a significant order, while Varta narrowly avoided bankruptcy through a Porsche rescue [Jonge Baas, 2024]. These cases illustrate the sector's dependence on Chinese imports and the financial instability of European suppliers. "OEMs can't produce batteries themselves, and suppliers add margins too, so EV production is still financially unsustainable," noted IM10.

In Brussels, some policymakers have compared the automotive sector to the tobacco industry, suggesting it can maintain profitability despite regulatory pressure. This perspective has been criticized by FI02, who argued, "The idea that the auto sector can endure regulatory pressure like the tobacco industry is a mistake. Making EVs profitable requires high sales volumes, and that's not happening yet." Respondents D01, D02, FI06, and FI07 emphasized that profitability depends on affordable models to drive mass uptake. "The assumption that by 2025, EVs will cost the same as combustion engine cars is no longer realistic," explained FI08.

Subsidy reductions across Europe exacerbate OEMs' challenges. EV subsidies have been withdrawn in Germany, and in France, they now apply only to domestically produced vehicles. FI02 remarked, "When subsidies stop, manufacturers panic because it becomes harder to hit their CO_2 targets. (...) and those fines are substantial." This situation has led Dutch automotive importers to lobby for policy changes to protect European manufacturers.

A nuance is that not all OEMs face the same pressure level. While brands like Volkswagen are struggling [Ob12], some brands within the group perform better [FI08]. This highlights a fragmentation within the sector, where certain OEMs are better positioned to navigate the current environment.

7-3 Chinese competition

The sector faces increasing pressure from affordable Chinese-made EVs, which accounted for 11 percent of the European EV market in June 2024 [Smith, 2024] and 7 percent in the Netherlands in 2023 [Centraal Bureau voor de Statistiek, 2024]. IM11 noted that the sector's profitability model is under pressure due to electrification and competition from cheaper Chinese imports.

Although Chinese competition was frequently discussed, only one of thirteen respondents expressed significant concern. Most view it as a general market challenge, adopting a wait-and-see approach rather than seeing it as an immediate threat. As D02 commented on Chinese competition, "Our network, expertise, and products fully support our customers. Chinese brands will need years to build similar infrastructures."

European OEMs struggle to balance competitiveness with regulatory goals. FI02 highlighted that EV profitability remains uncertain, with manufacturers relying on ICE models to cover costs. The influx of Chinese-made EVs, coupled with Europe's dependency on Chinese battery suppliers, places additional strain on European OEMs as they work to compete while meeting CO_2 targets. The European Union's new import tariffs on Chinese-made EVs aim to protect domestic manufacturers from cheaper imports, but their impact is uncertain [FI01].

These measures favor specific OEMs, particularly French manufacturers who are less reliant on Chinese supply chains. In contrast, manufacturers like Volkswagen, with greater reliance on Chinese markets and premium segments, face additional risks [FI02]. However, long-term effects remain uncertain [FI01].

Companies remain vulnerable to disruptions and competitive pressures without sustainable policy adjustments at both domestic and European levels. Consistent long-term policies are essential to support strategic planning, investment, and sustainable business models that align with environmental and economic goals. However, without reform, "challenging times lie ahead" [IM14].

7-4 PHEVs as transitional solution

Given the complexity of electrification and the political and economic uncertainties, the importance of PHEVs as a practical transitional solution is becoming more essential. The absence of a transparent revenue model for EVs is a concern. 9 out of 13 respondents expressed worries about this, with D03 noting, "The market's price sensitivity to EVs presents a challenge." In contrast, PHEVs offer a more affordable option for manufacturers and consumers. 8 out of 13 interviewees recommended that PHEVs be recognized as a transitional solution. PHEVs allow companies to maintain production volumes, which are essential for the long-term profitability of automotive firms. Interviewee D04 observed that "PHEVs provide a stepping stone towards electric driving, giving employees time to adjust while still meeting sustainability targets."

This approach addresses consumer hesitations regarding EVs by offering a more accessible alternative. Recent research from Nederlandse organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek (TNO) confirms that PHEVs have improved in sustainability, with improved battery efficiency making them more attractive to buyers while contributing to the sectors's environmental objectives [Steinmetz et al., 2024]. PHEVs offer companies the financial flexibility to meet consumer demand, serving as a more cost-effective alternative for manufacturers and consumers than EVs. FI02 noted, "Mass production of cars is an incredibly complex process, and PHEVs allow us to keep that scale going while moving towards sustainability."

7-5 Idealists versus skepticism

There is a clear divide within the sector regarding the feasibility of future targets. 12 out of 13 interviewees believe that the 2030 goals are not achievable. Additionally, 7 out of 13 are skeptical about reaching the 2035 targets, reflecting two groups: one skeptical of 2030 goals and another doubting both 2030 and 2035 objectives.

The idealists believe that alignment between policy and market conditions will stabilize over time. These viewpoints tend to be expressed formally and appear in two settings. The first setting is during interviews with dealers who have a day-to-day outlook. They trust in the long-term vision of EVs set by the European government and often reference their experience in overcoming difficulties in the past. D03 predicted, "I think that in ten years when we look back, we'll realize that we worried too much." The second context is during formal presentations by importers, where optimism is projected and expected in formal settings [Ob03a, Ob05a]. This optimism appears to be a requirement driven by the need to project confidence. To project confidence.

Outside of these formal settings, the tone changes significantly. During informal conversations, concerns are expressed more freely [Ob03b, Ob03b, Ob11]. Many within the sector doubt whether upcoming models will arrive on time and, if they do, whether they will meet expected quality standards. As IM09 highlighted: "At the importer, the CO_2 reduction target is widely discussed, with Germany pushing for a relaxation or postponement, while Italy resists any such changes." This skepticism often centers on specific brands and their ability to deliver on targets.

The divergence between formal optimism and informal skepticism underscores the sector's broader uncertainty. While idealists project confidence, skepticism arises from doubts about the alignment of government goals with realistic timelines and OEMs' ability to meet these objectives.

7-6 Key findings

This chapter addressed the question: *How do government policies influence the strategic decisions of Dutch automotive companies regarding the uptake of EVs and PHEVs up to 2025?* The research reveals how companies adapt to national and European challenges in positioning and shaping their strategic decisions up to 2025.

- The sector is struggling with an unpredictable regulatory landscape. Frequent policy changes caused by the 'hand on the tap' approach have created a reactive environment, forcing companies to prioritize short-term strategies. There is no concrete strategy for 2025-2028, reflecting widespread uncertainty in the sector [Ob03a].
- The governmental objectives are disconnected from sector realities, particularly in balancing zero-emission targets with the need for affordable and accessible mobility [FI01].
- European OEMs face dual pressure: competition from Chinese EVs and dependency on costly battery production [FI02]. This requires investment in electric and ICE vehicles, putting pressure on OEM revenue models [D03]. However, the automotive sector is awaiting the residual values of Chinese products to assess the true extent of their competition [FI02].
- A misconception exists among policymakers that the automotive sector can handle regulatory pressure like the tobacco industry. However, achieving electrification requires mass uptake, which is not yet happening.
- Automotive lobbyists are pushing for policy reforms in Brussels, expressing concerns that without intervention, European manufacturers could be at risk [Ob02]. As FI02 noted, "The Green Deal remains central to European policy, but there is a growing recognition that these goals need to be met without harming the European market."
- Political and economic instability has led to consumer hesitation, with purchases postponed or shifted to cheaper alternatives [D04, D05, IM11, IM13, Ob10; Lindeboom et al., 2024]. Over the past five years, the average cost of vehicles has risen by 36.5 percent, turning cars into luxury products [D01, FI08, Ob03a].
- Within the automotive sector, formal optimism contrasts with informal concerns. Confidence is projected in interviews or presentations. However, there are ongoing concerns about OEM innovation speed, notably Volkswagen [Ob03b]. "I wouldn't say we are the real innovators in this area. The Volkswagen Group is still quite conservative," FI01 remarked. Still, FI07 noted, "I do think that in three or four years, we'll have a solid program again, balanced between fully electric and non-electric models."

Chapter 8

Results: Strategies up to 2030

This chapter focuses on the strategies companies adopt towards 2030, a period representing a transformation phase. OEMs are focused on long-term technological development, while consumers take a much shorter-term perspective. This contrast influences the strategies being developed to navigate the challenges ahead.

Policymakers are beginning to recognize that achieving zero-emission targets requires a broader technological approach. While electrification remains central, there is increasing awareness of affordability limitations, infrastructure challenges, and consumer hesitation. In Section 8-1, the chapter discusses how companies are positioning themselves in response to these challenges. D04 noted, "Fiscal policies alone are not enough to drive widespread uptake, as the reality is still too complicated for most consumers to transition to electric mobility."

At the same time, automotive companies face pressure to remain competitive and profitable. Section 8-2 explores the impact of the shifting political landscape, both domestically and at the European level. Finally, Section 8-3 examines how technological diversification, such as developing e-fuels, offers a potential path to meeting future emission targets. Therefore, this chapter addresses sub-question 3: *What strategies are Dutch automotive companies expected to adopt, and how are they positioning themselves in the changing vehicle landscape leading up to 2030?*

8-1 Dutch automotive strategies toward 2030

The shift towards electrification, parallel with increasing vehicle costs and the phasing out of fiscal incentives for EVs after 2025, presents concerns within the automotive sector. Until now, EV uptake has primarily been driven by budgetary advantages, but these incentives are set to end in the Netherlands and across Europe. This marks a turning point where customer motivation needs to shift from external incentives to an intrinsic demand for EVs.

Dutch automotive companies are facing the necessity of a strategic shift. As discussed by Rutten et al. (2024), the Dutch government aims to incentivize more EVs for businesses by collaborating with Brussels, but the effect on private buyers remains unclear. The Dutch automotive sector is anticipating that around 60% of newly sold cars will be electric in 2030, according to FI07. D01 added, "In the Netherlands, we simply cannot achieve the dream of being ahead of the rest because we just don't have the financial means for it."

Automotive companies like dealers increasingly focus on simplifying business processes [Ob03a]. By enabling customers to handle more tasks independently, the need for employees is reduced, which lowers costs and improves the customer experience. Streamlining service offerings promotes a more efficient and user-friendly approach, helping businesses stay competitive while improving operational efficiency.

Business customers are becoming more central, highlighted by 12 out of 13 interviewees and in Ob03a. For businesses, new cars, particularly EVs, remain feasible options, with at the end of 2023, 26,5% of business drivers in the Netherlands fully electric [CBS, 2023]. Moreover, a strategic focus is required on the second-hand market to provide private consumers with more affordable vehicles [FI08, D01, D02, D03]. This double focus on B2B, mobility solutions, and the second-hand market is discussed in this section, shaping the future strategies of Dutch automotive companies.

8-1-1 Role of the second-hand market and private buyers

The ongoing economic trend of rising vehicle prices for both ICE and EV models creates a gap between what cars cost and what (private) consumers can afford. This shift positions cars as increasingly inaccessible luxury products [Ob03] [Business Insider Nederland, 2023]. The limited number of new EVs entering the market has affected the availability of second-hand EVs [FI01]. This shortage has driven up prices [D02]. Additionally, dealers face losses on second-hand EVs, making them less eager to focus on this segment [D01]. According to Krijgsman (2023), the average price of a second-hand car is now more than 28 percent above what the average consumer is willing to spend.

Since the Netherlands has one of the oldest car fleets in Europe, the second-hand market is essential in serving these private customers [FI08]. This market is currently underdeveloped. As FI02 noted, "The biggest problem we see in the Dutch second-hand market is that there are no cars available for the average consumer because they no longer have the money for a new car. Yet, there aren't any second-hand electric cars available." This reflects the current dilemma where low- and middle-income consumers who rely on second-hand cars cannot access affordable EVs.

To address this gap, automotive companies must position themselves in the second-hand market. Some dealers are importing cars themselves [FI02]. Moreover, as lease contracts expire, an influx of used EVs and PHEVs is expected to enter the second-hand market [FI04]. Informal conversations have revealed an outflow of second-hand EVs from the Netherlands, which may limit the availability of affordable used EVs domestically [Ob13]. However, a strategy for entering the second-hand EV market is still under development.

8-1-2 Business to business and mobility solutions

Currently, the Dutch automotive market relies heavily on forced sales. As D05 remarked, "We are pushing forced cars onto the market... The challenge is getting those cars to the market healthily." According to D03, this is unsustainable. Therefore, in the coming years, the sector will focus on B2B sales and mobility solutions [Ob03a, Ob05a, Ob11].

As this report indicates, as electrification progresses and vehicle costs continue to rise, new cars are becoming less affordable for private consumers. As D05 observed, "The private market is shrinking. There are fewer reasons for private consumers to purchase electric vehicles." Therefore, a shift toward corporate clients is essential. Businesses such as fleet operators, leasing companies, and corporations with sustainability targets are expected to influence future demand, particularly for EVs. These clients are better positioned to manage the high costs of new vehicles and are obligated to reduce their carbon emissions [FI03]. This growing focus on B2B sales is becoming central to the sector's long-term planning.

In addition to focusing on B2B, there is a growing need for dealers to offer mobility solutions that go beyond traditional vehicle sales. These include services such as fleet management, car-sharing, subscription models, and integrated mobility platforms. However, many Dutch dealers are still determining how best to implement these services to offer mobility packages instead of vehicle ownership alone [IM07]. Larger dealers, especially independent of a single importer, are growing in this area. In contrast, smaller or importer-dependent dealerships are still exploring how to integrate these new services into their operations and adapt to the changing landscape.

Dutch automotive companies must address their clients' operational and sustainability demands to achieve future growth. The ability to offer mobility solutions in addition to vehicle sales will likely become a differentiating factor in their success.

8-2 Political shift in the European landscape

As Dutch automotive companies move towards 2030, there is growing recognition that achieving zero-emission mobility requires more than just focusing on EVs. While dealers are not directly involved in this broader strategy, importers are participating in European discussions to ensure the wider interests of the automotive sector are considered [Ob04]. These companies highlight that reaching the goal of zero-emission mobility should not depend on one prescribed technology [FI02]. Instead, it should focus on CO_2 reduction without dictating specific solutions. The Dutch context strongly prefers this flexible approach, as the automotive sector is concerned about the reliance on EVs alone [Ob04].

In informal discussions, some supporters of electric mobility admitted that their goal was not promoting sustainable driving with EVs but reducing overall mobility [FI06]. This highlights internal differences and varying motivations behind the shift to electrification. As FI02 stated, "Don't demand a specific technology. Set a goal, like CO_2 reduction, and let the industry figure out how to get there. Whether it's through EVs, PHEVs, e-fuels, or hydrogen, flexibility is needed." This reflects the importance of a regulatory environment that allows different approaches to reducing emissions rather than forcing the sector into one direction.

All interviewees acknowledged the obstacles that remain before full electrification can happen. FI03 noted, "There isn't enough battery capacity available to let the whole world drive electric." Practical concerns around infrastructure, affordability, and resource availability continue. Moreover, subsidies to encourage consumers to adopt new technologies are ending. This suggests a shift is needed toward a more varied and realistic approach to sustainability goals [VER, 2024].

At the European level, automotive lobbyists are trying to keep a backdoor open', pushing for an approach that recognizes the difficulties of relying exclusively on EVs [FI02]. OEMs are looking into alternatives like e-fuels and hydrogen. This strategy also presents a chance to reduce dependence on China for batteries, which has become a growing concern for European automakers. Additionally, the imposition of import duties on Chinese-made cars is affecting the automotive market by complicating the ability to export cars to China [FI01]. These dynamics underscore the need for diversified solutions to meet environmental and geopolitical challenges.

In Brussels, the automotive sector, primarily through the Association de Constructeurs Européens d'Automobiles (ACEA), is known for being conservative. IM12 stated that Volkswagen is "very conservative," indicating slower adaptation to modern lobbying dynamics. By contrast, the Dutch automotive world adopts a more transparent and inclusive lobbying approach to balance perspectives [FI02]. This tension within the automotive industry shows the sector's internal struggles in achieving affordable zero-emission mobility.

8-3 Technological diversification: e-fuels

In the Dutch automotive landscape, discussions around alternatives have increasingly shifted towards e-fuels rather than hydrogen. Consequently, as this report centers on the perspective of the Dutch automotive sector, e-fuels are the point of discussion. Different OEMs are already exploring additional technologies: for example, BMW is developing hydrogen fuel cells, and Porsche has invested in e-fuels. In formal and informal interviews, e-fuels are viewed as a viable option, or there is limited knowledge about alternatives.

E-fuels, or synthetic fuels, are produced using renewable energy to combine hydrogen and carbon dioxide into a liquid fuel that can be used in ICE vehicles [Ravi et al., 2022]. This allows current vehicles to run on e-fuels without needing engine or fuel infrastructure transformations [FI02]. E-fuels offer higher conversion efficiencies and can use the existing fuel infrastructure, making them more immediately viable for large-scale uptake of passenger vehicles than hydrogen fuel cells [FI08, Ob04].

Another argument for e-fuels is their ability to provide an environmentally friendly option for consumers who cannot afford or are not ready to transition to EVs. If e-fuels are produced on a large scale and are not subject to additional taxes, they could be as affordable as traditional fuels. However, e-fuels are costly, with prices around €10 per liter, primarily due to low production levels and the investments required to scale the production process [FI01, Ob05a]. As production scales, costs are expected to decrease, making e-fuels a more feasible option for decarbonizing the existing fleet of ICE vehicles. Until electrification is fully achieved, e-fuels can function as a bridge solution. Afterward, they could be redirected to heavy-duty trucking, shipping, and aviation sectors, where electrification remains more challenging [Ob05a].

Political support is needed to enable mass production and lower the costs of e-fuels [FI02]. The automotive sector is operating to make policymakers aware of the benefits of e-fuels. Political parties that have been critical of alternatives to EVs, often viewing them as greenwashing, are slowly realizing that a single focus on electrification affects a large segment of the population [FI07]. This shift indicates a growing awareness that flexibility in technology adoption is necessary for achieving environmental goals.

8-4 Key findings

This chapter discusses sub-question 3: *What strategies are Dutch automotive companies expected to adopt, and how are they positioning themselves in the changing vehicle landscape leading up to 2030?* The uncertainty continues to shape how Dutch companies navigate the evolving landscape of mobility solutions, regulatory pressures, and consumer demands. However, there is recognition within the sector that a turning point is approaching, whether in 2028, 2029, or 2030.

- The findings reveal skepticism within the sector about achieving full electrification. As FI02 commented, "I don't believe we will be selling 100% electric cars by 2035, and I doubt we'll see only electric vehicles globally by 2050."
- The Dutch automotive companies recognize that the current business model is unsustainable. D05 pointed out, "The biggest challenge isn't just producing these cars, but bringing them to the market financially sustainably. If margins keep getting thinner, and you rely on subsidies, then it's not a viable long-term model."
- Dutch companies are shifting their strategies toward B2B sales and offering mobility solutions but are still figuring out how to implement them. Moreover, they are engaging more proactively in the second-hand market, which is underdeveloped, with vehicles largely unavailable and increasingly expensive.
- As full electrification remains uncertain, lobbying for alternative technologies such as e-fuels continues. E-fuels present an attractive solution, as they allow existing ICE vehicles to operate in a more environmentally friendly manner [Ob04].
- These diversified technologies could reduce dependency on Chinese imports, offering a more flexible path toward sustainability. FI04 noted, "If we continue on this path, we'll become completely dependent on China for mobility. But how green are Chinese products?"
- Political support remains uncertain due to greenwashing concerns, raising doubts about investments in this technology. E-fuels are currently expensive [IM17, Ob05a]. However, scaling production is expected to lower costs. If politics supports it and oil companies follow, e-fuels could have a future.

Chapter 9

Results: Broader system dynamics

Chapters 6, 7, and 8 analyzed specific challenges and how corporate entrepreneurial activities adapt to the changing landscape. This chapter focuses on feedback loops, examining how the interaction between functions drives or slows innovation. It addresses the research question: *How do corporate entrepreneurial activities within the Dutch automotive sector interact with the functions of the TIS framework to drive the electrification of passenger vehicles by 2030?* It zooms out to analyze how corporate entrepreneurial activities influence, and are influenced by, other TIS functions in the Dutch context.

The TIS framework identifies seven functions for understanding innovation dynamics: corporate entrepreneurial activities, knowledge development, knowledge diffusion, market formation, guidance of the search, legitimization, and resource mobilization. These functions are discussed in Section 9-1. Section 9-2 explores how corporate entrepreneurial activities interact with these functions, using interview results to demonstrate how Dutch automotive companies contribute to the transition to sustainable mobility.

9-1 Seven functions of innovation

This section discusses the seven functions of the TIS framework in the context of the electrification of the Dutch automotive sector. It examines how corporate entrepreneurial activities interact with the other six TIS functions. Since the Dutch automotive sector relies on external OEMs for production, OEMs are categorized under knowledge development rather than corporate entrepreneurial activities.

Function 1: Corporate entrepreneurial activities
In the Dutch automotive sector, corporate entrepreneurial activities are driven by dealers and importers. These activities focus on integrating sustainability into business strategies; however, they have limited influence on vehicle availability, relying on decisions made by OEMs. Importers determine specifications, pricing, and margins for vehicles in the Dutch market (see Chapter 8) [FI08]. They also serve as intermediaries between OEMs, the government, and consumers, navigating the demands of all parties.

Importers and dealers introduce new products, adapt models, and explore opportunities such as integrated mobility solutions and fleet management. They manage regulatory changes while addressing consumer hesitations toward sustainable mobility. However, profitability challenges and divided investments between ICE vehicles and EV technologies restrict the sector's focus on electrification. As indicated in this report, their responses are often reactive, relying on short-term promotions rather than proactively driving the uptake of EVs and PHEVs.

Active participation in coalitions such as RAI for importers and BOVAG for dealers is essential for knowledge diffusion, which, in turn, drives market formation. This intermediary role places automotive companies, particularly importers, at the forefront of balancing short-term financial objectives with the long-term goal of facilitating a sustainable and electrified mobility market.

Function 2: Knowledge development
Knowledge development includes activities related to research and development (R&D) and the creation of technological expertise. However, much of this development occurs outside the Netherlands in the Dutch automotive sector. The Dutch automotive sector relies on OEMs outside the country, such as the German automotive industry. OEMs like Volkswagen and Porsche are developing new models and technologies, including electric drive trains and advancements in battery technology [FI02]. For example, Porsche invests in e-fuels and battery production as part of its broader efforts [FI08].

In Dutch, automotive companies contribute to knowledge development through collaborations with universities, research institutions, technological firms, and coalitions. One example is that importers often collaborate with institutes like TNO [IM06], which conducts cost analyses of PHEVs. Moreover, importers organize knowledge-sharing sessions to discuss new technologies, share information, and brainstorm with experts from research institutions [Ob14]. As part of their contribution to knowledge development, importers also lend EVs to testing institutes, allowing these institutions to assess the viability of new technologies and provide valuable feedback on performance and user experience [FI01]. These collaborative efforts enable Dutch companies to participate in technological advancements.

Function 3: Knowledge diffusion
Corporate entrepreneurial activities depend on the knowledge diffused by OEMs, research institutions, and coalitions such as RAI and BOVAG. The diffusion of technological advances, like EV batteries and charging infrastructure improvements, enables businesses to adapt and innovate.

Knowledge diffusion refers to the spread of information and innovation through formal and informal networks. Coalitions (RAI, BOVAG, ANWB, NMA, and Stichting Natuur en Milieu) inform businesses and the government in the Dutch automotive sector. These networks act as intermediaries, connecting technology developers (like OEMs), corporate activities, and the market to facilitate collaboration and raise public awareness of new technologies. For instance, VER works to counter myths about electric driving and promote the uptake.

Information sharing within the sector remains fragmented. As D02 noted, "There is no fixed pattern: sometimes it's from someone who just picks something up, sometimes someone reads the news, and other times we are directly involved." This highlights the informal way knowledge is gathered within the sector, successfully combining different insights even without a fully structured method. FI03 marked: "It's not collected in a highly structured way, but it all comes together." Companies recognize that a more streamlined approach to knowledge diffusion could enhance coordination and clarity, with FI07 stating, "We are still in a phase of getting the basics in order."

By bringing together diverse sources of information, these networks shape the sector's understanding of technological advancements and market trends, though better organization remains necessary. As knowledge diffuses through these networks, it sets the stage for market formation by informing consumers and businesses about advancements in electric mobility, which ultimately drives demand and influences resource allocation.

Function 4: Market formation
Market formation marks the beginning of new technology uptake, as it involves generating demand and establishing the necessary infrastructure. In the Netherlands, the government supported market formation. Financial mechanisms, such as cash-back offers, road tax reductions, and public charging station development, created initial demand for EVs [D03]. However, as discussed in Chapter 7, incentives are insufficient to sustain long-term growth. Interview data from FI06 and FI08 confirm that subsidies are being phased out, and infrastructure limitations continue to slow growth. Additionally, inconsistent incentives and regulations have created uncertainty, further destabilizing the market. As government funding decreases, a more stable foundation for demand, rooted in public acceptance, becomes essential to continue EV uptake [IM13].

As discussed in Chapter 8, importers and dealers contribute to market formation through integrated mobility solutions. These include business leasing options, partnerships for charging infrastructure, and bundled services offering complete mobility packages [Ob03a, IM07]. Market formation is directly connected to the ability to secure the financial resources and skilled labor necessary for scaling EV infrastructure and production capabilities. As noted by FI05, the results of market formation also influence long-term policy guidance, as seen in the national goal of zero-emission vehicles by 2030.

Function 5: Guidance of the search
Guidance of the search refers to the direction provided by policy goals and long-term strategies, such as emission reduction targets or technological priorities. In the Dutch case, the government's policy mandates that all new cars entering the market must be zero-emission by 2030. This target is influenced by broader European goals, which set a 2035 deadline. Unlike market formation, which involves creating direct incentives, guidance of the search shapes the broader trajectory, influencing knowledge diffusion and legitimization.

The Dutch automotive sector faces challenges in navigating these ambitious long-term goals. As discussed in Chapter 7, government policy inconsistencies have created uncertainty [D05, FI07]. As FI03 highlighted, companies react to frequent policy shifts instead of making proactive long-term investments. These shifting policies around incentives and regulations raise doubts about the reliability and consistency of targets [FI04, D01, D03].

Function 6: Legitimization
Legitimization is the process of achieving social and political acceptance of new technologies, which is essential to initiating widespread uptake, often referred to as the "flywheel effect" (vliegwiel) [D02]. Without legitimacy, the entire system can slow down or stagnate. As noted in market formation, financial incentives have created initial demand, but societal acceptance must be strong enough to sustain market momentum once these incentives end. Therefore, long-term growth depends on maintaining public and governmental confidence.

In the Netherlands, FI08 observed that societal acceptance remains weak: "So people are not convinced to drive electric, but do it more because they have to." IM13 echoed this sentiment, emphasizing the lack of intrinsic motivation to adopt EVs. Additionally, the automotive sector faces challenges in countering misinformation and negative media attention regarding EVs, as discussed in Chapter 6.

Negative media coverage amplifies public skepticism, weakening trust in the technology and reducing social acceptance. This declining legitimacy affects business strategies, with companies adopting reactive rather than proactive approaches to driving EV uptake. Nine interviewees underscored the media's role in supporting or delaying the legitimization process. As D01 remarked, "There's a lot of negative media attention around electric driving right now, and that doesn't help." Isolated incidents distort public perception, allowing stories to develop their own life.

Misinformation further complicates stakeholder interactions. Companies also encounter internal resistance from employees or customers who remain skeptical about electrification. FI06 described this dynamic: "You always have 5% of people who start digging in their heels (...) And those who shout the loudest, you hear the most." Without sustained legitimization, corporate entrepreneurial activities slow, further reducing the momentum of the EV transition.

Function 7: Resource mobilization
Resource mobilization involves securing the financial investments, skilled employees, and technical resources needed to support new technologies. In the automotive sector, this includes areas such as battery technology and the need for specialized workers, like high-voltage employees, which are required for scaling the uptake of EVs [Ob11]. The ability to secure these financial and technical resources is directly tied to market growth.

OEMs face the challenge of investing in both ICE vehicles and EVs, which divides available resources and limits the capacity [D01, Ob12]. This divided focus on both technologies reduces the financial and human resources available for EV development [Ob12]. As noted by FI02, this divided investment strategy reduces overall profitability as they struggle to balance the costs of maintaining two different technological paths.

9-2 Interplay of innovation functions

Figure 9-1 illustrates the interactions between the seven functions of innovation of the TIS framework within the Dutch automotive sector. The arrows highlight the dynamic feedback loops indicated in this case study. Each function is represented in the boxes, with red, orange, and blue arrows indicating the directions of influence. The blue arrows represent regular feedback loops without significant limitations or drawbacks. Red arrows indicate areas of weakening, decreasing, or inconsistent feedback. Orange arrows indicate limited influence. The red and orange arrows are explained below, based on insights from interviews and prior chapters.

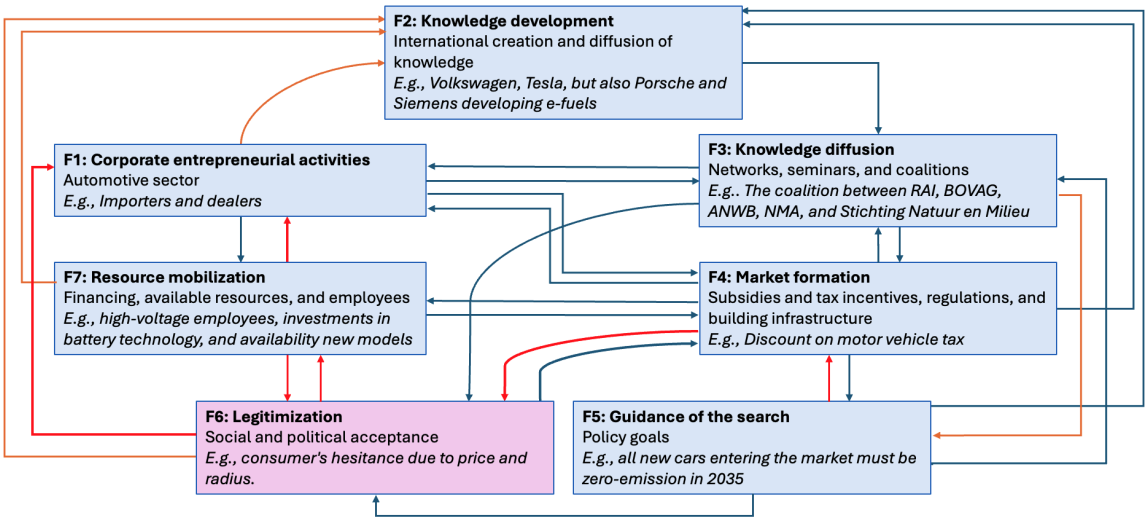

Figure 9-1: Feedback loops between the seven functions of innovation of the TIS framework

The purple box underscores the importance of legitimization in the early stages of technological transitions. As acceptance of EVs declines, the entire innovation system faces setbacks, slowing the transition to sustainable mobility. Weakening feedback loops emerge between corporate entrepreneurial activities and resource mobilization, as well as between legitimization and both market formation and guidance of the search. With weakening legitimacy and market formation, companies focus on short-term sales tactics and promotional efforts to maintain profitability. Media misinformation and consumer hesitation contribute to this weakening of legitimacy [FI08, IM13]. Misrepresenting EV risks and benefits undermines public confidence, hindering resource mobilization and EV sales [FI01, FI02, D01, D03]. These dynamics create a feedback loop that slows innovation, highlighting the need for sustained legitimacy to ensure resource availability and market momentum.

Red arrows: weakening, decreasing, or inconsistent feedback

- Resource mobilization (F7) to corporate entrepreneurial activities (F1)
  The Dutch automotive sector is facing challenges due to the unavailability of suitable models, making it difficult for companies to sell vehicles, as profits from these models are minimal. Interviewees FI02, FI08, and D01 mentioned that profit margins have decreased. Dealers currently experience long waiting times for vehicle maintenance, which they appreciate, as 70% of their income comes from these services [FI07, D02]. Due to these long waiting times, there is still no pressing need to train additional employees as high-voltage technicians, which is essential for servicing electric vehicles [Ob11]. At the same time, long waiting times also cause concern, as dealers are losing customers to competitors [D01]. As customer loyalty becomes increasingly important, dealers are careful. These issues reduce the incentive for dealers to prioritize EVs, as their focus remains on selling vehicles, whether powered by ICE or electricity.

- Legitimization (F6) to corporate entrepreneurial activities (F1)
  When consumers are hesitant to purchase EVs, it becomes increasingly difficult for dealers and importers to sell them. This challenge directly impacts their sales performance and overall business health. As legitimacy weakens, corporate entrepreneurial activities slow, with dealers and importers relying on reactive strategies. This shift in approach reflects the growing skepticism discussed in previous chapters and highlights the decline in entrepreneurial momentum within the automotive sector.

- Legitimization (F6) and resource mobilization (F7) in both directions
  When public and governmental support for EVs is limited, it directly affects the financial resources available for investment. OEMs face the challenge of investing in both ICE vehicles and EVs. This creates a negative feedback loop: public acceptance declines without adequate investment in affordable, efficient EV technologies. Consumer concerns make it harder for companies to secure the necessary financial support. This further weakens confidence in the EV transition. PHEVs offer a potential solution by maintaining progress while reducing some of the financial pressure on OEMs.

- Market Formation (F4) to legitimization (F6)
  In the early stages of market formation, legitimacy was promoted by generating demand for EVs through financial incentives to stimulate social acceptance. However, as government funding decreases and these financial advantages remain the primary motivator for EV uptake, societal acceptance declines, weakening legitimacy.

- Guidance of the search (F5) to market formation (F4)
  Government targets, such as the Netherlands' 2030 electrification goal, are intended to drive market formation, but skepticism within the automotive sector is growing. Ten out of fourteen interviewees do not see the 2030 goal as achievable, and there is active lobbying for a loophole regarding the 2035 target. Additionally, the government initially promoted EV uptake through financial incentives, but it has generated less revenue from the automotive sector than anticipated. Without continued financial support and growing doubts about long-term goals, the momentum for market growth slows.

Orange arrows: limited influence

- Corporate entrepreneurial activities (F1) to knowledge development (F2)
  Business contribute to knowledge development but have limited overall impact. Importers communicate market demand and preferences to OEMs, helping manufacturers understand consumer needs. However, whether these requests lead to new model developments is uncertain, as the final decisions lie with the OEMs. Dealers do not influence the models being produced. Importers remain active in other areas, such as investing in shared mobility and charging solutions, allowing them to stay involved in innovation.

- Corporate entrepreneurial activities (F1) to legitimization (F6)
  Corporate entrepreneurial activities, such as introducing new EV models or mobility solutions, aim to promote legitimacy but have limited influence. Importers and dealers cannot offer unavailable models, restricting their ability to meet market demand. Additionally, dealers and importers have little direct impact on shaping broader societal perceptions of EVs. Rather than actively influencing trends, they primarily react to them, which limits their capacity to strengthen public confidence and increase acceptance of EVs.

- Resource mobilization (F7) to knowledge development (F2)
  While financial and human resources are essential for knowledge development, progress is constrained by the absence of European battery manufacturers. European companies aiming to produce batteries struggle to secure the necessary funding to remain competitive, making establishing a local supply chain difficult. Despite investments in skilled labor and new technologies, the sector's ability to drive knowledge development is limited by its dependence on external suppliers for necessary technologies.

- Knowledge diffusion (F3) to guidance of the search (F5)
  Knowledge diffusion through societal coalitions, as discussed in Chapter 6, helps share insights but has a slow impact on long-term governmental policy. Although larger policy decisions are often driven by European-level objectives, such as the 2035 zero-emission target, the societal coalition has been established to send a signal to both local and European policymakers. Dutch political representatives in Brussels aim to bring these

issues to the forefront, but progress is slow. The Netherlands' limited domestic automotive sector relies on countries like Germany, France, and Italy to push these themes forward [FI01]. While the impact is gradual, it is not absent, as these networks continue to influence both short-term initiatives and contribute to broader policy discussions over time.

9-3 Key findings

This chapter addresses the question: *How do corporate entrepreneurial activities within the Dutch automotive sector interact with the functions of the Technological Innovation Systems framework to drive the electrification of passenger vehicles by 2030?* The analysis highlights the following points.

- The reliance on external OEMs and fragmented information-sharing practices limits the effectiveness of technological advancements. While knowledge diffusion supports corporate entrepreneurial activities to some extent, interviews emphasized the need for better coordination and collaboration to enhance innovation.
- The legitimacy of EVs depends on market formation, influenced by inconsistent government policies, the phase-out of financial incentives after 2025, and sector skepticism. The decline in public acceptance further complicates legitimacy.
- Divided investments between ICE and electric technologies reduce the financial capacity for targeted innovation. The phase-out of incentives and stagnating public acceptance drive companies to explore alternatives like e-fuels, redirecting focus away from EV adoption. Speculation about new technologies further increases consumer uncertainty, creating additional obstacles for the transition.
- Reduced public enthusiasm, fragmented resources, and technological uncertainties weaken feedback loops, affecting interconnected system functions such as market formation, resource mobilization, and legitimacy. This risks slowing overall progress in the electrification transition.

Chapter 10

Discussion

This chapter reflects on the assumptions made at the start of this research and the results that followed. The researcher initially assumed that companies in the Dutch automotive sector had clear strategies or roadmaps to accelerate electrification. However, the study revealed that the automotive sector does not see electrification as a primary objective but rather as a response to external pressures. Obstacles such as the dominance of short-term strategies, unstable government policies, and consumer hesitation complicate the sector's transition. These findings reveal differences between ambitious goals and practical implementation.

The discussion is organized as follows: Section 10-1 explores the short-term focus in the automotive sector. Section 10-2 addresses the misalignment of objectives. Section 10-3 examines corporate entrepreneurial activities and skepticism. Financial viability is analyzed in Section 10-4. Section 10-5 reflects on the TIS framework. Then, the scientific contribution is presented in Section 10-6. Last, Section 10-7 evaluates the research's validation and limitations.

10-1 Short-term focus

The researcher initially assumed that importers and dealers employed long-term strategies to accelerate the transition to electric mobility. However, this thesis reveals a gap between the academic concept of 'strategy' and its practical application. Interviews did not uncover fully developed long-term strategies, although interviewees may have been unwilling to share this information.

Instead, electrification is approached more as a response to regulatory pressures and market shifts than as a proactive effort to accelerate change. In practice, 'strategy' within the sector often translates to short-term actions like sales promotions. As a result, this thesis shifted its focus to companies' contributions to navigating the transition rather than accelerating it.

Interviews show that model availability is determined by brand representatives, with importers setting sales targets and supporting EV servicing through initiatives such as training high-voltage engineers. However, the absence of concrete long-term strategies leaves many respondents unclear about goals, challenges, and responsibilities. It seems almost like the automotive sector is primarily putting out fires. For instance, when an EV fire generates negative media coverage, importers are tasked with countering public skepticism.

10-2 Misalignment of objectives

The initial assumption was that government and businesses were aligned in promoting electrification. Interviews and observations instead revealed a misalignment between the objectives of governments, businesses, and consumers. While the overarching goal of electrification is shared, the priorities and motivations behind this differ greatly.

The government aims to balance three objectives: securing financial stability, ensuring affordable mobility, and only then achieving climate goals. For consumers, the focus is primarily on cost-effective and reliable transportation without range anxiety. Consumers focus on financial and practical considerations, such as cost-effectiveness and reliability, with climate concerns often secondary. Furthermore, the capitalist structure of the economy, where market forces dominate, does not align well with addressing climate challenges. Businesses struggle to pursue sustainability when it threatens their financial stability.

10-3 Corporate entrepreneurial activities and skepticism

The third assumption examines the role of corporate entrepreneurial activities during the transition towards electrification. It was expected that businesses within the sector would take the lead in overcoming barriers. However, the research revealed this assumption was overly optimistic, as the automotive sector is in a complex position between consumers, policymakers, and OEMs.

While it is often thought that the sector can solve the challenges surrounding electrification, the reality is more nuanced. The sector is neither fully committed to it nor completely opposed. The automotive sector does not see it as their role to accelerate the transition and often adopts a wait-and-see attitude. Companies remain optimistic, perhaps even somewhat naive, about waiting for new models to arrive or relying on short-term fixes to boost sales. This contrasts with the uncertainty they face regarding the sustainability of their businesses and their position within the landscape.

Interviewees expressed optimism in formal settings, projecting confidence in their businesses and future. However, a more skeptical tone appeared during informal conversations. Companies seemed hesitant to admit the full extent of their challenges publicly.

The disconnection between formal optimism and informal skepticism reflects a deeper issue of legitimacy within the sector. Consumers are changing: they are less focused on status and more on practical choices, where price and fiscal benefits remain drivers. There is a growing concern that new cars are becoming luxury products. Skepticism remains widespread, creating the impression that they do not want to be convinced to switch to EVs.

Dealers, in turn, encounter personal preferences and the profitability of their business models. Many employees in the automotive sector are 'petrol heads,' and this attachment to traditional cars complicates the full acceptance of EVs. During informal meetings, they were not negative towards EVs but extremely positive about ICEs. This creates an underlying paradox: those passionate about the roar of engines are expected to sell silent EVs. If the seller feels no personal connection to the product, how can it be expected that the customer develops one?

Government actions further amplify this skepticism. Interviewees expressed doubts not only about the feasibility of government goals but also about alternative fuels. These topics are often presented as more complex than necessary, creating an internal barrier for employees within the automotive sector. If they find it too complex to understand, they prefer to wait. Moreover, within automotive companies, there is communication between departments. However, the many connections across the sector make it difficult to ensure a consistent flow of information, which is essential in times of uncertainty.

10-4 Financial viability

A central challenge in the electrification process is ensuring its financial viability. Government policies were expected to be thoroughly planned and calculated. However, this research indicates gaps in these assumptions. As taxes from traditional vehicles decline, adjustments to tax policies will become unavoidable. There is a tipping point where the cost of subsidies outweighs the benefits, especially if EV sales do not compensate for the loss of tax revenue. This creates uncertainty for businesses and consumers, mainly as the government relies on a single calculation model to predict outcomes. However, this model contains errors, making its predictions unreliable and increasing the likelihood of policy reversals.

The challenge lies in balancing costs and benefits for both governments and businesses. One argument suggests that increasing costs for traditional options, such as through emissions fines, could push manufacturers toward producing cheaper EVs. However, this approach only works if the market remains flexible and is not restricted to a single technology. Simply subsidizing EVs is not a sustainable solution if momentum in the automotive sector is insufficient before funding is exhausted. Therefore, the main concern is whether the public will accept EVs quickly enough. If uptake is too slow, financial resources may be exhausted before the transition is complete, leaving the government, the automotive sector, and society in a difficult position.

10-5 Reflection on TIS framework

The TIS framework provided insights into how different functions interact to drive or slow innovation in the Dutch automotive sector. However, this research highlights limitations in its applicability. The framework relies on establishing legitimization early in innovation, driven by market formation through subsidies and incentives. Although these measures initially boosted demand for EVs, the system struggles to maintain legitimacy when financial support is reduced or removed. This reveals a 'loose end' in the framework: while it identifies system dynamics and barriers, it does not provide actionable strategies to resolve them. This limitation is particularly relevant for Pon, as the company faces challenges in determining actionable steps to advance electrification. For companies, this absence of actionable solutions is a challenge, as the framework is not suited for guiding the next steps in the transition.

Furthermore, the framework assumes that all functions drive innovation equally. This research shows that the weakening of legitimization has a disproportionately large impact on the overall system compared to other functions. Such uneven influence challenges the assumption that all functions are equally important, reducing the framework's effectiveness in reflecting real-world dynamics.

Moreover, the rigid structure of the TIS framework, which focuses on categorizing functions, often feels constraining and risks oversimplifying the roles of stakeholders and intermediaries. Assigning every actor to a single function is impossible, as some operate across multiple functions. By focusing on categorizing functions into distinct 'boxes', the framework risks overlooking the contributions of specific stakeholders. This rigid structure can marginalize actors who play multiple roles, limiting a nuanced understanding of their influence. These limitations are displayed in three ways within the Dutch automotive sector.

First, knowledge diffusion is limited by paid participation. Financial barriers restrict membership, leading to exclusion from important knowledge-sharing networks. Some brands, like Tesla, operate outside these coalitions, following their independent strategies. This exclusivity limits the overall diffusion of knowledge within the sector and is a limitation not fully addressed by the TIS framework. Second, the cautious approach to communication slows down the innovation process. In many cases, delays in decisions or public statements further complicate sector-wide progress as companies wait for official positions before taking action. This cautiousness mainly affects the legitimacy function, as unclear communication influences trust and alignment among stakeholders. Third, the dynamics of knowledge sharing are further complicated by long-standing competition between dealers, which restricts the flow of information and restrains collaboration across the sector. Moreover, including new players, such as a Chinese brand within RAI, introduces political sensitivities. RAI must now navigate a more cautious approach regarding its stance on Chinese import tariffs, complicating coalition dynamics, as public statements must now consider all members' interests. These sensitivities create an environment where companies hesitate to share openly, fearing reputational damage, further limiting the potential for collaboration.

10-6 Scientific contribution

This study extends the understanding of the Dutch automotive sector's transition to electric mobility by offering a unique perspective on corporate entrepreneurial activities. These activities are shaped by external dependencies, a topic under-explored in previous research. The assumption was that companies would be more influential in driving the transition. This research reveals that importers and dealers are constrained. It highlights a gap in the literature, where much of the focus has been on technological innovation and policy-making, overlooking the external pressures that limit companies' independence within the sector.

10-6-1 Theoretical insights

This research suggests that the TIS framework is partially suitable for analyzing the Dutch automotive sector's electrification. Its broad, system-wide perspective effectively identifies feedback loop dynamics and systemic barriers. However, the framework's rigid and illustrative nature limits its applicability in addressing businesses' practical needs, particularly when feedback loops stagnate.

Compared to the existing literature, this research adds a unique corporate perspective, highlighting the strategic actions of established businesses within the TIS framework. While studies such as [Hekkert et al., 2007; Bergek et al., 2008] extensively discuss entrepreneurial activities, they often overlook the nuanced role of corporate entrepreneurial activities. Additionally, this study diverges from prior work by challenging the assumption that all TIS functions carry equal weight. For example, findings demonstrate that weakening legitimization disproportionately impacts system dynamics, a nuance less emphasized in studies such as [Suurs et al., 2009; Van Wee et al., 2022]. It highlights the need for a more dynamic understanding of how certain functions dominate in specific contexts, offering a new dimension to the existing framework.

This research suggests adaptations and alternative approaches to address the identified limitations of the TIS framework. Incorporating elements from the Multi-Level Perspective framework could provide a broader socio-technical analysis, including insights into macro-level trends and cultural shifts [El Bilali, 2019; Bakhuis et al., 2024].

Modifications should focus on introducing strategic roadmaps or toolkits for stakeholders to make the TIS framework more applicable to practical contexts. These additions would help bridge the gap between academic analysis and real-world challenges, offering actionable guidance for navigating systemic barriers. Moreover, incorporating mechanisms to address structural limitations, such as financial entry barriers in coalitions, would ensure broader inclusion and improve the framework's effectiveness in supporting collaborative innovation. Addressing such barriers could enhance knowledge-sharing processes, making the framework more reflective of the complexities observed in the Dutch automotive sector.

10-6-2 Practical insights

This research adds perspectives on informal skepticism, the sector's financial fragility, and the barriers to knowledge sharing that are not always visible from the outside. The assumption that companies could accelerate the electrification process through targeted strategies has proven overly optimistic. The sector is still searching for its role within the evolving landscape. Concrete steps to address the present challenges are not in place, or perhaps these solutions are not openly shared (a point worth questioning).

Furthermore, the automotive sector remains optimistic about its future solutions in a formal setting. Dealers seem confident in receiving the appropriate models on time, raising questions about whether the optimism is justified. Even if the suitable models are available on time, another challenge lies in the practicalities of ownership, particularly the absence of adequate parking spaces with charging facilities.

Or perhaps this optimism is well-founded. When examining broader market trends, demand for PHEVs grew by 22%, resulting in 68% of all newly registered vehicles being partially or fully electric [Van Gastel, 2024]. This suggests that the transition, while seemingly slow, may need more time to gain total momentum. Rather than viewing the slower uptake rate as a failure, it may be part of a natural progression that requires patience and continued support.

10-7 Validation and limitations

It is important to note that the findings were derived from the perspective of one Dutch importer and corresponding dealers. The reliance on qualitative semi-structured interviews may reflect subjective biases or incomplete perspectives. The data gathered through interviews might not cover the full range of opinions or provide a comprehensive understanding of every stakeholder's view.

The focus on the Dutch market limits the generalization of the findings to other regions, as different markets may experience distinct challenges and dynamics. Moreover, while the research offers valuable insights into broader sector dynamics, the context may not fully reflect all players' experiences in the Dutch automotive sector. Therefore, the validity of the findings is most reliable within a narrow Dutch context, particularly for importers and dealers operating under similar constraints.

Chapter 11

Conclusion and future studies

This research highlights companies' dependency on external factors, offering new insights into their challenges in shaping the innovation process. While earlier studies have primarily focused on technological advancements or government interventions, this research reveals internal and external factors influencing companies' strategic actions. These findings provide a more nuanced understanding of the sector's transition toward sustainable mobility.

11-1 Conclusion

The Netherlands' broader uptake of EVs and PHEVs faces challenges due to skepticism within the sector, fluctuating government policies, financial uncertainties, and practical issues such as the limited availability of affordable models and insufficient charging infrastructure. These challenges contribute to a reactive, wait-and-see approach within the sector, delaying progress toward sustainable mobility.

At the same time, this research identifies actionable steps to build a more sustainable business model and drive the transition to zero-emission mobility by 2030. Therefore, this chapter addresses the main research question: *How can the broader uptake of electric and plug-in hybrid vehicles be driven in the Netherlands up to 2030, focusing on the strategic role of companies in this transition within the passenger mobility sector?*

The insights of this thesis lead to the following action points.

1. To drive the uptake of EVs and PHEVs in the Netherlands, *automotive companies* must shift from reactive to proactive strategies with a business-to-business focus. Findings challenge the assumption that the importer and dealers have long-term strategies to accelerate electrification. Instead, automotive companies remain reactive, driven by short-term market pressures, sales targets, and dependencies on external OEMs. Therefore, the focus must shift from short-term sales strategies to long-term plans centered on the B2B market.

The B2B market represents the most viable future pathway, as business customers are more likely to afford new vehicles and are increasingly required to report on their CO_2 emissions. By targeting corporate fleets and leasing markets, companies can align with these environmental reporting requirements and position themselves around sustainability.

As the parties with the best understanding of market needs and dynamics, the importer is uniquely positioned to guide the transition to B2B strategies. Proactively facilitating this shift, the importer can equip dealers with tools and techniques to target corporate customers. Furthermore, the importer can support dealers in developing second-hand EV markets, providing an affordable pathway to expand EV uptake beyond corporate clients.

In doing so, the importer enhances their relevance in the mobility transition and ensures dealers maintain stable revenue streams during the sector's transformation. By aligning with the B2B market's financial and environmental demands, automotive companies can create a sustainable business model for the long term.

2. *Dealers* need to diversify their business models to maintain profitability. One important step in the sector's transition is diversifying business models beyond traditional vehicle sales. Offering services such as EV warranties, maintenance packages, and complete mobility solutions, like fleet management and charging solutions, helps create new revenue streams. These services provide financial sustainability for companies during the transition and strengthen customer loyalty. Additionally, this approach allows companies to increase their presence in the B2B market, which is more likely to afford new vehicles.

For this diversification to succeed, knowledge must be centralized at the importer level. The importer must lead by guiding and supporting dealers throughout this process. By sharing expertise and providing clear strategies, the importer can ensure that dealers are well-equipped to offer these new services and adapt to the evolving market.

3. To drive the uptake of EVs and PHEVs, *the importer* must lobby for consistent government policies. The transition to EVs and PHEVs in the Dutch automotive sector reveals the complex interactions between corporate entrepreneurial activities and the other six functions of the TIS framework. One of the challenges is the weakening of legitimization, driven by insufficient public enthusiasm and sector skepticism for electrification. Additionally, inconsistent government policies create uncertainty for both companies and consumers.

Due to frequent regulatory shifts, automotive firms have adopted a skeptical wait-and-see attitude, hesitating to commit fully to electrification. Stable and forward-looking policies are essential to enable companies to develop long-term strategies. Therefore, lobbying for such policies is necessary.

4. To drive the uptake of EVs and PHEVs, *the automotive sector* must improve public perception and address skepticism among coworkers. Inconsistent government policies have not only resulted in short-term strategies but also contributed to growing skepticism within the automotive sector. While optimism is often projected in formal settings, informal conversations among stakeholders reveal deeper concerns about whether companies can deliver the necessary vehicle models on time and whether these models meet expected quality standards. The contrast between formal optimism and informal skepticism is important because it reflects the gap between public-facing narratives and internal challenges.

In response, the sector has begun diversifying revenue streams by offering warranties on EVs. This not only boosts consumer confidence but also provides additional income for the importer. Concrete steps, such as clear long-term plans for dealers, could address skepticism and strengthen belief in the future of electrification. When dealers believe in electrification, their enthusiasm will likely translate into more substantial consumer confidence, further supporting EV uptake. Moreover, through initiatives like test drives, consumers can be encouraged to experience EVs firsthand. This experiential approach can help overcome consumer hesitation and, consequently, reduce the perception that driving an EV is a challenge.

5. *The importer* must lobby for PHEVs and e-fuels to support zero-emission goals and help maintain mobility accessibility. Socio-economic factors continue to present barriers to the widespread uptake of sustainable mobility. Rising costs of new EVs and ICE vehicles and the absence of affordable second-hand EVs exclude many consumers from participating in the mobility transition. Charging infrastructure also remains a challenge, with home charging mainly available to those with private driveways and businesses facing long delays for necessary grid upgrades. These factors highlight the need for alternative solutions.

PHEVs offer a practical transitional solution for consumers who require an affordable and reliable option for daily commuting. Automotive companies are also exploring alternatives like e-fuels, recognizing that focusing only on EVs may not be sustainable long-term. E-fuels provide a potential zero-emission solution, particularly in sectors where full electrification is less feasible. Once the passenger vehicle market transitions to electric, e-fuels can be redirected for transport and potentially even aviation sectors, where electrification faces more significant challenges.

E-fuels like batteries can also help reduce Europe's dependency on China. By diversifying the technological portfolio with PHEVs and e-fuels, Europe can strengthen its supply chain resilience and reduce its reliance on Chinese imports, enhancing its competitive position in the global automotive market.

Figure 11-1 below summarizes these insights and provides a roadmap for the transition to sustainable mobility.

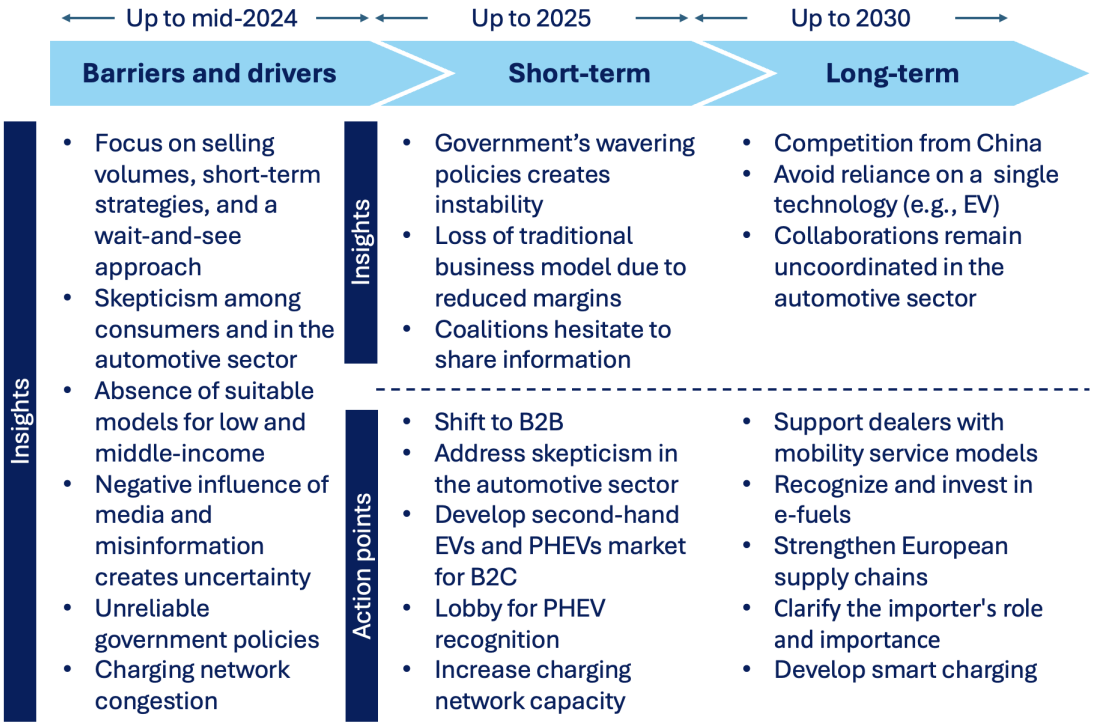

Figure 11-1: Schematic overview of thesis results and functions as a roadmap for the transition to sustainable mobility by 2030.

11-2 Future studies

Based on the thesis results, six areas of future research are identified that can contribute to the academic literature and the Dutch automotive sector's understanding of the electrification process. These recommendations highlight theoretical and empirical gaps in the research and suggest new directions for research.

1. Adapting the TIS framework for stagnating adoption in later-stage innovation. Future research should examine how the TIS framework can be adapted for later stages of technological innovation, particularly when adoption stagnates. While effective in early diffusion, its use in mature stages, focused on market stabilization and socio-economic integration, remains underexplored. Researchers could study how functions like legitimization evolve and interact with societal and political goals. They should also develop an extended framework incorporating feedback loops and structural changes, collaborating with policymakers and industry experts to ensure its relevance to real-world challenges.

2. Improving the visualization of feedback loops and function overlaps in the TIS framework. As technological systems grow more complex, it is essential to visualize feedback loop interactions and define where functions overlap or where actors contribute across multiple functions within the TIS framework. Researchers should develop methods to illustrate how specific feedback loops operate in practice and highlight their importance, providing a clearer understanding of actor interactions across functions. University researchers could collaborate with software developers to create tools or digital models that visualize these dynamics, prioritizing usability for academic study and practical decision-making.

3. Investigating the role of coalitions in knowledge diffusion. While stakeholder coalitions like RAI and BOVAG promote knowledge diffusion, financial barriers often limit smaller companies' participation in innovation networks. Future studies should investigate how these barriers can be addressed to strengthen knowledge diffusion across the sector and encourage open discussions within coalitions, particularly regarding freedom of speech. Academic researchers could analyze coalition structures to identify ways to make knowledge diffusion more inclusive and share their findings with coalitions to guide policy improvements, such as subsidy programs or adjusted membership models.

4. Examining collaborations to enhance corporate entrepreneurial activities. Corporate entrepreneurial activities in the Dutch automotive sector encounter barriers to collaboration and knowledge-sharing. Future research should investigate how coalition-building strategies can enhance cross-company collaboration and innovation networks. By analyzing case studies of successful partnerships, researchers can provide practical lessons to promote a collaborative innovation environment, supporting sustainable mobility solutions. Policymakers, coalitions, and academic researchers should collaborate. Coalitions should focus on promoting trust and transparency while researchers evaluate these efforts. Their findings should directly inform coalition strategies to ensure alignment with sector needs.

5. Exploring the impact of media on legitimization. The role of media in shaping public perception and legitimizing technological transitions is underexplored. Future research should examine how positive and negative media coverage influences consumer confidence and public support for EVs and PHEVs. It should also investigate how companies can engage with media to shape narratives and how media dynamics can be integrated into the TIS framework for legitimization. Automotive companies, communication experts, and governments should collaborate to counter misinformation and proactively engage with media platforms. Researchers could analyze the effects of targeted media campaigns on public perception.

6. Analyzing how to support the development of a second-hand EV market. The absence of a second-hand EV market remains a barrier to mass uptake in the Dutch market. Empirical research should explore how policies and business strategies, such as financial incentives, certification programs, and leasing options, can support its development and make EVs more accessible. Building consumer trust through warranties, battery health checks, and resale guarantees should also be investigated. Policymakers, OEMs, and automotive coalitions must collaborate to implement certification schemes, subsidies, and trust-building programs. Research should assess how these initiatives influence the affordability and uptake of second-hand EVs.

11-3 Final words

The Dutch automotive sector is struggling to navigate the transition to electrification. While formal optimism is present, informal conversations reveal skepticism. No single player can be expected to lead this transition, especially not those with a passion for traditional combustion engines. Even though electrification has started, the automotive sector remains cautious, driven by skepticism, uncertainty, and reliance on external factors like government policies and OEM developments. Therefore, collaboration and consistency are more important than ever. Cooperation between the government and the automotive sector, the importer and dealers, and even among dealers is essential to move forward. The sector must shift from reactive to proactive strategies, focusing on long-term planning and innovation. Consumers increasingly prioritize affordability and fiscal benefits over car ownership as a status symbol. Moreover, electric driving still feels like a 'forced' choice for many. This sense of obligation, combined with the perception that switching to electric driving is challenging, complicates the transition. This challenge must be removed to make the shift toward electrification more accessible. Complete mobility solutions, better alignment between government policies and sector strategies, and a focus on consumer education are essential to accelerate the uptake of EVs and PHEVs. Without a clear roadmap and consistent support, the ambitious targets will remain challenging to achieve and could cause the automotive sector to fall behind.

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Appendix A

Identified themes across formal interviews, informal meetings, and observations

Due to anonymity considerations, this appendix's content is not included in the public publication.

Appendix B

Interview protocol

This interview protocol functions as a flexible checklist, allowing for discussion adaptability while ensuring that all areas regarding the transition to EVs and PHEVs within the Dutch automotive sector are covered. The order of questions varied based on the specific flow of each conversation to adapt to the natural progression of dialogue. This flexibility enabled participants to elaborate on topics of interest. The protocol includes opportunities for follow-up questions, allowing the interviewer to investigate participants' responses deeper and improve the flow of conversation. The inclusion of overlapping questions helps to guarantee that essential topics are explored and addressed throughout the interview.

In Chapter 2, an overview of the required information was provided, organized into five themes. These themes are reflected in the interview protocol, ensuring consistency and focus throughout the research. Additionally, each question in the protocol is linked to specific functions of the TIS framework, connecting the analysis to the theoretical foundation.

Interview protocol

At the beginning of the interview, participants are informed about their privacy and asked for consent (Appendix C): "To protect your privacy and confirm your participation in the research, I ask you to sign the informed consent form. Is it acceptable if I record the conversation from now on?"

Introduction

- Can you tell me about your role and experience in the automotive sector?
- What are your current strategies and goals moving forward? (Corporate entrepreneurial activities)

Market and economy

- **Trends**
  - From your perspective, what are the current trends in the automotive sector in the Netherlands? (Market formation)
  - What do you expect of the market, and how do you see the growth in the next five years? (Guidance of the search)
- **Market dynamics**
  - Have you observed any shift in consumer interest or market demand recently? (Legitimization)
  - How do you evaluate the current market dynamics for EVs and PHEVs compared to traditional ICE? (Market formation)
- **Sales trends**
  - How have sales for EVs developed? What factors do you believe are driving these changes?
  - What differences in consumer preferences do you see between the Netherlands and other countries? (Specified question for importers)
- **Market growth**
  - What are the challenges your sector currently faces? (Market formation) (Identifying barriers)
  - How have these barriers impacted your business operations and sales strategies? How do you see the automotive sector's future in the next five years? (Market formation)
  - How are these challenges being addressed within your organization? What opportunities do you see? (Market formation) (Identifying opportunities)

Consumer behavior

- **Preferences and motivations**
  - What preferences do you notice consumers express when considering a new car? What factors do you believe are influencing their purchasing decisions? (Legitimization) (Specified question for dealers and charging operators)
  - Based on your experiences, how do you experience consumer attitudes towards EVs? What are the most common reasons consumers reject or buy EVs? (Legitimization) (Specified question for dealers and charging operators)
  - How does customer service influence the decision of customers to buy an EV or PHEV, including price, costs, annual maintenance, and promotions? (Legitimization) (Specified question for dealers and charging operators)
- **Feedback**
  - What kind of feedback do you receive from users? Is the customer who bought an EV before more likely to buy a new one after a few years? (Legitimization) (Specified question for dealers and charging operators)
  - How do consumer charging habits influence your strategic planning? (Specified question for charging operators)

Technological development

- How is technological innovation influencing your sector? What are the expected technological innovations, and how would they affect the market? (Knowledge development and Guidance of the search)

Business perspective

- What strategies have been successful in introducing cars? (Corporate entrepreneurial activities and Resource mobilization)
- What are the strategies moving forward? (Corporate entrepreneurial activities)
- What challenges do you face in the transition/adoption to/of EVs and PHEVs? How are these challenges being addressed within your organization? (Corporate entrepreneurial activities)
- What opportunities do you see for further growth in this sector? (Corporate entrepreneurial activities)
- Can you discuss any collaborations or partnerships your organization has engaged in? What makes these collaborations effective, and what challenges have they faced? (Knowledge diffusion and Resource mobilization)
- **Support and maintenance**: How do you prepare your staff to sell and maintain EVs and PHEVs? (Resource mobilization) (Specific question for dealers)

Policy and government

- How have recent government policies and regulations impacted the automotive sector? What policies have had the most impact on business decisions? (Guidance of the search, Market formation, and Legitimization)
- How do you feel about the approaching 2030 and 2035 government targets? (Guidance of the search and Market formation)

Final

- How do you stay updated, for example, with changes in regulations or new technologies?
- Do you drive an electric vehicle?
- Is there anything else you would like to add about the future of the automotive sector or the transition to EVs? Do you have final thoughts or insights you would like to share?

Appendix C

Informed consent

Dear participant,

You are invited to participate in a research study titled 'The role of corporate entrepreneurial activities in the electrification of the passenger mobility transition within the Netherlands.' Emma van Zee is doing this study from the TU Delft in collaboration with Pon Mobility Netherlands.

This research study aims to analyze the broader diffusion of electric and plug-in hybrid vehicles in the Netherlands, focusing on the strategic role of companies in promoting this transition within the passenger mobility sector. It will take you approximately 60 minutes to participate. The data will be used for academic research and provide insights to companies. We will ask you to answer questions about your experiences, knowledge, and perspectives on the transition to electric and plug-in hybrid vehicles.

All collected data, including your responses, will be incorporated in the final report, which will use generalized privacy terms to ensure that individual responses remain untraceable. The final report will anonymize the collected personal information, such as your name, contact details, and professional role, to provide context for the study.

Data access and usage:

- The primary researcher, the TU Delft and Pon Mobility supervisors, will have access to the raw data.

- The data will be stored securely and only used for the purposes outlined in this consent form. While we do not intend to publish raw data openly, anonymized quotes or interview summaries can be included in the report's appendix for documentation and transparency. It will only be made public if they are fully anonymized and approved by the participants for specific purposes.

Participation in this study is entirely voluntary, and you can withdraw anytime. You are free to omit any questions. You can request the deletion of your responses within two weeks of participation. Please check the appropriate boxes in the list below to ensure you are fully informed about the procedure.

Signatures

I, as participant, have accurately fulfilled and understand the information sheet and, thereby, I confirm my participation in the study.

_____	_____	_____
Name of participant	Signature	Date

I, as legal representative, have witnessed the accurate reading of the consent form with the potential participant and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

_____	_____	_____
Name of witness	Signature	Date

I, as researcher, have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____	_____	_____
Researcher name	Signature	Date

Study contact details for further information: *Emma van Zee, E.M.Z.vanZee@student.tudelft.nl*

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICPANT TASKS AND VOLUNTARY PARTICIPATION		
1. I have read and understood the study information, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions, and I can withdraw from the study within two weeks of participation, without having to give a reason.	☐	☐
3. I understand that taking part in the study involves: - The interviews will be conducted as audio-recorded semi-structured discussions to allow for flexibility in response while ensuring detailed documentation. Detailed written notes will be taken during the interview and transcribed to capture important information and nuances. - The original audio files will be securely stored until the study ends, after which they will be destroyed. The use of company phone and laptop ensures the safety of the data. - The collection of personal information will be minimized. Only necessary information, essential for context of study, will be collected.	☐	☐
4. I understand that the study will end December 2024.	☐	☐
B: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		
5. I understand that after the research study the de-identified information I provide will be primary used for the thesis report, which will be submitted to Delft University of Technology and Pon Mobility Netherlands. This report will detail findings, analyses and conclusions derived from the study. Moreover, the transcription of the anonymized semi-structured interviews will be included in the appendix. The final report of the thesis will also be shared during the final presentation.	☐	☐
6. I agree that my responses, views or other input can be quoted anonymously in research outputs and can be used for insights for commercial ends by the company.	☐	☐
C: (LONGTERM) DATA STORAGE, ACCESS AND REUSE		
7. I give permission for the de-identified interview transcripts that I provide to be archived in 4TU.ResearchData repository so it can be used for future research.	☐	☐