THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Together, We Can Get Somewhere

exploring potential factors for the implementation of shared, autonomous public transport

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Together, We Can Get Somewhere: exploring potential factors for the implementation of shared, autonomous public transport

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Summary

This thesis explores the factors influencing the implementation of shared autonomous vehicles (SAVs) as part of public transport. Originally titled "Societal Readiness Levels for Autonomous Vehicles," the research shifted early on to focus on SAVs, distinguishing itself from studies on privately owned autonomous vehicles. Conducted as an industrial PhD project, the research examines the interplay between technological acceptance and societal adaptation in the deployment of SAVs in a public transport context.

The study focuses on Australia and Sweden, with its methodology adapting to the challenges posed by the COVID-19 pandemic. The pandemic significantly influenced the scope and approach, prompting a shift toward digital data collection methods. This allowed for continued exploration of shared mobility, even when it became a sensitive topic for stakeholders and users.

A multilevel analytical model (MLAM) was developed to identify and evaluate factors affecting the adoption of SAVs within a sociotechnical system. The model examines three interconnected levels:

- **Macro level**—encompassing national policies, regulatory frameworks, technological development, infrastructure investment, cultural values, and economic conditions, with key actors shaping the enabling environment.
- **Meso level**—focusing on regional stakeholders like transportation authorities and local governments, who interpret and adapt national policies to meet local needs, particularly within regional mobility networks and digital infrastructure.
- **Micro level**—centered on individual users, analyzing sociodemographic, psychographic, and behavioral drivers of acceptance.

The research identified 53 factors influencing SAV adoption across these levels. Willingness to share mobility journeys (human-driven, as in dynamic ridepooling or ridehailing) emerged as a strong predictor of acceptance of SAVs, as did prior experiences with public transport or ridesharing. Key barriers include *sharing anxiety* and *authority vacuum*, both of which reduce users' trust in and willingness to share AVs with others, positive

The thesis also highlights interdependencies between factors, emphasizing their cascading effects across societal levels. For instance, national policies directly shape regional implementations, which in turn influence individual behaviors. The lack of a coherent vision among Swedish stakeholders was identified as a challenge for integrating autonomous technology into public transit systems, complicating long-term planning.

Building on these findings, the study developed a preliminary Societal Readiness Index for Shared Autonomy (SRISA). This index offers a structured framework for assessing societal readiness and mapping pathways to implement SAVs in public transport. It underscores the need for alignment between technological advancements, societal expectations, and regulatory frameworks to achieve sustainable and inclusive mobility, particularly when using autonomous technology in as part of the public transport offer.

This research contributes to academic literature by offering a sociotechnical system perspective on SAV implementation. It emphasizes the importance of macro-level stakeholders creating a strong regulatory and administrative environment for meso-level stakeholders to make decisions, take actions, and engage with the public. It also enables regional stakeholders to understand the micro-level social concerns surrounding AV systems so that they can design better, more effective public transport for all.

Keywords: Autonomous vehicles; Public transport; Shared Autonomous Vehicles; Autonomous public transport; Implementation; Societal Readiness; Multilevel analytical model, Shared autonomy

Sammanfattning

Denna avhandling undersöker faktorer som påverkar implementeringen av delade självkörande fordon (SAV) som en del av kollektivtrafiken. Från att först ha kallats "Societal Readiness Levels for Autonomous Vehicles" skiftade forskningen tidigt fokus till SAV och skiljer sig alltså från studier om privatägda självkörande fordon. Forskningen är genomförd som ett industriellt doktorandprojekt och undersöker samspelet mellan teknologisk acceptans och samhällelig anpassning vid implementeringen av SAV inom en kollektivtrafikmiljö.

Studien fokuserar på Australien och Sverige, och dess metodik anpassades till de utmaningar som COVID-19-pandemin medförde. Pandemin påverkade forskningen och ledde till en övergång mot digitala datainsamlingsmetoder. Detta möjliggjorde fortsatt utforskning av delad mobilitet, även när ämnet blev känsligt för intressenter och användare.

En analytisk modell i flera nivåer (MLAM) utvecklades för att identifiera och utvärdera faktorer som påverkar upptagningen av SAV inom ett sociotekniskt system. Modellen analyserar tre sammankopplade nivåer:

- **Makronivå** – omfattar nationella policyer, regelverk, teknologisk utveckling, infrastrukturinvesteringar, kulturella värderingar och ekonomiska förhållanden, med centrala aktörer som formar de övergripande förutsättningarna.
- **Mesonivå** – fokuserar på regionala aktörer som kollektivtrafikmyndigheter och kommuner, vilka tolkar och anpassar nationella policyer till lokala behov, särskilt inom regionala transportsystem och digital infrastruktur.
- **Mikronivå** – centrerad kring användare, där sociodemografiska, psykologiska och beteendemässiga drivkrafter för acceptans analyseras.

Forskningen identifierade 53 faktorer som påverkar upptagningen av SAV på dessa nivåer. Centrala hinder inkluderar "delningsångest" och ett "auktoritetsvakuum", vilka båda minskar användarnas förtroende och vilja att dela fordon med andra. Å andra sidan påverkade positiva tidigare erfarenheter av kollektivtrafik eller samåkning användarnas benägenhet att använda SAV positivt. Viljan att dela resor (med mänskliga förare, som vid samåkning eller ridehailing) visade sig vara en stark indikator på vilja att använda SAVs.

Avhandlingen belyser också beroenden mellan faktorer och deras kumulativa effekter på samhällsnivå. Exempelvis påverkar nationella policyer direkt regionala implementeringar, vilka i sin tur formar individuella beteenden. Avsaknaden av en sammanhängande vision bland svenska aktörer identifierades som en utmaning för att integrera självkörande och delade mobilitetssystem, vilket försvårar långsiktig planering.

Utifrån dessa resultat utvecklades ett preliminärt samhällsberedskapsindex för delad autonomi (SRISA). Detta index erbjuder en strukturerad ram för att bedöma samhällsberedskap och kartlägga vägar för implementering av SAV i kollektivtrafik. Det betonar behovet av att harmonisera teknologiska framsteg, samhälleliga förväntningar och regelverk för att uppnå hållbar och inkluderande mobilitet, särskilt när självkörande teknologi implementeras inom kollektivtrafiken.

Forskningen bidrar till den akademiska litteraturen genom att erbjuda ett sociotekniskt systemperspektiv på implementeringen av SAV. Den lyfter fram vikten av att makronivåaktörer skapar en stark reglerande och administrativ miljö för att mesonivåaktörer ska kunna fatta beslut, agera och samverka med allmänheten. Den möjliggör också för regionala aktörer att förstå mikronivåns sociala frågor kring självkörande system och därigenom utforma bättre och mer mer effektiv kollektivtrafik för alla.

Nyckelord: Självkörande fordon; Kollektivtrafik; Delade självkörande fordon; Självkörande kollektivtrafik; Implementering; Samhällsberedskap; analytisk modell i flera nivåer

List of appended papers

I **Dolins**, S., Strömberg, H., Wong, Y. Z., and Karlsson, M. (2021). Sharing anxiety is in the driver's seat: Analyzing user acceptance of dynamic ridepooling and its implications for shared autonomous mobility. *Sustainability*, 13(14), 7828. doi:https://doi.org/10.3390/su13147828

II **Dolins**, S., Karlsson, M, & Strömberg, H. (2023). AVs Have a Sharing Problem: Examining User Acceptance of Shared, Autonomous Public Transport in Sweden, Intelligent Transportation Systems (ITSC) (ITSC 2023), Bilbao, Bizkaia, Spain.

III **Dolins**, S., Karlsson, M., Smith, G., & Strömberg, H. (forthcoming) Driven to Share: Understanding Determinants of Willingness to Use Shared Autonomous Vehicles. Submitted to *Travel Behaviour and Society*.

IV **Dolins**, S., Karlsson, M., Smith, G., & Strömberg, H. (forthcoming). Riding with strangers: profiling skeptics and adopters of Shared Autonomous Vehicles in Swedish cities. *Transportation*.

V **Dolins,** S., Wong, Y. Z., and Nelson, J. D. (2021). The 'Sharing Trap': A case study of societal and stakeholder readiness for on-demand and autonomous public transport in New South Wales, Australia. *Sustainability*, 13(17), 9574. doi: https://doi.org/10.3390/su13179574

VI **Dolins**, S., Karlsson, M., Smith, G., & Strömberg, H. (2024). Whose Job Is Sharing Anyway? Exploring Swedish expert and actor views on the introduction of autonomous, on-demand public transport, 7th Conference on Sustainable Mobility (CSUM), Plastiras, Greece.

VII **Dolins**, S., Karlsson, M., Smith, G., & Strömberg, H. (2024). Navigating the Future with A Modern Delphi: Identifying Factors influencing the Introduction of Autonomous Public Transport, Thredbo 18: Thredbo International Conference Series on Competition and Ownership in Land Passenger Transport, Cape Town, South Africa.

Author Contributions

Paper I: SD, YZW and JN designed the study. SD and YZW collected the data. SD analyzed the data. SD wrote the original draft. All authors reviewed, edited, and approved the final version of the manuscript.

Paper II: SD, MAK and HS designed the study. SD analyzed the data. SD wrote the original draft and presented it at conference. All authors reviewed, edited, and approved the final version of the manuscript.

Paper III: SD, MAK and HS designed the study. SD analyzed the data. SD wrote the original draft. SD, MAK, HS, and GS reviewed, edited, and approved the final version of the manuscript.

Paper IV: SD, MAK and HS designed the study. SD analyzed the data. SD wrote the original draft. SD, MAK, HS, and GS reviewed, edited, and approved the final version of the manuscript.

Paper V: SD, YZW and JN designed the study. SD and YZW collected data. SD analyzed the data. SD wrote the original draft. All authors reviewed, edited, and approved the final version of the manuscript.

Paper VI: SD, MAK and HS designed the study. SD collected and analyzed the data. SD wrote the original draft. SD, MAK, HS, and GS reviewed, edited, and approved the final version of the manuscript.

Paper VII: SD, MAK and HS designed the study. SD analyzed the data. SD wrote the original draft. SD, MAK, HS, and GS reviewed, edited, and approved the final version of the manuscript. GS presented it at conference.

You got a fast car
I want a ticket to anywhere
Maybe we make a deal
Maybe together we can get somewhere

Tracy Chapman, "Fast Car"

Table of Contents

SUMMARY I

SAMMANFATTNING I

LIST OF APPENDED PAPERS IV

ACKNOWLEDGEMENTS XI

LIST OF TABLES XV

LIST OF FIGURES XV

LIST OF COMMONLY USED ABBREVIATIONS XVII

TERMINOLOGY AND DEFINITIONS XIX

1. INTRODUCTION 1

1.1. SCOPE 1
1.2. RESEARCH GAP 3
1.3. AIM AND RESEARCH QUESTIONS 5
1.4. DELIMITATIONS 6
1.5. THESIS STRUCTURE 7

2. FRAMEWORK 9

2.1. A SOCIOTECHNICAL SYSTEMS LENS 9
2.2. THE MULTILEVEL ANALYTICAL MODEL 11
2.2.1. The Macro Level 12
2.2.2. The Meso Level 13
2.2.3. The Micro Level 14
2.3. INTERDEPENDENCIES BETWEEN LEVELS 15

3. LITERATURE REVIEW: IDENTIFYING POTENTIAL FACTORS 19

3.1. INTRODUCTION 19
3.2. MACRO LEVEL FACTORS 19
3.2.1. Policy and Regulation Factors 20
3.2.2. National Infrastructure, Investment, and Innovation Factors 23
3.2.3. Social and Cultural Impact Factors 25
3.3. MESO LEVEL FACTORS 26
3.3.1. Infrastructural Factors 27
3.3.2. Economy and Policy Factors 30
3.4. MICRO LEVEL FACTORS 34
3.4.1. Sociodemographic Factors 34
3.4.2. Psychographic Factors 37
3.4.3. Behavioral Factors 41
3.4.4. Not Factors but Facets 43
3.5. INITIALLY IDENTIFIED FACTORS AT MICRO, MESO, MACRO LEVELS 45

4. THE RESEARCH PROCESS 49

4.1. OVERVIEW OF THE RESEARCH PROCESS 49
4.2. TRIANGULATION 51
4.3. CHOICE OF RESEARCH CONTEXT 52

4.4. Overview of the Studies 53
4.5. Cross-study Synthesis 57
4.6. Drafting the Societal Readiness Index for Shared Autonomy 57

5. FINDINGS 59

5.1. Study A Literature Review 59
5.1.1. Aim 59
5.1.2. Method 59
5.1.3. Findings 62
5.1.4. Implications for the Multilevel Analytical Model 63
5.2. Study B Focus groups with potential users in Australia 64
5.2.1. Aim 64
5.2.2. Method 64
5.2.3. Findings 65
5.2.4. Implications for the Multilevel Analytical Model 66
5.3. Study C Focus groups with potential users in Sweden 67
5.3.1. Aim 67
5.3.2. Method 68
5.3.3. Findings 69
5.3.4. Implications for the Multilevel Analytical Model 71
5.4. Study D Multinational Survey 71
5.4.1. Aim 72
5.4.2. Method 72
5.4.3. Findings from Wave 1 73
5.4.4. Findings from Wave 2 74
5.4.5. Implications for the Multilevel Analytical Model 74
5.5. Study E Australian Stakeholder Interviews 75
5.5.1. Aim 75
5.5.2. Method 76
5.5.3. Findings 76
5.5.4. Implications for the Multilevel Analytical Model 77
5.6. Study F Interviews with Swedish stakeholders 78
5.6.1. Aim 78
5.6.2. Method 78
5.6.3. Findings 78
5.6.4. Implications for the Multilevel Analytical Model 79
5.7. Study G Governmental Policy Reviews, Sweden 80
5.7.1. Aim 80
5.7.2. Method 81
5.7.3. Findings and Implications for the Multilevel Analytical Model 81
5.8. Study H International Delphi Study 85
5.8.1. Aim 85
5.8.2. Method 85
5.8.3. Findings and Implications for the Multilevel Analytical Model 85

6. SYNTHESIS OF FACTORS 91

6.1. Potential Factors and Their Rationale 91
6.2. Interdependencies Between Factors and Levels 102
6.3. Macro-level factors and their Meso and Micro Interdependencies 103

6.4. MESO-LEVEL FACTORS AND THEIR MACRO AND MICRO INTERDEPENDENCIES 105
6.5. MICRO-LEVEL FACTORS AND THEIR MACRO AND MESO INTERDEPENDENCIES 107

7. INDEX CREATION 112

7.1. DEFINING INDEX GOALS 112
7.2. APPLYING PRIOR WORK TO INDEX CREATION 113
7.3. EVALUATION CRITERIA 114
7.3.1. FACTORS DEEMED UNSUITABLE FOR SRISA 114
7.3.2. THE CASE FOR SHARING ANXIETY 115
7.3.3. SUITABLE FACTORS AND THE CHOICE OF INDICATORS 116
7.4. THE INDEX 116

8. SUMMARY AND DISCUSSION 130

8.1. THE RESEARCH QUESTIONS AND MY FINDINGS 130
8.2. EXAMINING INTERDEPENDENCIES IN A SAPT SYSTEM 134
8.3. THE CONTRIBUTION OF THIS WORK 135
8.3.1. THE MULTILEVEL ANALYTICAL MODEL 136
8.3.2. THE *SOCIETAL READINESS INDEX FOR SHARED AUTONOMY.* 137
8.4. REFLECTIONS ON THE METHODOLOGY 138
8.4.1. CONTRADICTIONS IN DATA 139
8.4.2. INTERNAL VALIDITY 140
8.4.3. EXTERNAL VALIDITY AND TRANSFERABILITY 141
8.5. APPLYING THE FINDINGS 142

9. REFLECTIONS 145

9.1. INITIAL REFLECTIONS 145
9.2. FUTURE DEVELOPMENT OF THIS WORK 145
9.2.1. VERIFICATION OF FACTORS 145
9.2.2. FURTHER DEVELOPMENT OF SRISA 146
9.2.3. AVENUES FOR FUTURE RESEARCH 147
9.2.4. A CALL FOR BRAVERY 148

REFERENCES 150

APPENDED PAPERS 164

FOLLOWED BY FIVE APPENDED PAPERS (PAPER I-VII)

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"Isn't life one long shared ride?"
is how I ended my licentiate acknowledgements.
And what a long, long, *long* ride it's been!

But I'm here at the end of it now, and I realize
that the journey was only made possible because of
the patience, effort, and care
of an enormous cadre of friends,
neighbors, mentors, supervisors
and מענטשן,
cheering me on through time and space,
when I really wasn't sure I should keep going.

Within me there is far too much gratitude and love that can be put into words
and still print this thesis.

However,
since they say an image is worth a thousand words,
let me be economical with that love.

Göteborg, November 2024

Sigma Dolins

List of Tables

Table 1 The studies, their research methods, which questions they were designed to answer, and which questions they incidentally contributed to answering. 54
Table 2 Revealed factors by level and organization from the Swedish government remiss. 83
Table 3 While 24 factors remained at the end of the survey, 14 factors were explicitly discussed during the post-survey workshop. These factors are listed here. 88
Table 4 Macro-level factors, the studies that affirmed them, and their rationale for inclusion into the multilevel analytical model. 92
Table 5 Meso-level factors, the studies that affirmed them, and their rationale for inclusion into the multilevel analytical model. 95
Table 6 Micro level factors, the studies that affirmed them, and their rationale for inclusion into the multilevel analytical model. 97
Table 7 Macro themes, factors, and potential indicators and data sources for the *Societal Readiness Index for Shared Autonomy.* 117
Table 8 Meso themes, factors, and potential indicators and data sources for the Societal Readiness Index for Shared Autonomy. 122
Table 9 Micro themes, factors, and potential indicators and data sources for the Societal Readiness Index for Shared Autonomy. 125

List of Figures

Figure 1 The sociotechnical systems model, adapted from Clegg (1979); Challenger et al. (2010); Davis et al. (2014). Illustrates how different elements in the system impact and are connected to one another 10
Figure 2 A common hierarchical depiction of macro, meso, and micro levels. 16
Figure 3 The outline of the multilevel analytical model employed for this thesis, with space for future identified factors. Each of the actors at the macro, meso, and micro levels are influencing each other, although the direction of that influence is not yet made clear. 17
Figure 4 Macro level factors. The first iteration of the multilevel analytical model for implementation of autonomous public transport, given identified factors from the literature review. 46
Figure 5 Meso level factors. The first iteration of the multilevel analytical model for implementation of shared, autonomous public transport, given identified factors from the literature review. 47

Figure 6 Micro level factors, with the three latent constructs included. The first iteration of the multilevel analytical model for implementation of shared, autonomous public transport, given identified factors from the literature review. 48
Figure 7 The structure of the research project, highlighting eight key studies ranging from literature reviews and focus groups to stakeholder interviews across various countries. Together the research papers and conference papers contribute to the overarching goal of synthesizing the findings for the creation of the Societal Readiness Index for Shared Autonomy... 50
Figure 8 CARTI methodology-inspired for the development of the SRISA. The CARTI methodology includes three main phases and 11 steps. In this thesis, I performed steps 1-3.. 58
Figure 9 PRISMA Flow Diagram for a literature review, detailing the process of identifying, screening, and including studies in the review................................... 60
Figure 10 The Navya Arma used in the Gothenburg pilots, accommodating approximately 12 persons in the vehicle. Permissions for photo granted by RISE. 69
Figure 11 An evolved version of the model first shown in Chapter 3 after Study A, displaying the revealed and affirmed factors across the different levels. Factors revealed in Studies B-H are in bold. 101
Figure 12 On the left, the hierarchical version of multilevel interaction (as originally shown in Chapter 2); on the right, a more nuanced version of the levels and their interaction and interdependencies.. 103
Figure 13 This image demonstrates how central government facilitation affects factors in other levels, primarily regional actors and the factor of role and mission confusion. (Note: This image does not display the entirety of the macro level or meso level.) 105
Figure 14 This image demonstrates how central government facilitation affects factors in other levels, primarily regional actors and the factor of role and mission confusion. (Note: This image does not display the entirety of the macro level or meso level.) 107
Figure 15 This image illustrates how actors and factors from the macro and meso levels impact factors and users in the micro level. (Note: This image does not display the entirety of all three levels, nor all the factors in the model.)......................... 108

List of Commonly Used Abbreviations

ADA:	Americans With Disabilities Act
ADAS:	Advanced driver assistance systems
AI:	Artificial Intelligence
ASBs:	Autonomous Shuttle Busses
AVRI:	KPMG Autonomous Vehicles Readiness Index
AVs:	Autonomous Vehicles
C-ITS:	Cooperative intelligent transport systems
CCTV:	Closed-Circuit Television
CHAID:	Chi-squared Automatic Interaction Detection
CISA:	Cybersecurity & Infrastructure Security Agency
CPI:	Consumer Price Index
CRPD:	Convention on the Rights of Persons with Disabilities
ELASTIC:	Evaluative and Logical Approach to Sustainable Transport Indicator Compilation
ENISA:	European Union Agency for Cybersecurity
EPA:	Environmental Protection Agency
GCI:	Global Connectivity Index
GDP:	Gross Domestic Product
GEMRIX:	Global E-Mobility Readiness Index
GPDR:	General Data Protection Regulation
GSMA:	Global System for Mobile Communications Association
ITS:	Intelligent transport system
LIMA:	Lindholmen Integrated Mobility Arena
MaaS:	Mobility-as-a-Service
MLAM:	Multilevel Analytical Model
NSW:	New South Wales
OEM:	Original equipment manufacturer
PPP:	Public-Private Partnerships
RISE:	Research Institutes of Sweden
SAPT:	Shared, Autonomous Public Transport

SAVs:	Shared Autonomous Vehicles
SRISA:	Societal Readiness Index for Shared Autonomy
TAM:	Technology Acceptance Model
TfNSW:	Transport for New South Wales
TNCs:	Transportation Network Companies
TNO:	Netherlands Organisation for Applied Scientific Research
TPB:	Theory of Planned Behavior
UITP:	International Association of Public Transport
UTAUT:	Unified Theory of Acceptance and Use of Technology

Terminology and definitions

Autonomous vehicle: Autonomous vehicles, or an automated or self-driving vehicle, can be generally understood as vehicles with varying levels of capabilities for navigation and operation without human intervention. SAE International has defined AVs at levels 0-5, with 0 being completely human-operated with limited computerized features like emergency braking and blind spot detection. At level 5, the vehicle operates entirely independently, handling all aspects of driving, including navigation, obstacle avoidance, and decision-making, in all environments and weather conditions.

Shared autonomous vehicle: Shared autonomous vehicles are a service design that uses autonomous vehicles to offer rides to multiple unrelated passengers. This could be part of a taxi, community transit or public transport offer.

Shared autonomous public transport: Autonomous vehicles explicitly used for public transport services and settings.

Ridesharing: Ridesharing connotates that the driver and passenger(s) share the same, or at least nearby final destinations, thereby reducing the number of cars and hence net road space required to complete the journey of at least two separate parties. It is somewhat related to the idea of carpooling. However, due to the popularity of ridehailing, it is often confused in usage by the media, users, and practitioners alike to describe ridehailing and dynamic ridepooling services.

Ridehailing: Users download a mobile phone application for a transportation network company that allows them to digitally connect with a driver. Some TNCs use licensed taxi drivers, others contract out to ordinary citizens who own their own vehicle. These drivers then take the user to the requested destination. The primary differences between ridehailing and taxi services are a) TNCs spread the use of app-based, on-demand rides before traditional taxi companies; and b) TNCs in most countries do not require taxi licenses for drivers on their platform

Transportation Network Company: a business that connects passengers with drivers of personal, non-commercial vehicles via a digital platform, typically a mobile app. TNCs operate as intermediaries, facilitating ride-hailing or ride-sharing services between users and drivers.

On-demand ridehailing: refers to a transportation service that allows users to request a ride in real-time through a mobile application, connecting them with nearby drivers immediately available to transport them to their desired destination. This service operates without the need for prior reservations, offering flexibility and convenience to users.

Dynamic ridepooling: a sub-set of ridehailing services that expand on the typical on-demand matching of taxis or TNCs to potential riders, and in a tradeoff of convenience and price, place multiple riders in the same vehicle. This is the truer sense of ridesharing, since riders without previous association share the mobility journey and vehicle as they travel to their respective destinations.

Implementation: the process of putting a decision or plan into effect; execution; the carrying out of planned, intentional activities that aim to turn evidence and ideas into policies and practices that work for people in the real world.

Integration: the process of combining two or more things into one, to bring together or incorporate (parts) into a whole. To make up, combine, or complete to produce a whole or a larger unit, as parts do.

1. Introduction

This introductory chapter describes the background and motivation for exploring the implementation of shared autonomous vehicles (SAVs) as part of the public transport[1] system. It discusses the problematic nature of public and expert perceptions surrounding autonomous vehicles, emphasizing the importance of shared mobility for achieving environmental and societal benefits. Highlighting the gap in discussions about the societal use and acceptance of AVs for shared public transport, it references key studies advocating for electric, autonomous, and shared transport solutions and apply autonomous technology specifically for public transport deployment. The chapter proposes examining factors influencing SAV acceptance and thus its implementation for public transport.

1.1. Scope

While the public imagination has been captured by autonomous vehicles (AVs)[2], the narrative and promise of what AVs would do for cities and modern life has spun in many, sometimes conflicting directions; autonomous vehicles will reduce greenhouse gasses (Pyper, 2014); driverless cars could eliminate traffic and reduce vehicles in the city (Claudel and Ratti, 2015); increased safety and mobility for low-income groups is possible, but not until 2040 (Litman, 2015); AVs are a potential liability minefield (Bagloee, 2016). In just a few years, robotic cars will drive us everywhere; deliver our dry-cleaning, pick up our children (Tremoulet et al., 2020)! Or, in a darker timeline, fleets of Teslas will be hacked, becoming dispassionate, two-ton threats that will block highway exits (Council, 2023).

Against this fanciful backdrop, the automotive industry has worked diligently on improving the 5G, LiDAR sensors, and artificial intelligence that will make AVs a reality. Commercial operators promise environmental benefits that could undo the damage conventionally fueled vehicles have wrought; and so, numerous studies have been done on the potential environmental impacts of AV technology, such as how the conversion from conventionally fueled, conventionally driven vehicles to

[1] Being American, I am inclined to refer to government-subsidized and organized transportation systems as "public transit". However, depending on country and the dominance of either American or British English, "transit" could be understood to mean transport systems in an urban context. To avoid confusion I reluctantly cede use to the term "public transport" in this thesis to refer to government-subsidized and organized transportation systems, irrespective of their urban or regional setting. But it does sting a little to do so.

[2] Autonomous vehicles, or an automated or self-driving vehicle, can be generally understood as vehicles with varying levels of capabilities for navigation and operation without human intervention. SAE International has defined AVs at levels 0-5, with 0 being completely human-operated with limited computerized features like emergency braking and blind spot detection, and 5 being a fully automated vehicle that requires no human operation and can drive under all conditions (SAE International, 2021).

electric, self-driving vehicles would reduce emissions (e.g., Metz, 2018; Wang et al., 2018) or how AVs driving empty to pick up passengers would actually worsen congestion (Levin, 2017). A common refrain among many studies is the assumption that AVs (assumed electric), are an improvement over conventional vehicle. These studies explore various aspects of energy efficiency, congestion patterns, and user acceptance of AV technology, yet despite differing focuses, they often converge on one point: AVs are most efficiently used when they are shared among multiple passengers, optimizing vehicle capacity on limited roadways (Fagnant and Kockelman, 2014; Levin, 2017; Moreno et al., 2018).

This thesis is built on **the first core assumption** that **shared autonomous vehicles (SAVs) represent the most effective and socially beneficial use of AV technology.**

Different approaches to sharing vehicles and mobility journeys already exist, each offering different levels of user control and access. For instance, options like bicycles, private cars, and kickscooters allow users a high degree of control over their usage, providing flexible, individualized mobility while technically remaining within the framework of shared mobility (Guidon et al. 2019). A step further is car-sharing, where a vehicle is shared among multiple users but not owned by any single person or household (Mounce and Nelson, 2019). While users retain some control, they must adhere to booking systems or designated drop-off points, trading some flexibility for accessibility.

Further along the sharing spectrum is carpooling, often used for commuting with colleagues. Carpooling requires passengers to relinquish more control, as travel decisions are dictated by the driver’s schedule and route preferences, underscoring a collaborative use of the vehicle. Moving toward more flexible shared mobility, ridehailing services, such as those offered by Uber and Moia, involve bringing a vehicle directly to the user on-demand, via an app. However, this model also involves a tradeoff; while users select their pickup point, route flexibility and availability depend on fleet management, sometimes determining the eventual pricing or pickup order (Wright, et al., 2020).

A subset of ridehailing, ridepooling, sacrifices additional convenience for cost savings by allowing several parties to share the same vehicle (Bansal et al., 2019). Although it maximizes vehicle occupancy, ridepooling often lengthens travel time for some passengers (Sanguinetti et al., 2019). Nevertheless, it exemplifies a cost-effective and shared use of resources, reflecting the principles of high-efficiency mobility in urban settings.

As driving technology advances, it becomes increasingly feasible to introduce AVs into these existing shared mobility models. Autonomous taxi services, such as those by Waymo, Didi Chuxing, and Uber, illustrate AV applications within the ridehailing sector. However, as these autonomous taxis often resemble privately owned cars in form and function, they largely retain the personal-use orientation of traditional vehicles, limiting the broader societal benefits that shared mobility might achieve and potentially contributing to the same negative externalities that privately owned, conventionally driven cars cause today (Nunes and Hernandez, 2020).

This brings us to the core concern: while AVs in private or ridehailing contexts offer advancements, they lack the shared benefits of more structured public transport systems. Public transport inherently involves shared rides, making it a logical area to explore the potential of autonomous vehicle technology in maximizing societal and environmental benefits. Autonomous public transport could achieve greater efficiency, reducing personnel costs and enabling flexible, on-demand services for passengers (Gray, Farrington, and Kagermeier, 2008; Imhof, Frölicher and von Arx, 2020). Furthermore, by deploying different vehicle types, AV services could cater to diverse user needs, improving both accessibility and user experience (Lenz and Fraedrich, 2016). The integration of dynamic ridepooling and live routing into autonomous public transport could further transform the system's flexibility, allowing for real-time route adjustments based on passenger demand. This model would eliminate the constraints of fixed routes and schedules, especially benefiting users in both urban and rural areas (Clewlow and Mishra, 2017; Sörensen et al., 2021).

Thus, I draw the conclusion that forms **the second core assumption of this thesis: shared AVs are best suited for public transport contexts, providing on-demand service when desired.** Given this assumption—that shared, autonomous public transport provides the most societal value—preparing society for its implementation is critical. The question then arises: What factors contribute to the successful implementation of shared, autonomous public transport (SAPT)? This thesis will explore these factors, examining societal readiness and the interplay of technical, social, and infrastructural elements necessary to implement shared autonomous vehicles into public transport systems.

1.2. Research Gap

The successful implementation of shared autonomous vehicles (SAVs) for SAPT relies on people accepting and being willing to use such services. Several studies of shared mobility on car-sharing and carpooling (Bansal, Kockelman and Singh, 2016; Burghard and Scherrer, 2022; Krueger, Rashidi and Rose, 2016; Lavieri and Bhat, 2019) identify individual factors in terms of demographics and socio-economic factors (e.g., gender, age, income level, education, etc.) as relevant for user acceptance of these shared mobility contexts. Other well-studied factors refer to how users perceive and assess shared mobility services provided in terms of costs, usefulness, convenience, and safety. However, less explored or poorly understood factors appear to be those of regional and societal norms, personal space, or herd behavior (or community culture), which may also impact an individual's willingness to engage in shared mobility–they might even emerge as strong predictors of willingness to use shared, autonomous mobility.

Regarding AVs, most of the existing literature has focused overwhelmingly on technological user acceptance of AVs (Adnan et al., 2018; Bala et al., 2023; Becker and Axhausen, 2017; Haboucha et al., 2017; Merat et al., 2017; Lee et al., 2018; Nastjuk et al., 2020). These are studies supported by theories and models such as Davis's Technology Acceptance Model (TAM) (Davis, 1989). Ajzen's Theory of Planned Behavior (TPB) (Ajzen, 1991) further explores how individual attitudes, subjective norms, and perceived behavioral control influence decision-making. Venkatesh et al.'s Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) integrates these factors, offering a comprehensive perspective on individual user acceptance of AVs.

However, shared autonomous vehicle environments introduce additional complexity, such as interpersonal trust and privacy concerns. Little attention has been given to the social dimensions of SAVs, particularly if integrated within public transport systems. Specifically, there is limited research on how individuals feel about sharing AVs with others or their willingness to do so.

Yet understanding more about the individual's experience and acceptance of SAVs is not enough. There is a significant knowledge gap in understanding how SAVs interact with broader social and cultural dynamics, as well as the sociotechnical systems that support their deployment. The successful implementation of shared, autonomous public transport relies on more than just micro-level actors, i.e. users, and their acceptance of AV technology or their willingness to share. Several studies (e.g. Karlsson et al., 2020; Lindkvist and Govick, 2024; Melander et al., 2022) point out that a multilevel perspective is necessary to understand conditions for the successful development and implementation of new mobility solutions in a transport system. In addition to the micro-level, which refers to individuals as users, the meso level represents regional stakeholders, politicians, organizations, and agencies, tasked with enforcing national policies and programs, while the macro level represents the national organizations, highest level decision-makers, as well as existing cultural norms of a society.

There are a few studies investigating the opinions and concerns of actors on primarily a meso level regarding the introduction of AVs (exceptions include e.g. Andersen et al., 2014; Dokic et al., 2015; Strömberg et al., 2021). Even fewer studies have addressed or investigated the necessary conditions at the meso and macro levels for the implementation of SAVs for SAPT.

The third assumption made is that **the implementation of SAVs, as a new model of public transport, depends upon how ready different levels of society–the factors and the actors that make up those levels–are for introducing and using this service type**. Essentially, this describes 'societal readiness'. In this thesis, societal readiness refers to the extent to which a society is prepared to accept, adopt, and sustainably integrate a new technology or mobility innovation across various levels—from individual users at the micro level to national policy frameworks at the macro level. An instructive precursor to this concept appears in the work of Yun and Lee (2015), who advocated for a balanced strategy that advances societal readiness alongside technological development. Importantly, they emphasized that societal readiness encompasses more than just technological maturity or user-friendliness; it also includes cultural, regulatory, infrastructural, and psychological factors that are critical to the successful implementation of any new technology (ibid.).

Given that there has been so much emphasis on technological acceptance at the individual level, there is a need to expand the perspective for a holistic view of the societal system, to include the organizations and pressures that impact public transport–from the macro and national level and the regional, meso actors that create the environment in which users exist and make decisions.

Therefore, **the research gap** that this thesis seeks to address **is the lack of understanding of the factors that influence societal readiness for implementing SAVs as part of public transport.**

This requires exploring a broad range of factors, such as cultural norms, user expectations, public support, and governance structures, and how they might could be meaningful for the implementation of shared autonomous vehicles in a public transport context–and how prepared societies are to embrace this shift.

1.3. Aim and Research Questions

The overall aim of the thesis is to contribute to the development of shared, sustainable mobility. Broadly, the thesis primarily aims to contribute to the emerging literature on societal acceptance of SAVs. The following three research questions have shaped the work:

RQ 1: *What factors potentially influence the implementation of shared autonomous vehicles as part of public transport at the **macro level**?*

RQ 2: *What factors potentially influence the implementation of shared autonomous vehicles as part of public transport at the **meso level**?*

***RQ 3:** What factors potentially influence the implementation of shared autonomous vehicles as part of public transport at the **micro level**?*

Through identifying potential factors, this thesis engages in a cross-study synthesis to form a model of these factors that could influence the implementation of shared, autonomous public transport. Building on that work, I suggest a tool that could support stakeholders at the macro- and meso-level (e.g., transportation leaders, public entities) who consider implementing autonomous technology in a public transport context, the *Societal Readiness Index for Shared Autonomy*.

1.4. Delimitations

An important distinction that must be emphasized is that this work focuses on **public** autonomous transport systems and thus does not cover or consider the use of autonomous vehicles for **private** transportation. This thesis explicitly explores the shared context of AVs, used for public transport, and ignores the market attraction of autonomous taxis or self-driving, privately owned cars.

While this thesis sets out ambitious goals to explore the potential of shared, autonomous public transport, there are some important limitations. Firstly, this thesis does not investigate deeply the form factor of what these autonomous vehicles might look like; whether they are shuttles (as the earliest forms of AVs have been thus far), sedan-like cars with autonomous capabilities, full-length buses, or some new vehicle type. This research tries to focus on the service offer of SAVs for public transport use and does not perform studies comparing user preferences on vehicle design.

Although there are aspects of these findings that could be applied in many different global contexts, this empirical work was focused on two key regions: New South Wales, Australia, and urban areas in Sweden, particularly Stockholm and Gothenburg. Because of this, the results may not directly translate to rural areas or regions with different infrastructure, political, or cultural conditions. Indeed, the site selection of Australia and Sweden excludes the context and conditions of the global south, which limits aspects of my work's applicability. In addition, the data in this study were mainly collected through qualitative interviews, focus groups, and surveys of respondents in Australia and Sweden. While these provide valuable insights, they may not fully capture every relevant perspective, particularly across different demographic or socioeconomic groups. Also, the data was collected during a specific period (2019 – 2023), so any changes in technology, policy, or a global pandemic that may have happened since then might not be fully reflected here.

Another aspect of this work is the assumption of who the actors in a transportation system are; the actors described in the multilevel analytical model can be understood as the most common participants in developing, administering, evaluating, and implementing mobility services and transport. I introduce these actors and discuss their interactions with factors in the model, but as my focus is on exploring *factors* and not actors, I do not go into great detail about each stakeholder type, and I did not perform studies exploring potential actors.

The *Societal Readiness Index for Shared Autonomy* (SRISA) proposed in this thesis is still in a preliminary stage. More research is needed to refine and develop it before it can be applied more broadly. And finally, while this thesis focuses on the social, regulatory, and technological aspects of implementing autonomous public transport, it doesn’t delve into economic factors like cost-benefit analyses or detailed economic forecasting, which would be necessary to get a full picture of how feasible these systems really are.

1.5. Thesis Structure

This thesis consists of eight chapters, the contents of which are briefly described below.

Chapter 1 introduces the area of research by giving background into the topics of AVs, SAVs, and commercial dynamic ride hailing, as well as the problem area–the lack of understanding of the societal readiness for implementing SAVs as part of public transport. The aim and research questions are presented, and the chapter ends with a brief outline of the thesis structure (the current section).

Chapter 2 provides the Framework and relevant theoretical concepts for this work and introduces the concept of the multilevel analytical model.

Chapter 3 covers a literature review spanning many articles, focusing on mobility concepts up and to the inclusion of autonomous vehicles: ridehailing, ridepooling, car-sharing, carpooling, AV pilots, and on-demand public transport. The wide scope of the literature review was needed to identify factors that previous work confirmed as meaningful for accepting shared AVs with a variety of features typically associated with AVs: on-demand, shared, driverless, and part of public transport. Factors were found and categorized according to macro, meso, and micro levels, with further thematic groups within each level.

Chapter 4 describes the research design and methods used in the studies on which the thesis is built.

Chapter 5 highlights and analyzes the findings of the research studies, including which factors were confirmed as meaningful at the micro, meso, and macro levels (i.e. for RQs 1, 2, and 3, respectively). This gives the basis for understanding what mechanisms are available for managing the implementation of SAPT, and the implications of each study on the multilevel analytical model.

Chapter 6 presents the results of a cross-study synthesis, an analysis of the outcomes of the literature review and empirical studies, and how the findings and factors relate to each other. It develops the connections between factors, actors, and the interlevel dependencies in the multilevel analytical model.

Chapter 7 is a brief introduction to a tentative *Societal Readiness Index for Shared Autonomy* (SRISA); using factors that were confirmed from the studies as its basis, this chapter explains how they could be used to construct a descriptive and prescriptive tool for stakeholders and practitioners who want to prepare a group or region for SAPT.

Chapter 8 is a discussion of the results and the research approach taken and provides implications for what the study findings mean for stakeholders; what the SRISA could be used for, and how it could be further improved or tested.

Chapter 9 concludes the thesis with a reflection of where this work could go from here, including avenues for future research on SAVs and autonomous public transport.

2. Framework

In the previous chapter I have presented the framework for exploring societal readiness for shared autonomous public transport and the rationale behind investigating factors that could affect the implementation SAVs as part of public transport. This chapter explains and motivates how a multilevel analytical framework and sociotechnical theory are applied for the research in this thesis.

2.1. A Sociotechnical Systems Lens

Numerous technological advancements have been introduced to the public with little preparation, such as the iPhone or Uber; being first to the market with a new device or service is often the hallmark of innovation or "disrupting the industry" (Isaac and Davis, 2014; Lepore, 2014). However, technological maturity alone does not guarantee successful deployment, and it doesn't guarantee that negative externalities will not arise from adoption and use.

As noted by the Netherlands Organisation for Applied Scientific Research (TNO), societal concerns are often overlooked during early technology development, which can lead to delays or failures in implementation (Sprenkeling et al., 2022). Sociotechnical systems theory is a fundamental lens through which to examine the intricate relationship between society and technology. Sociotechnical theory originated at the Tavistock Institute in London, led by Trist and Bamforth (1951). It was developed in response to models that were technologically deterministic and ignored human factors (Kling, 1980; Trist, 1981). Going against the predominantly technological approach of the time, Trist and Bamforth proposed that individuals were not just extensions of machines, but complementary. Their approach encouraged a viewing of social as well as technological subsystems as contributing to a greater, interrelated system. According to Pasmore et al. (1982), "the sociotechnical system perspective contends that organizations are made up of people that produce products or services using some technology, and that each affects the operation and appropriateness of the technology as well as the actions of the people who operate it."

Perhaps more simply, sociotechnical research is about what is derived from the intersection of social and technical elements (Emery, 1980; Ropohl, 1999). And as more aspects of society become indivisible from technology, this "heralds the need for an integrated perspective to understand innovation as emerging from the complex interplay of multiple, partly autonomous elements and processes at different scales" (Spijkerboer et al., 2022). A sociotechnical system "displays how social functions are actively produced in processes where societal groups act in systemic interactions—these groups are not only part of the production, development and refinement of a sociotechnical system, they also bring in various interests, perceptions, values and norms, preferences, strategies and resources" (Fraedrich et al., 2015). When I discuss a societal readiness index, it is an attempt to reconcile the fact that AV technology is a component of a sociotechnical system.

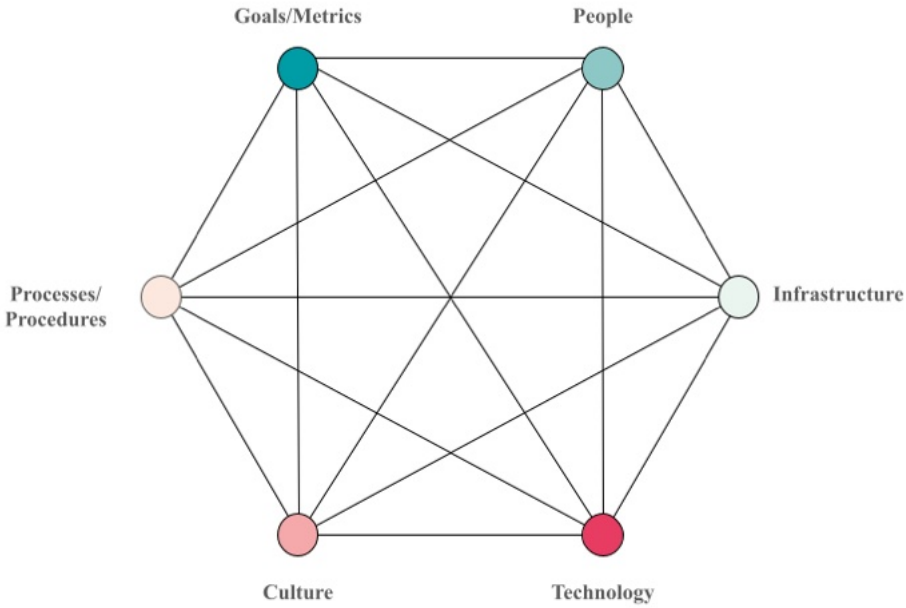

Figure 1 The sociotechnical systems model, adapted from Clegg (1979); Challenger et al. (2010); Davis et al. (2014). Illustrates how different elements in the system impact and are connected to one another.

Thus, from a sociotechnical systems perspective, the successful implementation and adoption of technological innovations are dependent on the integration of both the technical systems and the social systems in which they operate (Emery and Trist, 1960); neither technological nor social factors can be considered in isolation when seeking to understand technological change and its societal impacts. Ultimately, change within a sociotechnical system is not sparked by technology alone (such as autonomous vehicles); instead, it is the result of intricate interactions among societal groups, various stakeholders, and the convergence of certain factors (Fraedrich et al., 2015).

Sociotechnical systems thinking has been applied to various domains, including transportation systems. For example, Auvinen and Tuominen (2014) describe, "a transport system is a socio-technical system that consists of a cluster of aligned elements: artifacts, knowledge, markets, regulation, cultural meaning, infrastructure, maintenance networks, supply networks, etc." Furthermore, transport systems are complex, involving interactions between social components, such as travel behaviors, and technical infrastructure. This relationship underscores "the necessity of understanding how these social and technical elements interact within transportation systems" (Chan et al., 2024). Using a socio-technical systems perspective, this research sets the foundation for a multilevel analytical model that examines the factors influencing the implementation of SAPT. These factors span individual user attitudes, organizational stakeholder roles, and national legislation, providing an overview of the complex pathways needed to implement SAVs as part of public transportation successfully.

2.2. The Multilevel Analytical Model

As described in the Introduction to the thesis, much of the discussion surrounding AVs for passenger transport has focused heavily on **technological** factors and **technological** user acceptance. Yet social changes also take place beyond the individual user, i.e. at levels above the micro level. Organizationally, there are regional and national governmental stakeholders who are charged with the very policy-making that must navigate the balance between promoting innovation and ensuring public safety and equity, actively positioning shared autonomous technology as preferable to privately owned.

As an emerging, future mobility service, shared autonomous public transport exists within a sociotechnical system that involves multiple layers of stakeholders who operate at different levels of influence. The multilevel model introduced here provides a structured approach for examining and understanding how actors and factors at different levels interact to shape the development and deployment of innovative mobility solutions.

The same multilevel approach has been used in various studies to examine drivers and barriers across different levels of influence. For instance, Leviäkangas and Öörni (2020) studied cooperative intelligent transport systems (C-ITS) from a business ecosystem perspective, looking at the end-user, business models, the business value of a supply chain, and societal value. Similarly, Karlsson et al. (2020) conducted a macro, meso, and micro analysis of the barriers to the implementation of Mobility-as-a-Service (MaaS), while Melander et al. (2022) investigated uncertainties at these levels by examining drivers and barriers to using electric freight vehicles. Nemoto (2022) used a multi-level perspective framework to discuss how automated minibuses (ASBs) serve as niche innovations within such systems, demonstrating the importance of aligning technological advancements with societal readiness and sustainability goals. [3] These examples demonstrate how macro, meso, and micro levels can provide insight into complex transportation systems.

The multilevel model is based on three elements. The first is the *levels*, or the distinct areas in the system which include different actors: macro (national policy and governance), meso (regional and organizational), and micro (individual users) levels (cf. Karlsson et al., 2020; Melander e al., 2022).[4]

The second is the *actors*. In sociotechnical systems theory, an actor is an entity that can influence or be influenced by the system.[5] This includes individuals, organizations, and institutions that play a role in the functioning and development of the system; these actors are integral components of systems, influencing each other and the system's environment, driving change and adaptation. I include actors and stakeholders that are commonly understood to be drivers and participants in a transportation system (but an exhaustive description of actors is not the focus of this work).

The third, which is the main focus of the thesis, are *factors*. By factors, this thesis refers to various elements that have the potential to impact or affect events, situations, decisions, behaviors, or outcomes in different contexts such as demographic, geographical, and psychological factors. Each of these plays a critical role in shaping the implementation and adoption of shared autonomous vehicles at various levels of society.

By applying this multilevel analytical framework, the thesis can investigate how the implementation of shared, autonomous public is affected by factors like national policies and actors like regional transport authorities and individual users.

2.2.1. The Macro Level

The macro level refers thus to factors and actors at a primarily national level. At this level, national legislation, cultural values, and infrastructure investments are assumed to shape the environment in which SAPT can develop and be directed or applied towards public transport use.

At the macro level, *actors* typically have a broad influence and operate at the national (or international) scale. Examples of actors in the macro level are:

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[3] The multilevel analytical model I suggest to use may seem similar to Geels' work in developing the multilevel perspective (MLP), which also uses macro, meso, and micro terms. However, Geels and MLP focuses on technological transitions and innovation, characterising the meso level as actors who are resistant to change and the micro level as niche innovations or technical advances.

[4] There could technically be a zeroth level, interpreted as the meta or globalized, multinational collection of factors and actors, but for the purposes of this thesis, I refrain from including it.

[5] Some authors use the term agent, but they can be interchangeable terms in a discussion of sociotechnical systems and systems theory (De Bruijn and Herder, 2009).

- Government parties and ruling coalitions that handle the daily state of affairs for a country, usually setting long term environmental and economic goals for the public.
- Government agencies and authorities, such as transportation ministries, which influence the legal and regulatory landscape and make decisions that can impact the speed and scope of SAPT deployment, the availability of shared mobility services, and set the budget for public transport and mobility infrastructure.
- National research institutions, like (in Sweden) Research Institutes of Sweden (RISE) or (in the United States) the Transportation Research Board; these institutions conduct essential research and provide data and recommendations that shape national transportation policies and innovation priorities.
- Large national and international corporations, such as Volvo Group, Ericsson, or Telia: these companies provide infrastructure and services that support transportation systems, either through vehicles, communication networks and/or data services.

An analysis of macro level actors and factors or actions that impact them–or are a product of their actions–extends to national policies, legislative actions and even wider societal trends that shape the broader deployment landscape for SAV technologies. This includes examining how national frameworks for technology adoption and infrastructure development influence the rate and manner in which SAVs are integrated into public systems. An example of this is detailed in previous work such as the KPMG Autonomous Vehicle Readiness Index (2019), which focuses explicitly on the technological adoption of AVs; it lists policy and legislation, technological innovation, and infrastructure spending as national factors contributing to a region or country's ability to implement AVs. Similarly, work by Lindkvist and Govick (2024) and Melander (2022) highlights the issues in implementing highly technical, digital infrastructure that needs to transcend traditional or long-held roles between private and public actors. Understanding factors that affect the macro level can help align national policies with both technological advancements and societal needs, ensuring a welcoming environment for the acceptance and implementation of SAPT.

2.2.2. The Meso Level

The meso level refers to factors and actors at a regional scale; usually it is a significant geographic area, encompassing several cities and towns, with distinct organizations and authorities that administrate the area. While policies may be determined at the macro level, they are implemented by meso level actors–who, in turn, can develop and implement policies of their own.

The actors on the meso level include regional stakeholders, such as transportation authorities, local governments, and research institutions. These actors operate in a limited geographic capacity, implementing and adapting national policies or programs to local contexts, manage public transportation infrastructure, and engage with the community to ensure that the benefits of SAPT, especially those for public use and not private deployment, are realized at the regional level. They work directly with communities and businesses to develop and maintain transportation infrastructure. Examples of actors in the meso level are:

- Regional planning councils or transportation authorities: these organizations coordinate regional development and transportation planning, ensuring that infrastructure projects meet the needs of local communities and align with broader regional goals.
- Universities and regional research institutions: these institutions conduct applied research and pilot projects that address local transportation challenges and opportunities, providing data and innovations tailored to the region.
- Regional business associations and chambers of commerce: these organizations represent the interests of local businesses, advocating for transportation solutions that support economic activities and improve access to markets.
- Community advocacy groups: these groups represent the interests of residents, usually around an issue or characteristic (such as a bicycle-safety group) advocating for transportation solutions that meet the needs of diverse community members, including marginalized populations.

At the meso level, the focus is on organizational adaptation and stakeholder engagement at regional levels. According to Karlsson et al. (2020), the organizations at the meso level are not just service providers but also act as intermediaries and facilitators in the broader adoption of the new mobility technology; in the context of SAVs, these organizations are needed to align their own strategic goals with broader public interests. Municipalities and transport providers must consider these changes as part of their strategic planning to ensure that AVs can operate efficiently and safely within their jurisdictions.

2.2.3. The Micro Level

The micro level refers here to and focuses on individual users of the transportation system and their interaction with SAPT. This level is concerned with how personal factors, such as age, income, travel preferences, and previous experiences with ridehailing affect users' willingness to use shared autonomous transport.

Understanding user behavior is critical to designing systems that meet the needs of diverse populations, from daily commuters to tourists.

These actors have diverse needs and preferences, which any transportation system must accommodate to be effective and inclusive. There are different types of transport system users, for example, commuters and regular user of the transport system, tourists and occasional users, students, the elderly, families with small children, and users with special needs due to physical and/or mental characteristics that raise the difficulty of using standard transport systems. Nevertheless, in the multilevel analytical model I am creating, 'user' refers to an individual. I do not delve further into different types or the unique needs and nuances that impact decision-making for those different types.[6]

At the micro level, it is necessary to understand people's current engagement with shared mobility services, like on-demand ridehailing and dynamic ridepooling, with autonomous vehicles, and with public transport, and how they react to the trade-offs involved. Haboucha et al. (2017) examined user preferences and willingness to share rides in autonomous vehicles, revealing how privacy concerns and convenience are key trade-offs that influence user acceptance; Fagnant and Kockelman (2014) highlighted the potential benefits of shared autonomous vehicles in urban areas, while also acknowledging trade-offs related to congestion and operational efficiency. Additionally, research by Clewlow and Mishra (2017) explored how ridehailing services like Uber and Lyft interacted with public transport systems, showing that these services can complement or compete with public transport, depending on user perceptions and preferences. Understanding these dynamics is crucial for developing an effective shared autonomous public transport system.

2.3. Interdependencies Between Levels

By applying a sociotechnical framework that covers micro, meso, and macro levels, this research aims to capture a range of factors that potentially affect SAPT implementation. Insights gathered from the micro level can inform policy adjustments at the macro level, ensuring that national strategies are sensitive to user needs and concerns. Similarly, the meso level, involving regional transportation authorities and service providers, also plays a crucial role in facilitating or hindering implementation through organizational strategies and regional policies. Understanding the challenges and opportunities at the meso level can help in designing interventions that align organizational practices with both individual user

[6] I refrain from differentiating between users, not because I hold the perspective that all people are the same, but because to add this dimension to my research would vastly increase its complexity. I also do not evaluate users as citizens or participants in the governance system.

expectations and national policy mandates. Thus, the multilevel analytical model can help explore these relationships and potential interdependencies.

Often multilevel models infer a hierarchical perspective (see Figure 2, below) and based on the assumption that input and effects take place at the highest level and influence the levels and factors below.

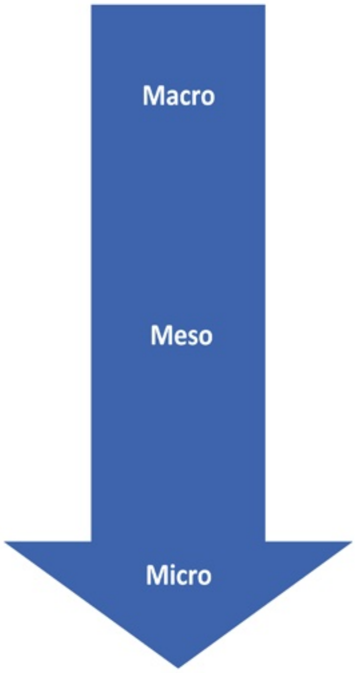

Figure 2 A common hierarchical depiction of macro, meso, and micro levels.

However, my thinking is that the levels are not so straightforwardly hierarchical with top-down directionality. Through consideration of the macro, meso, and micro levels and the actors within them, the model in Figure 3 aims to capture the diverse and interdependent transport system.

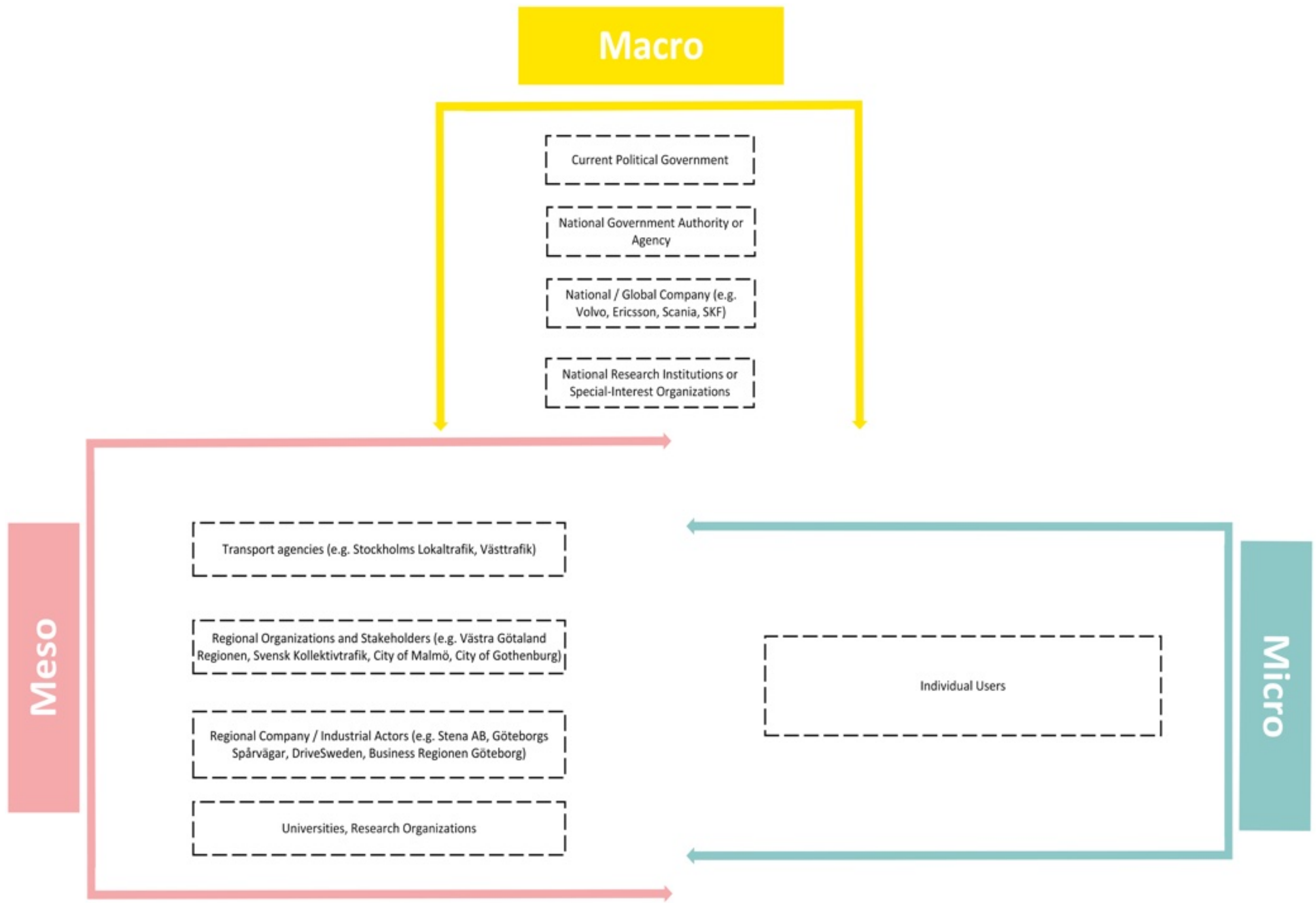

Figure 3 The outline of the multilevel analytical model employed for this thesis, with space for future identified factors. Each of the actors at the macro, meso, and micro levels are influencing each other, although the direction of that influence is not yet made clear.

3. Literature Review: Identifying Potential Factors

This chapter presents a comprehensive review of existing literature on autonomous vehicles and shared mobility services and systems. At the time of this research, there were few concrete studies looking at explicitly shared AVs and their users (given that the technology is new). As a result, many of these factors are investigated for their potential value towards the acceptance or adoption of AVs, ridehailing, or SAVs, which are seen as components towards the implementation of autonomous public transport.

3.1. Introduction

With this multilevel perspective in mind, the literature review examines the body of literature related to on-demand ridehailing, dynamic ridepooling, and AV technology from the micro, meso, and macro levels, in order to identify factors that could influence the implementation of shared autonomous public transport.

Determining to which level the factors belonged was straightforward in some cases and unclear in others. Age and gender, for example, are obviously sociodemographic characteristics applied to individuals at the micro level. It became apparent over the course of the literature review that, between the three levels, the meso level was particularly difficult to define because of its complex interplay and placement between macro and micro levels. While there is work, particularly from EU Horizon 2020 projects (e.g., Doiber et al., 2019; Homem de Gouveia et al., 2023), that discuss and involve regional actors as participants in shared mobility or autonomous systems, there appears to be limited research on factors that affect the regional actors and their decision-making processes. This realization was confirmed by the fact that there were far fewer articles relevant for the meso level than compared to either micro or macro.

3.2. Macro Level Factors

To understand how to affect societal readiness for SAPT, understanding the macro-level factors influencing SAPT implementation is essential. These factors, spanning policy, economic, technological, and socio-cultural domains, collectively shape how AV technologies are developed, deployed, and accepted. Macro factors often reflect broader societal, economic, and regulatory landscapes that can either accelerate or hinder the progress of SAPT.

Through a thematic exploration of the following categories of policy and regulation, economic and infrastructure investment, technology development and security, and social and cultural influences, this section aims to provide structured insight into which macro factors have been revealed by previous work.

3.2.1. *Policy and Regulation Factors*

Under the broad umbrella term of policy, the literature revealed several distinct factors: cybersecurity and data privacy, environmental policies, legislative and regulatory frameworks, machine ethics and safety/security, and public safety laws and policies.

Cybersecurity and data privacy concerns refer to protecting the integrity, confidentiality, and availability of data collected and used by AVs from unauthorized access and breaches. Kouroutakis (2020) looked at legislation in Germany and the UK and found differences in how each country created regulations for AVs, including the issues of cybersecurity or data privacy, finding that “the German law-making process takes into consideration the concerns of data protection and privacy, while the UK lawmakers did not include a provision on this issue”, along with setting clearer expectations and requirements for vehicles, compared to the UK. Another aspect of data privacy is what the KPMG AV Readiness Index calls “a data-sharing environment”, or how well countries are to adopting open and shared data approaches to enable greater collaboration between government and private industry (KPMG, 2019). Khan et al. (2023) examined the role stakeholders in various countries have in creating cybersecurity policies, finding that it would be necessary to have regulatory requisites for automakers, encompassing certification for fundamental cybersecurity standards and effective management of software life-cycle. According to Khan et al. (ibid.), “policy decisions made at the national and international levels have resulted in gaps within the regulatory framework concerning the transformation of ITS infrastructure. Closing this gap is vital, particularly for automakers to adapt their advanced driver assistance systems (ADAS) to comply with regulations in different countries.”

Environmental policies refer to prioritizing environmental goals and choices at a national scale and are considered crucial in shaping decisions about transportation infrastructure and innovations. Toth et al. (2022) suggest that replacing traditional route-and-timetable public transport with on-demand autonomous taxis would be more sustainable, and Kammerlander (2015) highlights the environmental benefits of lowering emissions through advanced transportation solutions. Suck et al. (2023) found that most interviewed transportation experts agreed that AVs would have environmental benefits but disagreed on how to maximize that potential. Wolf (2021) discussed how the national government of the United States’ substantial purchasing power was a pivotal tool for encouraging the private sector to advance emerging technologies, particularly in the development of smart, environmentally friendly vehicles. In particular, the Environmental Protection Agency (EPA), through its Environmentally Preferable Purchasing Program, initiated guided federal agencies in choosing products that minimize environmental impact, including the adoption of greener vehicle technologies (Wolf, 2021).

Legislative and regulatory frameworks refer to the laws, regulations, guidelines, and policies established by governments or governing bodies that dictate how certain technologies, industries, or practices are governed, controlled, and operated within a society- in this case, that of AVs and mobility systems like public transport. Frameworks that are conducive to new commercial actors entering the transportation ecosystem, or policy interventions designed to making private car ownership more difficult, all demonstrate a country's willingness to use its legal system to affect transportation choices. The works of Milakis et al. (2017), Marletto (2019), and others highlight the necessity of proactive policy interventions to manage the transition towards autonomous mobility, including its potential societal impacts, existing regulatory challenges, and the need for infrastructure adjustments. Kammerlander et al. (2015) call these policies or policy interventions "push" or "pull" measures; "push measures" aim at making driving a car less attractive and "pull measures" aim at offering alternative mobility options. This can include efforts such as congestion charges or higher taxes for unsustainable modes of travel, limiting parking places and expanding pedestrian zones, as well as campaigns and initiatives that support cycling, walking and using public transportation and investments in well-developed bicycle lanes, safe and well-designed footpaths. Riggs and Pande (2022) highlight the Americans With Disabilities Act (ADA) with changing the approach to accessible transportation and support the idea that this attitude is necessary to adopt early into the development of AVs. Authors like Wolf (2021) and Kouroutakis (2020) explored technological uncertainties, public skepticism, and the rapid pace of technological change that made it difficult to introduce new policies for AVs and saw these elements as barriers to policy formation. They argued for more adaptive regulatory frameworks that can quickly respond to new developments and challenges in the field, thus facilitating smoother implementation of AVs into existing transportation systems.

Feasibility and accessibility concerns involves evaluating whether AV technology is realistically implementable in a given area and how accessible it is for various populations, including those with disabilities or those in rural areas. Prioleau et al. (2021) discusses how availability of AV technology could be most useful in rural areas, which typically have greater access issues to mobility services, of any kind, than compared to urban users; in the authors' estimations, the financial aspect of AVs needs to be assessed because if rural communities cannot afford them, it further victimizes these communities as they do not have access to the same opportunities as their urban counterparts (Prioleau et al., 2021). Riggs and Pande (2022) discussed how current accessibility legislation in the United States improved traditional modes of transportation, and that policies for AVs need to include better collaboration and adoption of best practices to address the needs of individuals with different disability types. Khan et al. (2023) point out that factors like age, wealth, and population impact ethical decisions in the operation of AVs, and they argue that future AV policy needs to incorporate the needs of disadvantaged groups, as without the buy-in or acceptance from these users, critical mass of acceptance and a strong enough user base for shared, autonomous public transportation is not possible. In other words, the justification for acceptance from users cannot only be around the economics of scale but should include scales of access (the concept of transport equity).

Machine ethics, safety and security refers to the safety measures implemented to ensure that AV operations align with societal norms and safety standards. Kouroutakis (2020) addresses the critical importance of integrating ethical considerations and strong safety protocols in the technical development and deployment of AVs and emphasizes that the advancement of AV technology must be accompanied by rigorous testing, transparent ethical guidelines, and comprehensive security measures to protect users and pedestrians from potential risks associated with automation. In some countries, such as Sweden, Transportstyrelsen (the Swedish Transport Agency), required “safety hosts” on board AVs during pilots and trials that had a bus-format driving license.[7] While it is rather humorous to think of a driverless vehicle legally requiring an on-board driving authority, it is an example of a country trying to address this factor. Martinho et al. (2021) note that AV companies often take a pragmatic, low-liability risk approach by implementing crash-avoidance algorithms, data tracking through "black-box" devices for post-accident analysis, and setting rules for responsibility allocation in accidents; unfortunately, this shows the AV manufacturing industry’s technical problem-solving focus rather than on ethical theory implementation.

Public safety laws and policies refer to the laws and regulations that are meant to prevent potential harms associated with new transportation technologies, especially AVs. According to Anderson et al. (2014), effective public safety laws and policies address the unique challenges posed by AVs, such as decision-making in emergency scenarios and liability in accidents. These policies are crucial for ensuring that AVs enhance rather than compromise public safety, and they contribute to a wider societal acceptance of AVs as part of the transport offer in a region or country.

Central government facilitation involves the role of national governments in creating favorable policies and legislation that enable AV technology to be

[7] As of July 2024, the “drivers” of AVs no longer need to be on board, so they can operate or supervise the vehicle remotely, but depending on the size and class of vehicle, the “driver” still needs the requisite license. Transportstyrelsen, 2024.

deployed, both on public roads and for the public's consumption. Effective facilitation can include legislation that supports AV testing and integration into public transport systems. Olin and Mladenović (2022) examined the discourse surrounding self-driving vehicles in the Finnish context; they describe a "false dichotomy of laissez-faire versus dictatorial control" regarding government behavior and its facilitation of policies. Instead, they categorize the roles of national bodies as "facilitators of specific dynamics, mitigators of undesired effects, and enablers of societal engagement". The lack of central government facilitation, in their estimation, leads to "insufficiently inclusive, unreflective, and incomprehensive deliberation".

3.2.2. *National Infrastructure, Investment, and Innovation Factors*

The next theme of macro factors includes those factors that revolve around national infrastructure; not only the infrastructure itself, but the investment in future infrastructure and the innovative atmosphere in the region or country that supports more development.

Government-funded innovation investment and collaboration in AV research and development can accelerate innovation and lead to more advanced and reliable technologies. This support can also help reduce the commercial risk for private companies. Auvinen and Tuominen (2014) identified government-led collaborative efforts as a natural part of long-term planning and foresight for autonomous transportation, highlighting the importance of cooperation between various stakeholders including government bodies, technology developers, and the public. Collaborative governance can help address complex issues such as route planning for autonomous buses in urban areas and create the right conditions for commercialization. With another mobility innovation, Smith et al. (2018) examined the development of Mobility-as-a-Service (MaaS) in Sweden and Finland and found that Finland's institutions demonstrate the importance of top-level support, of inter-organizational collaboration and of trust among key stakeholders, while the Swedish case study "reiterates the need for inter-sectorial collaboration". Their work showed that macro-level Swedish and Finnish institutions (e.g. public funding of pilots) affected the chances of a viable mobility-as-a-service product being able to launch to the public. Thus, government-funded innovation investment into a new service or technology, such as SAVs, can reflect national priorities and directly contribute to acceptance and success.

Cost and implementation of new technologies refer here to the financial aspects of adopting AV technologies and the logistical challenges involved in integrating them into existing transport systems. Wolf (2021) discussed how the development of AVs requires significant financial investment; in 2016, manufacturers reportedly invested over $50 billion in autonomous vehicle technology research and development. Wolf suggested regulatory bodies that govern environmental policy could offer emissions credits to companies that earnestly strive to develop cleaner technologies. Such an emissions credit program would give manufacturers more regulatory flexibility and financial motivation to innovate in the field of autonomous vehicle technologies than would be possible with technology waivers alone, and cost-effective implementation is crucial for widespread adoption and sustainability.

Existing infrastructure and its effectiveness can both contribute to a region or nation's prosperity but also make it more difficult to embrace new technologies or systems. Nikitas (2021) and Litman (2020) analyze the challenges and opportunities in adapting existing roads, bridges, and transit systems to accommodate next-generation vehicles, such as machine-readable signage and 5G or 6G connectivity. Fagnant and Kockelman (2015) specifically look at the implications of autonomous vehicles on current infrastructure, suggesting that significant upgrades may be necessary to fully realize the benefits of automation. Giesecke, Surakka, and Hakonen (2016), emphasize the need for comprehensive planning and investment to ensure that existing infrastructure can meet future demands and support new mobility services. This factor can be affected by legal and regulatory frameworks, as Anderson et al. (2014) discusses the need for updated frameworks, since "infrastructure improvements may increase the performance and safety of autonomous vehicles" (ibid.).

A related factor would be *digital infrastructure.* Several studies focused on digital infrastructure in the context of AV governance, looking at the technological requirements and considerations needed to support the deployment and operation of AVs, which was confirmed as a meaningful factor for the successful introduction of AV technology (Canitez, 2021; Taeihagh and Lim, 2019; Khan et al., 2023). Audouin (2019) found that digital infrastructure is crucial for the successful implementation of new mobility services. The work emphasized that a strong digital infrastructure or backend is necessary for integrating various modes of transportation (e.g., public transport, car-sharing, bike-sharing) into a unified platform, thus supporting real-time data exchange, seamless payment systems, and efficient management of mobility services (ibid.). They concluded that digital infrastructure can enhance user trust and confidence in AVs and shared mobility services by ensuring reliability, safety, and ease of use. Public authorities and state-owned enterprises exhibited reluctance towards digital infrastructure-supported integrated mobility schemes brought by external actors, primarily due to concerns about losing control over transportation systems and the challenges of integrating new technologies with existing digital infrastructures (ibid.).

Planned infrastructure investments at the national level are critical for supporting economic growth, improving quality of life, as well as leading to significant economic benefits that could reduce travel time or vehicle costs. Kammerlander et al. (2015) highlighted the impact of strategic infrastructure investments on urban revitalization and the enhancement of public transportation systems; interestingly, in their study, interviewed stakeholders with a government or public sector background seemed to think the market drove innovation, yet recognized a need for government frameworks to set conditions under which new businesses could operate successfully and manage risks. Such a balancing act would be necessary in an environment that seeks to introduce a new technology (AVs) and a new behavior (sharing them or using them as public transport). The KPMG AV Index of 2019 identified several potential indicators for infrastructure, such as EV charging stations and 4G coverage.

Technology maturity refers to the development stage of AV technology and its readiness for public deployment. Maturity in this context ensures that the technology is reliable, safe, and capable of operating under a variety of urban and rural conditions. Nieuwenhuijsen et al. (2018) created a model based on varying levels of AV maturity and found that the maturity of AV technology is influenced by investment, which is driven by the potential market size of that level, and that as technology develops the fleet size and adoption rate also grows because it is inspiring consumer confidence. The KPMG AV Index of 2019 identified specific indicators of technological maturity, such as industry partnerships, AV technology firm headquarters being based in the region or country, and the number of AV-related patents.[8] Technology maturity at this level depends heavily on government policies, infrastructure readiness, and collaboration between industries and public agencies, which are typically influenced by broader economic and regulatory environments.

3.2.3. *Social and Cultural Impact Factors*

For this literature review, "social and cultural impact factors" encompasses a range of examined factors including cultural values, economic status, and market penetration of shared mobility services. These elements reflect the unique trends and tendencies within a nation that distinguish it from its neighbors and other countries globally.

Cultural values reflect the societal values and goals that permeate throughout the population and, in turn, guide everything from public policy to individual behavior within a country. Studies, such as those by Kouroutakis (2020), illustrate how Germany and the UK have had different approaches to creating AV policy; Germany has a "precise and strict definition" of liability, whereas in the UK the law is written

[8] I categorized this as a macro-level factor because it involves large-scale aspects that transcend organizational actions.

to be more flexible, but vague, with a different emphasis on who bears liability for the vehicle, indicating that cultural values have impacted their approaches. Soh and Martens (2023) state a little more broadly that "in a policy vacuum, public values can serve as a basis for creating policies aligned with public interest"; in other words, the cultural values of a region or nation can serve or direct its policies later.

Economic status also plays a crucial role in shaping national culture as it determines the financial capacity of governments and individuals to invest in and adopt new technologies like AVs. This financial aspect can greatly influence the feasibility of implementing advanced transportation systems and thus directly affects the pace at which innovations are integrated into societal frameworks. Spickermann et al. (2014) identified how strong economies and high tax revenues make it possible to subsidize multimodal transport, yet uncertainty in future market behavior makes it necessary for private sector support. Milakis and Müller (2021) describe how international economic policies exert influence on the transition path of a technology, which Nordhoff et al.'s (2018) international survey compared GDP per capita of the nations of respondents, finding that respondents from higher-income countries gave more negative ratings to intention to use AVs and less responsive to a potential future car-free environment.

Countries with a higher *presence or market penetration shared mobility services* exhibit a greater willingness to use AVs. For instance, the KPMG Autonomous Vehicles Readiness Index (AVRI) highlights nations like the Netherlands and Singapore, which have strong shared mobility infrastructures, rank highly in consumer acceptance and readiness for AVs (KPMG, 2019). In their research report, Fulton, Mason and Meroux (2017) state that in some countries, like India, "high levels of shared vehicle trips already largely exists, and the main challenge is to preserve it." They suggest that "support for small bus and van programs that can provide on-demand and at least near door-to-door service may also hold major potential for improving system efficiency", which suggests that integrating shared AV services with public transport can increase overall acceptance and usage. Ruhrort (2020) further suggests that shared mobility services significantly contribute to the acceptance of AVs by promoting an alternative socio-technical regime of mobility. This shift would encourage a reduction in private car usage, as individuals become more accustomed to the benefits of shared, on-demand travel modes.

3.3. Meso Level Factors

Having identified macro-level factors that the literature supports having likely influence shared mobility or AVs, I introduce the next level of the multilevel analysis, the meso level, and associated factors that have been found in other literature to play a role in shaping the deployment and acceptance of either shared mobility services, or shared autonomous technology, within specific regions and communities.

At this intermediate scale, I identified throughout the literature two themes, which I categorized as infrastructural factors, and economic and policy factors. By examining factors in these themes, one can better understand the complex interplay between regional economic conditions, demographic trends, specific policy frameworks, and the readiness of existing infrastructure to support advanced mobility solutions. This analysis is critical for identifying actionable strategies that can enhance the effectiveness of SAPT implementation tailored to meet regional needs and conditions.

3.3.1. *Infrastructural Factors*

The first theme in the meso level is the infrastructural factors, of which I identified five: transit accessibility, regional mobility and public transport network, digital infrastructure, and geographic location.

Transit accessibility, or what aspects of the transportation system are designed for persons with mobility challenges or disabilities, is a factor. I categorized this as a meso factor and not a micro factor because it's not about individual accessibility – although that is of course, also important! – but how a region, or nation handles accessibility issues with contemporary transportation can also be meaningful for how future plans are made for introducing SAVs. AVs have the potential for enhancing mobility access for persons with difficulties, but that largely depends on whether it is made a priority by metropolitan planning organizations, through legislation and infrastructure commitments.

Allu et al. (2017) discussed the state of U.S. legislation on AVs, noting that 41 states have considered legislation, with 12 states enacting laws allowing high-level operation of AVs. Yet while existing legislation for AVs is advancing, Allu et al. (2017) claim that this legislation often fails to address the accessibility needs of people with disabilities in current transportation modes and overlooks requirements it could enact that would support the development of AVs for people with mobility challenges, suggesting a need for more inclusive laws to ensure AVs are accessible to all. Therefore, this factor, transit accessibility, refers to how well a city or region has developed their transportation network, so that they have high or low accessibility for their residents, as well as the overall access residents in one neighborhood or region at one income level might have compared to residents at a different income level.[9]

Cohn et al. (2019) investigated how AVs might impact transportation equity across different populations. Their study focused on the Washington, D.C. region and used a travel demand model to analyze how AV adoption might influence disadvantaged and non-disadvantaged communities. Their findings suggested that AVs and enhanced transit systems provided greater equity benefits by increasing accessibility and reducing the mobility gap for disadvantaged communities; thus, they highlight that investment decisions will play a crucial role in determining the accessibility and benefits of AV systems for different population groups.

Next in infrastructure factors, *regional mobility and public transport network* refer to the movement of people and goods across a specific geographical area. These patterns can highlight disparities in mobility options and access to different travel modes, particularly between urban and rural areas, or across different socioeconomic groups. Additionally, regional mobility patterns consider the frequency and types of transport modalities used, such as private vehicles, public transport, walking, and cycling, which in turn helps urban planners and policymakers identify where to focus infrastructure improvements and policy interventions to enhance overall mobility efficiency and equity. A region's public transport networks (a part of the regional mobility pattern) indicate how strong a region's commitment to offering transport is and how much potential infrastructure already exists to support it. Understanding what patterns exist today is increasingly important in the context of integrating new technologies such as shared AVs into existing networks.

Moreno et al. (2018) designed a modeling simulation of AVs to understand how AV usage would affect regional mobility patterns in the city of Munich, noting that "to prepare cities to the upcoming arrival of AVs, transport models need to be built today to analyze the impact of this technology", and admitted that their study was built on what was available and a possibly incomplete understanding of the current mobility pattern. Moradi and Vagnoni (2018) performed a comprehensive review of related literature and stakeholders to investigate the driving and restraining forces of transition process for future mobility. In doing so they found that the dominant transportation system (private cars) and alternative systems (public and non-motorized transport) are in a sort of tug-of-war, each hindered by the entrenched interests and infrastructural biases of the other; the transport operators and authorities have complained about the high operational costs of public transport

[9] While the argument could be made that this latter description is closer to transit equity and belongs in a different category at the meso level, often poor transit equity is related to lack of infrastructure and investment, so I defend my choice to include both definitions as the same factor here.

systems as these costs are so high that the income generated from fares doesn't cover them, making public transport heavily reliant on government support. This financial dependency weakens the public transport system, preventing it from being a strong competitor to private cars (ibid.). Lim et al. (2023) used Delphi methodology with public and private experts and found that there were contrasting views between respondents over the ability of AVs to adapt to existing infrastructure; according to one participant, "Three to four years ago, the view was that AVs would be infrastructure-free, but the reality is that we are not likely to get there, so we will need to change all the infrastructure that we currently have in place" (Lim et al., 2023).

Digital infrastructure, first identified at the macro level, also was identified at the meso level. Chen et al. (2020) noted that among their interviewed stakeholders, significant concerns existed about the potential damage to existing communication systems and the costs involved in upgrading or building new infrastructure necessary for AVs to operate efficiently, involving everything from internet connectivity to traffic signal systems. Suck et al. (2023) conducted an expert survey with 28 stakeholders from Austria, Germany and Belgium, and found that data lines, satellite systems and 5G networks were seen by respondents as much-needed digital infrastructure components, the lack of which was a barrier to implementing AVs for transport.

Lim et al. (2023) found that some level of digital infrastructure development and investment into improving existing digital infrastructure is necessary to accommodate AVs and facilitate their wider acceptance, although to what extent is still unclear. Some of their participants point to the intertwined nature of digital and physical infrastructure issues by pointing out that not all roads are government owned, which complicates the funding process. In Sweden, Mukhtar-Landgren and Paulson (2021) studied how administrative practices of governing create smart mobility as a governable object. The public authorities in Sweden used experimental governance methods to form pilots and testbeds, through government-funded financing of special and specific programs, in order to learn from new mobility services and technologies in a controlled setting (Mukhtar-Landgren and Paulson, 2021). One such project was the Drive Sweden initiative LIMA – Lindholmen Integrated Mobility Arena – which was government-funded and focused on developing and testing a new smart, shared mobility service for a group of 1000 people working in Lindholmen Science Park; this involved government financing to create both physical infrastructure (mobility hubs and stations) and digital infrastructure (an app) (Mukhtar-Landgren and Paulson, 2021).

The nature of a region's *geographic location* – whether rural or urban – is another factor believed to affect how a large group of people will accept or reject shared AV.

Urban areas, with their higher population densities and more complex transportation needs, may drive faster adoption and offer more immediate benefits from AV technology. Conversely, rural areas might face challenges due to longer distances, higher rates of car ownership, and less dense infrastructure, a potential barrier to the implementation of SAPT. But they also offer the most opportunity, given that there are fewer other transportation modes to compete with and less existing infrastructure to change or interfere. Dijkhuijs et al. (2023) found major regional differences in acceptance between respondents in the Randstad, Netherlands, compared to respondents living in Sydney, Australia and Montreal, Canada; they performed factor analyses which suggested that those living in the Randstad tend to have a positive attitude towards sharing, in contrast to the other two regions. Dijkhuijs et al. (2023) theorized that regional locations might influence this difference since walking, cycling and the usage of public transport are more common in the Netherlands compared to the more car-centric travel cultures found in Australia and Canada. A review by McAslan et al. (2021) of metropolitan planning organizations throughout the United States found that one of the most commonly mentioned issues was that of land use and parking and how it related to public transportation, and travel demand and behavior. While the adoption of AVs might result in more efficient land use and reduce the need for parking in the cities, AVs "may just as easily facilitate sprawl. By reducing the cost, time and effort to drive, advanced vehicles could encourage choices to live further from urban centers" (McAslan et al., 2021).

3.3.2. *Economy and Policy Factors*

After exploring the infrastructural influences on the implementation of SAVs, I now turn focus to the economic and policy theme, where I found literature that confirmed or made claims that five factors influence the regional adoption and integration of AVs: *economic investment or advantage, public transport and AV policy, public-private frameworks, affordability,* and the *labor market.*

Regions with a strong *economic investment* or have significant economic advantages are often better positioned to develop and implement AV technology or incorporate new technologies (such as vehicle-to-infrastructure devices) for public transport use; this includes investments in infrastructure or direct funding for AV projects. Walters et al., (2022) describe how "rural communities continue to have higher levels of poverty, social exclusion and inequality compared with urban communities" and that improving access to transportation in these areas could address these problems. However, if these areas are already experiencing poverty and do not have the economic resources to invest in transportation solutions, then it stands to reason that they will not be able to take advantage of technological innovations such as AVs, potentially falling further behind wealthier neighboring communities.

Freemark et al. (2019) performed a study with municipal planners in various U.S. cities and presented data indicating that there is variation in the responses of municipal officials based on the median household income of their cities. For example, cities in the top quartile of median household income tend to have different concerns and preparedness levels for AVs compared to cities in the bottom quartile; thus higher income cities might be more concerned about AVs reducing transportation employment or less worried about AVs reducing transit ridership, which contrasted with lower income cities which might prioritize different concerns due to their unique economic situations (Freemark et al., 2019). Merfeld et al. (2019) performed a Delphi study with 40 transport planners and municipal employees and found that economic factors were highlighted as potential drivers of a shared, on-demand AVs; “the service must be financially attractive to consumers in terms of cheaper transportation costs compared to other modes of transport” (Merfeld et al., 2019). (Household income as a micro-level factor is examined later.)

Crafting *public transport and AV policy* is considered significant for shaping the integration of AV technology with existing public transportation systems. Guerra (2016) performed a review of long-range transportation plans and interviews with city planners, finding that because of the uncertainties presented by how AVs might impact the city, planners saw AVs as removed from the types of policy decisions that long-range planning supports and justifies. Interviewees routinely described the long-range planning process as reactive and, as one planner lamented, they tend to plan in the rear-view mirror. Brovarone et al. (2021) had similar findings in their study, which found that door-to-door AV usage and wider access to individual car trips could be to the detriment of public transport and active mobility; moreover, their case study of Turin found that the attitude of local authorities was dominated by a laissez-faire approach, noting that “planners are reluctant to play an active role in this transition, due to the great uncertainty and the lack of usable knowledge to act in the short and medium term”.

Yet in some cases, policymakers craft regulations that shape mobility usage in ways that (intentionally or not) benefit mobility services, now and in the future. Cheong et al. (2023) described how MOIA, an on-demand ridehailing service in Hamburg, was forced to have a virtual pickup and drop-off network rather than “door-to-door” service because German regulation does not allow pickup or drop-off commercially for long periods of time at just any point. While reducing somewhat the convenience of the service, this regulation effectively reduces empty vehicle mileage, increases the efficiency of the ridesharing mode and, furthermore, reduces the overall energy consumption by transportation in general.

Public-private frameworks refer to the different roles, responsibilities, and interactions between public (governmental) and private (business or individual) entities in shared mobility and AV services. One common form of collaboration is public-private partnerships, where government regulators, transportation departments, urban planners, AV manufacturers, technology firms, and service providers collaborate to manage the AV ecosystem (Chen and Johnson, 2020; Marucci et al., 2021). Audouin (2019) discusses public-private partnerships (called PPPs) and collaborative frameworks; they define them as "some sort of durability between public and private actors in which they jointly develop products and services and share risks, costs, and resources which are connected with these products". In the context of transportation, they examine how public authorities engage with private actors to develop Mobility-as-a-Service (MaaS) through data-sharing agreements, ICT-supported integration, and smart cards, highlighting the evolution from government-led to collaborative governance approaches, where both sectors share resources and responsibilities for innovative mobility services, through frameworks like multi-level governance and collaborative structures.

However, the degree of cooperation in these partnerships and frameworks can vary widely across cities, regions, and states. The World Bank outlined several key components of these frameworks, including legal structures, clearly defined processes for project selection and implementation, and public financial management practices (World Bank, 2017). These components ensure that collaborations between the public and private sectors are transparent, accountable, and aligned with both economic and social goals (Sällberg and Numminen, 2021).

Jiang et al. (2022) explored the readiness of cities for shared AVs, finding that no concrete frameworks or criteria currently existed to measure city readiness. Their study surveyed both professional and public stakeholders, assessing cities' infrastructure, policy, and regulation readiness. The results indicated that infrastructure readiness was considered the most important factor, while policy and regulation readiness were deemed less critical.

Interestingly, Jiang et al.'s findings contradict those of Anderson et al. (2014), who authored a comprehensive guide for policymakers on AVs. Anderson et al. (2014) concluded that regulatory readiness is crucial for AV deployment, particularly in the context of conflicting state laws across the U.S. Original equipment manufacturers emphasized the need for a unified legislative framework that applies consistently across all 50 states, arguing that legislative fragmentation could significantly hinder AV deployment. This divergence highlights the potential disconnect between the priorities of technology developers and those of policymakers. Supporting Anderson et al.'s concerns, Suck et al. (2023) found that regulatory conflicts between political entities and technology-producing companies are an ongoing challenge. Their expert stakeholder survey revealed that the rapid introduction of new mobility technologies, such as e-scooters, often outpaces regulatory frameworks, leading to chaotic road incidents due to a lack of clear legal rules.

Anderson et al. (2014) use data sharing agreements as an example of how this public-private framework *should* function: AV service providers, or private entities, would collect extensive data through their fleet operations. This data can include traffic patterns, vehicle performance, and usage rates. City governments, or public entities, require access to this data to better understand traffic flow, plan for infrastructure needs, enhance public safety measures, and integrate AVs into their urban planning strategies.

Therefore, an agreement where AV companies share relevant operational data with city authorities under specific guidelines that protect user privacy and proprietary information would help cities optimize their transportation systems and allows companies to operate within city environments effectively. These frameworks can sometimes be revealed by the presence of a public-private partnership for developing a new service, technology, or infrastructure feature (Meier and O'Toole 2011). Thus, I see public-private frameworks (and the partnerships that arise from such frameworks) as a key factor for the implementation of SAVs for public transport.

Another meso-level economic factor is *affordability*. Merfeld et al. (2019) quoted one of the respondents in their study, who said “cheaper costs will make door-to-door transport more affordable than taxis in many developed countries, where taxis are way too expensive, in areas which are ill-served by mass transportation”. Affordability could play a crucial role; the relative costs of gasoline versus electricity can influence consumer preferences for AVs, particularly electric AVs, depending on their cost-efficiency compared to traditional vehicles. Affordability has historically been a driver for other forms of shared mobility; Hwang and Guiliano (1990) performed a literature review on the determinants of ridesharing and found there are two main reasons for the higher propensity to carpool among long distance commuters: the inconvenience is relatively small and the benefit of sharing the cost of the travel is significantly larger. So economic circumstances that affect the cost of living in a region will most likely impact the adoption of a new mobility service, if that service is offering reduced cost or increased benefit for cost.

The *labor market* and the presence of major industries, such as technology or automotive sectors, can also drive the adoption of AVs. Regions with a strong presence of relevant industries might experience quicker adoption due to better access to skilled labor, technological expertise, and institutional support Taeihagh and Lim (2019) examined the risks associated with AV acceptance, and identified economic consequences and changes to employment as significant barriers, as automation may lead to significant job displacement for professional drivers and create ripple effects in related industries, including motor trades, insurance, vehicle repair, and law enforcement; they emphasize that to reduce these potential negative outcomes, "it is crucial to begin retraining and transitioning affected workers as soon as possible". Their study draws the conclusion that regions or countries that have strong labor markets or are willing to protect their vehicle-based industries during the transition to AVs, are more likely to have higher societal acceptance for shared AVs. Additionally, the public transport industry (in Sweden, and in many countries, as a result of pandemic) suffers from a lack of availability of bus drivers (Nordic Labour Journal, 2023; International Road Transport Union, 2024), which should be considered a component of evaluating the labor market. Groshen et al. (2018) estimates that over a million driving jobs would be lost over the course of 30 years, and different skills and roles would emerge to address the deployment and maintenance of autonomous transport systems.

3.4. Micro Level Factors

Transitioning from the broader societal and infrastructural considerations at the meso level, I now investigate the micro level factors that directly influence individual user acceptance and utilization of shared AVs.[10] I break down the factors here into three categories: sociodemographic factors, psychographic factors, and behavioral factors. These factors are necessary in understanding how personal circumstances, preferences, and attitudes can significantly shape the perception of and interaction with shared mobility, AVs, and SAPT.

3.4.1. *Sociodemographic Factors*

Sociodemographic characteristics such as age, gender, income, education, and household size have been found to impact user acceptance and utilization of AVs and shared mobility services. These factors often dictate not only the usability of such services, but also the attitudes and preferences towards them.

Age is a fundamental demographic factor and is often associated with changes in physical abilities, cognitive function, life experiences, and behaviors. Research by authors like Bansal et al. (2016) and Clayton et al. (2020) investigated how age influences people's mobility choices, technology adoption, health outcomes, and

[10] I make a point here to differentiate between the macro, meso, and micro levels with the use of the terms "implementing SAPT" and "adopting" or "accepting" AVs or SAVs. Macro- and meso-level actors can implement SAPT; however, users can only choose or refuse to use it. They are not responsible (or capable) of pushing its implementation. Given that there are few true representations of SAPT in which to study micro-level factors, much of my review of the factors and discussion about how users are affected by these factors will thus sometimes refer to users' acceptance or adoption of SAVs.

social behaviors, particularly in how certain age groups respond differently to technological innovation and adoption.

Gender is a socio-cultural term referring to roles, behaviors, activities, and attributes that a given society considers appropriate for men and women.[11] The work of other authors such as Sarriera et al. (2017), Park et al. (2018) and Patel et al. (2023) explored how gender roles and gender identities impact occupational choices, consumer behavior, and interaction with technology, all of which could also affect acceptance at the micro level for shared, autonomous public transport.

Household income refers to the total gross income of all working members of a household and is considered a measure of economic status, particularly at the individual level. It can significantly impact an individual’s quality of life, access to resources, and opportunities; income is tightly connected to transportation access. Studies by Dias et al. (2017) and Barbour et al. (2019) looked at how household income affects access to transportation as well as attitudes towards new mobility modes or technology.

Education examines the impact of individuals' educational backgrounds on various aspects of societal participation and behavior (Dias et al. 2017; Gerte, Konduri, and Eluri 2018). Othman (2023) performed a study focused on education and found that the northeastern regions of the United States and high educational levels were highly correlated with high willingness to trust and to pay more for trips with AVs. However, Othman’s study also noted that the more informed someone was about AVs, the less they were willing to use or adopt AVs, which infers that publicly dissemination information may predominantly emphasize negative aspects, leading to a negative shift in willingness to use.

Employment status has been found to impact commuting patterns, car ownership, and the use of public transportation. Neoh, Chipulu and Marshall (2017) studied how occupational demands influence commuting times and preferences. Nazari et al. (2018) and Clayton et al. (2020) studied the correlation between employment stability and the utilization of public transportation services. Nair and Bhat (2021) examined the relationship between employment patterns and commuting habits, suggesting that higher educational levels and certain employment sectors favor specific transit options. Gkritza et al. (2022) found that those who were innovators and early adopters of mobility services in Chicago were from significantly higher income and more highly educated groups than their counterparts in Indianapolis. Nikitas et al. (2021) performed a multinational study on how respondents felt about AVs potentially challenging their employment status, noting that “awareness about

[11] And in more contemporary examinations, other categories; however this thesis is limited in its scope to binary gender roles, an oversight the author apologizes for.

the risks on own employment were factors influencing respondents' perceptions of whether transport professionals' job security will be jeopardized”, and that governments were not prepared for the impact AVs would force upon workplace conditions.

Ethnicity-related studies examine how cultural and ethnic backgrounds influence behavior patterns, including mobility and transportation use. Sarriera et al. (2017) and Gerte, Konduri and Eluru (2018) discuss the variance in transportation preference across different ethnic groups; in Gerte, Konduri and Eluru’s study, which looked at demand for Uber and the percentage of the population that was African American in a taxi zone, they found a negative relationship, raising questions of equity. Zhao et al.’s (2017) work on how ethnicity impacts the experiences of users in shared rides is quite significant for understanding how shared mobility journeys effect and are affected by users’ perceptions of safety, trust, and how ethnicity can be part of that equation. Confirming this effect, Lavieri and Bhat (2019) found that non-Hispanic white users of ridehailing services are hesitant to use pooled ridehailing services. Middleton and Zhao (2019) found that “discriminatory attitudes toward fellow passengers of differing class and race in the shared ride are positively correlated with respondents that are male or are women with children”; put more simply, men and women with children were more likely to express discriminatory attitudes towards fellow passengers of different class and race. They found that while their respondents’ own race did not directly influence distriminatory attitudes, white respondents in majority-white countries were more likely to have discriminatory attitudes (Middleton and Zhao, 2019). These findings have strong implications for not only what will affect users’ willingness to share AVs in an SAPT context, and with who, but raise questions about how to mitigate discrimination and racism in a driverless setting.

Household size plays a crucial role in shaping mobility needs and preferences, impacting everything from car ownership rates to preferences for public transport and shared mobility solutions. Research by Lavieri (2018) has indicated that household size is significantly correlated with the utilization of carpooling options and the likelihood of participating in ridesharing programs, as larger families might prioritize cost-efficiency and convenience.

Residential density influences public transport usage and the adoption of non-conventional mobility services like bike-sharing and electric scooters. Research such as that by Dias et al. (2017) has shown that high-density residential living (like in city centers where homes and apartments are close together) leads to a higher likelihood of people participating in ridesharing. This is because such areas often have more ridesharing options, and it is more convenient to share rides in busy, compact areas. Low-density residential living (like in suburbs or rural areas where houses are spread out) leads to a lower likelihood of people participating in ridesharing; in these areas, people are more spread out, making ride-sharing less convenient and thus less appealing (ibid.).

The distinction between *urban and nonurban residences* significantly affects transportation behaviors and preferences, reflecting differences in infrastructure, accessibility, and cultural attitudes towards various modes of transport. Those living in nonurban areas face challenges such as longer travel distances and less frequent public transportation services, leading to a greater reliance on personal vehicles and higher fare sensitivity, as shown by researchers like Golbabaei et al. (2023), who argued that “respondents residing in peri-urban areas tend to be more concerned about fares when using autonomous shuttle busses (ASBs) compared to conventional shuttles”. Hilgarter and Granig (2020) showed that residents in rural areas had a stronger positive reception towards AVs than urban areas. Jiang et al. (2020) did a high-level geographic examination and compared regions of the United States, revealing significant geographical differences in attitudes towards AVs; the northeastern United States, for example, showed a higher receptivity to AVs compared to other regions in clusters that correspond to the locations of Washington D.C., Philadelphia, Boston, and New York City – places of high urban density. This suggests that location significantly influences how people perceive and are willing to interact with AV technology.

3.4.2. *Psychographic Factors*

Psychographic characteristics encompass the attitudes, values, personalities, lifestyles, and interests of individuals. Unlike sociodemographic factors that describe "who" the consumer is, psychographic factors are concerned with "why" consumers behave the way they do. These traits offer a deeper understanding of the motivations behind the acceptance and utilization of autonomous vehicles and shared mobility services.

Environmental attitudes reflect the personal and societal values concerning environmental conservation and sustainable living. A positive perception of environmental impacts, such as reduced emissions and efficient energy use, associated with AVs can significantly shift public opinion in their favor. Research by Acheampong et al. (2021) highlighted that consumers who prioritize environmental benefits are more likely to support and adopt AV technology, underlining the crucial role of green preferences in the acceptance of new mobility solutions.

Social norms play a role in the adoption of AVs. At the micro level, since it refers to individuals, it can be difficult to distinguish which cultural norm is affecting users, especially if they have a multinational or multicultural background. As

Amirkiaee and Evangelopoulos (2018) discussed, societal acceptance can be heavily influenced by examples of what they called “commitment to community” (which I consider as *social norm*). Bachmann et al. (2018) and Liu and Yang (2018) explored how societal pressures, and perceived social acceptance can drive or hinder the adoption of AVs, something which Liu and Yang termed “herd behavior” (I consider all of these pressures as social norm as well). A review from Bala et al. (2023) found that the proportion of people with positive intention to use SAVs varied substantially cross-culturally; for example, respondents from North America, Europe and Australia displayed lower willingness to use AVs in the form of ridepooling services compared to respondents from Asia, where more than 80% of the respondents from Singapore and China found shared AVs to be a desirable service which they intend to use themselves and are also willing to recommend to their social circle. This indicates that cultural values from the macro level can affect social norms and societal image, which in turn can affect attitudes towards technological adoption.

Perceived benefits, including enhanced safety, increased efficiency, and time savings, are considered critical in shaping public opinion towards SAVs. Margolin et al. (1978) highlighted that perceptions about time savings and social interactions within carpools (both positive and negative) significantly affect the willingness to participate in carpooling. Solo drivers often viewed carpooling less favorably due to perceived inconveniences and a lack of flexibility. Xu et al. (2018) found that perceived usefulness were positive predictors of participants’ intention to use SAVs. Merat et al. (2017) considered several aspects of perceived benefits, such as comfort, privacy, and hedonic motivation as factors that increased AV acceptance.

Conversely, *perceived risks* were often found to be present in the participants of studies reviewed in the literature. Research by Efthymiou et al. (2013) found strong safety concerns among users of both bike-sharing and car-sharing programs. Etminani-Ghasrodashti et al. (2021) found in focus groups that safety was a universal concern among their participants, focusing on “the lack of human operators in a self-driving vehicle, safely boarding the vehicle, notifying the SAV about the stop locations, stopping it at the destination, and assisting in an emergency while riding in a self-driving car”. Interestingly, Nair and Bhat (2021) found that how people feel about AVs – whether excited or anxious – influenced their sense of safety around AVs, confirming that perception of safety is a factor in SAV acceptance, yet what influences or impacts safety and security concerns is complex. Sarriera et al. (2017) examined ridesharing users, and found that safety concerns were paramount, especially for women, who often preferred ridesharing with passengers of the same gender to feel safer.

Personality traits have been found to influence how individuals perceive and interact with technology, as well as other people. Personalities can be shaped by culture and geography, and they govern likes and dislikes which, in turn, steer the choices that individuals make. Authors like Mack, et al. (2021) focused on traits such as openness to experience and technophilia, which can predispose individuals to be more receptive to autonomous vehicle technologies; Zhang et al. (2022) found that traits such as extraversion, agreeableness, conscientiousness, and emotional stability positively influenced expectations of AVs. Understanding how personality traits could impact the acceptance of shared, driverless spaces is important for knowing how to introduce and market such services.

Privacy concerns are especially significant in the context of AV adoption, where the potential for data breaches and surveillance exists. Lavieri and Bhat (2019) found that privacy concerns are a major reason why many people, particularly non-Hispanic white users of ridehailing services, are hesitant to use pooled ridehailing services. It is natural to conclude that this reluctance would translate to a lower acceptance of using future shared AVs, especially since there's no driver to act as a safeguard when sharing rides with strangers.

Technological attitudes impact the acceptance of shared mobility and AVs. Wang et al. (2020)'s main finding was that people who are favorable towards technology and prefer more regulated traffic conditions generally have more positive attitudes towards AVs. Nair and Bhat (2021) found that positive experiences with technology had a stronger impact on improving perceived safety (and thus on acceptance of AVs) than just being 'tech-savvy'. Jiang et al. (2020)'s investigations looked at technological acceptance regarding AVs through the concept of "Pro-Technology" attitudes; they identified four key factors affecting attitudes toward AVs: technology acceptance, driving enjoyment, risk-taking, and traffic regulation. They saw that those with positive technology acceptance were more likely to view AVs favorably and consider purchasing or using them.

(AV) Technological familiarity is my broad categorization of factors that different authors investigated regarding the experience and ease potential users had with sharing, ridehailing, or driverless services. Becker and Axhausen (2017) found in their literature review that individuals who already own vehicles equipped with ADAS are particularly positive about using AVs. Alemi et al. (2019) looked at the use of smartphones for determining trip destinations and routes, and the frequency of air travel as indicators of technological engagement and found that individuals who frequently use technology for travel logistics and those who travel often by air are more likely to adopt and use ridehailing services.

Trust fundamentally shapes how individuals perceive and interact with AVs and shared mobility services. Diels et al. (2017) believed "the major challenge for automated and shared vehicles is to instill a sufficient and appropriate, or calibrated, level of trust. Trust develops over time but can be facilitated by providing the right type of information”, inferring that the passenger must have trust in both the technology and the SAV system and service. Ekman (2023) examines user trust in AV technology, finding that trust as affected by the perceived predictability, reliability of the AV, and how well the vehicle behaved when executing tasks; users’ trust in AVs was higher in highway settings and lower in urban settings, due to the complexity of these areas and the greater perceived risk.

Diels et al. (2017) proposed that trust encompassed three types of awareness: mode (who or what is controlling the vehicle at any moment); situation (what the vehicle perceives in its surroundings) and behavior (anticipating the vehicle’s next actions based on situational context). It is worth noting that Diels and colleagues focused primarily on technological trust and only briefly touched on the concept of proxemics, stating that “Privacy and personal space are critical factors influencing the acceptance of shared mobility services” (ibid.). Paddeu et al. (2020) defined trust as an essential factor influencing both acceptance and comfort in AVs; in their study, trust is seen as an attitude that depends on people’s beliefs about automation, affecting their intention to use the technology. Like Diels et al. (2017), they too only briefly mention the interpersonal dimension in their definitions of trust. However, other studies have shown that trust in both the technology itself and the entities that manage and regulate ridehailing and AV services is essential for their adoption; for instance, Park et al. (2017) examined the ridesharing service Cabbit in Korea and found that even though they had created a trust-based network for finding people to share cabs with, it was difficult to recommend effective matches based on the relatively small size of the user pool.

Examining social or interpersonal trust, a study by Middleton, and Zhao (2019) reveals trust issues are driven by discriminatory attitudes based on race and social class and significantly impact the adoption and satisfaction of ridesharing services. Users harboring these biases are less likely to choose shared rides, report lower satisfaction with them, and, if they haven't yet tried shared services, are more hesitant to do so in the future; thus, they considered this lack of trust in others to pose a considerable challenge to the long-term success and widespread adoption of shared mobility options (ibid.).

Given that the different studies interpreted trust to suit their own contexts, I interpreted the factor of trust broadly–to refer to not only technological trust, and not only trust in the actors or companies providing mobility services, but trust in the people participating in the service alongside the user.

3.4.3. *Behavioral Factors*

Behavioral factors are crucial for understanding how individuals might interact with and accept SAVs, particularly in a public transport context. This is a broad interpretation of actions and factors that cover demonstrated and learned behaviors.

In my literature review, I identified four factors: car ownership, travel preferences and behavior, user experiences and expectations of AV, user experiences and expectations of ridehailing as distinct factors other researchers have investigated or confirmed as impactful. (I also found three latent constructs–not factors themselves, but heavily researched and confirmed as impactful nonetheless that I will briefly review–willingness to pay, willingness to share journeys, and willingness to use AVs.) Together, these factors provide valuable insights into user preferences and the challenges that may hinder the adoption of SAVs for public transport use.

Car ownership often indicates a preference for private transportation, potentially reducing openness to shared services; it can also indicate a user's subscription to the "social norms" around them. Nielsen et al. (2015) examined car owners and their reasons for using a car as their main transportation mode, and how they responded to carpooling as a transportation option. Pakusch et al. (2018) found that car owners prefer autonomous taxis to autonomous public transport, which suggested that users value privacy, independence, and convenience– elements that present challenges for the sustainable use of AV technology, which relies on sharing vehicles. Taking measures to reduce private car ownership is a typical measure in urban areas to increase public transport. Dias et al. (2017) found that households owning vehicles are generally less likely to use car sharing services, which suggested that car ownership directly competes with car-sharing as an option for mobility. Patel et al. (2023) confirmed these findings by demonstrating that car ownership is negatively correlated with the willingness to use shared AVs, indicating that private vehicle users are less likely to switch to shared forms of vehicles.

Travel preferences or travel behavior was another common behavioral characteristic found in my literature review. Bansal et al. (2016) asked respondents in Austin, Texas about their current travel patterns, finding that current car owners were eager to add driverless features to their vehicles, but that more than 80% of those who relied on car-sharing or ridehailing services were unwilling to pay more for AV versions of those services than they already did at the time of the survey. Like age and gender, travel preferences or behavior–especially those at the time of data collection–are commonly investigated factors that, on their own may, not be strong enough to increase the acceptance of SAVs, but in confluence with other factors (such as willingness to pay or willingness to share, which I describe later) contribute or inhibit that acceptance. For example, Middleton and Zhao (2019) examined racially discriminatory attitudes in survey respondents who had used ridehailing and found that discriminatory attitudes among riders do not significantly affect whether someone tries a ridesharing service for the first time, yet those attitudes are linked to less frequent use, lower satisfaction, and reduced willingness to continue using ridesharing services in the future.

User experiences and expectations of AV technology cover both responses to actual uses (typically of AV pilots) and stated preferences to future or hypothetical situations. Fraederich et al. (2016)'s study showed that in the case of unfamiliar technological innovations where earlier experiences are not available yet, people tended to base their attitudes more on emotional responses; thus, perceived affects towards AVs offer added explanatory and predictive value for the overall attitudes and future behavioral intentions. For example, users who experienced autonomous driving features such as automatic parking saw the function as reducing stress, saving time, and increasing comfort; this function increased respondents' trust and positive impressions of AVs (Fraederich et al., 2016). Harb et al. (2018) conducted a naturalistic experiment where users always had a chauffeured vehicle available to them. This led to user groups such as retirees to benefit from the ability to travel at night and on longer trips without having to worry about safety; for families, children were brought to activities without their parents, giving the children more freedom to travel and the parents more time to focus on other tasks or chores. Given that vehicle miles traveled went up for all participants involved in Harb et al. (2018)'s experiment, it is safe to assume that the service had a positive impact on users, and they were willing to continue using the "autonomous" vehicles.

Similarly, *user experiences and expectations of ridehailing* also impact how satisfied people are with ridehailing or ridepooling services, and by extension, how they might embrace or reject SAVs. Dedema and Zhang (2019) found that passengers' emotional experiences in rides, particularly shared rides[12], impacted

[12] First, it must be noted that the term "ridesharing" was used in different contexts and not consistently across the literature. Sometimes using that term revealed articles focused on "carpooling", a behavior where a car driver already headed to a destination takes on an additional passenger (sometimes a familiar person, like a co-worker, and sometimes a stranger), facilitated by the use of a matching service. Other times it revealed articles that were focused on short-term car-sharing schemes, where a member of a service has access to a vehicle as part of a fleet of vehicles, uses it privately, and then returns it so that the next member can utilize the vehicle. Twenty-six articles used the term "dynamic rideshare" or "dynamic ride-share" (DRS) to identify the subset of ridehailing services that expand on the typical on-demand matching of taxis or transportation network companies (TNCs) to potential riders, and in a tradeoff of convenience and price, place multiple riders in the same vehicle. However, because SAE International has deprecated the term "ridesharing" due to its widespread use in a variety of mobility contexts, two articles used the term "ridepooling" or "ride-pooling" to cover the same service and behavior type as other authors called "dynamic ridesharing". To avoid future confusion, while acknowledging that the general public still uses the term ridesharing to refer to a diverse

their likelihood to ride again; while satisfied customers had generally similar reasons for being satisfied and would return to using the service quickly, dissatisfied customers had widely ranging experiences, which made them more reluctant to use the ridesharing service again, thus costing the ridesharing services repeat business in the future. Sarriera et al. (2017) examined the influence of social aspects on the use of dynamic ridesharing and found that while social interactions—such as networking opportunities or engaging conversations—are recognized and seen as positives, they are less influential than practical concerns like time and cost. Their study also revealed that negative social experiences, such as being paired with an unpleasant passenger, deterred users more significantly than the potential for positive interactions encouraged them.

3.4.4. *Not Factors but Facets*

Lastly, three behavioral characteristics I want to mention are not factors, yet they are the focus of much work in the field and thus bear mentioning here. They are facets of willingness: willingness to pay, willingness to share, and willingness to use AVs. These three are distinctly different concepts but deeply intertwined–with each other, and with the previously mentioned factors. It may be better to describe willingness as a latent construct, a predisposition that reflects an individual's likelihood of adopting and using shared mobility and AVs, influenced by various beliefs, attitudes, and sociodemographic factors.

Willingness to pay reflects the financial commitment that users are prepared to make towards using a mobility service, be it ridehailing, car-sharing, or AVs. This willingness is often influenced by perceived value, convenience, and the comparative costs of alternative transportation modes. Quite obviously for expensive technology such as AVs, willingness to pay for autonomous mobility can be a strong indicator of the economic viability of such services; yet willingness to pay for contemporary, similar services, like Uber or car-sharing schemes, also indicates market tolerance. For instance, Shaheen et al. (2016) identified that although consumers express interest in the features of AVs, their willingness to pay a premium for these features is dependent on tangible improvements over consumers' existing transportation options, such as reduced travel times or increased productivity during commutes. Lavieri and Bhat (2019) found that discounted fares for sharing rides encouraged on-demand ridesharing, and Gurumurthy and Kockelman (2019) found that if a SAV service offers minimal added travel time and competitive pricing, it becomes more attractive to users, thus showing that effective

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array of mobility services, I focused on the term "dynamic ridepooling" to be explicit about the on-demand, co-riding nature of the mobility experience I am investigating.

pricing strategies that reflect the real and perceived benefits of AVs can enhance user willingness to engage with these technologies, thereby increasing their desire to use them regularly. The same study also showed that willingness to pay varied depending on income levels or if users live in areas with high employment density.

Willingness to share encompasses the readiness of individuals to engage in shared mobility services and SAV services, rather than opting for private vehicle usage. This characteristic is, as established earlier, crucial for assessing the potential success of shared mobility solutions like SAPT. Research by Cohen and Shaheen (2018) suggests that willingness to share is often hindered by concerns over privacy, security, and the reliability of sharing with strangers, indicating that successful implementation of SAVs for public transport must thoroughly address these concerns. A report by Hou et al. (2020) examined willingness to share in ridehailing trips in the Chicago area, identifying that an incremental 10% increase in the difference in fare between shared/private trip corresponds to a 0.82% increase in willingness to share a ride. König et al. (2021) found that detailed information about fellow passengers, such as names, pictures, and ratings, increased willingness to share among users, meaning they would require less of a discount to agree to share a ride. However, *only* providing a name, especially a male name, had the effect of increasing compensation demands from both men and women, a finding that bears the inference that all participants were more reluctant to share their journeys with strange men. All of this has strong implications for how shared AVs might be accepted, promoted, or rejected in the future.

Willingness to use AVs is an indicator of the general acceptance and readiness of potential users to adopt autonomous driving technology for their personal or shared mobility needs. This willingness has been found to be significantly shaped by factors such as trust in technology, perceived safety, and personal experiences with technology-based services. Nordhoff et al. (2018) performed a large, multinational survey which indicated that sociodemographic characteristics like age, gender, and income had less influence on the willingness to use AVs compared to specific attitudes about AV technology; for example, men generally exhibited a more positive attitude towards AVs and a higher willingness to pay for automated features. A study by Nazari et al. (2023) confirmed that perceived benefit as a primary factor on behavioral intention to use AVs, and that attitudes on shared mobility influence willingness to use AVs by influencing desire for ownership–those who have low trust of strangers prefer to own their AV or ride alone. Becker and Axhausen (2017)'s seminal review found a number of factors that influence the acceptance and willingness to use AVs, not the least of which are attitudes towards using technology–the acceptance of advanced driving systems, for example, and general awareness of technology and how it is developing, were positive factors in increasing willingness to use AVs.

3.5. Initially Identified Factors at Micro, Meso, Macro Levels

This review made it possible to begin building the foundational "model" for a multilevel analysis of shared, autonomous mobility, including the revealed factors at their appropriate levels. For clarity, the model is shown by level in Figures 4, 5, and 6, below.

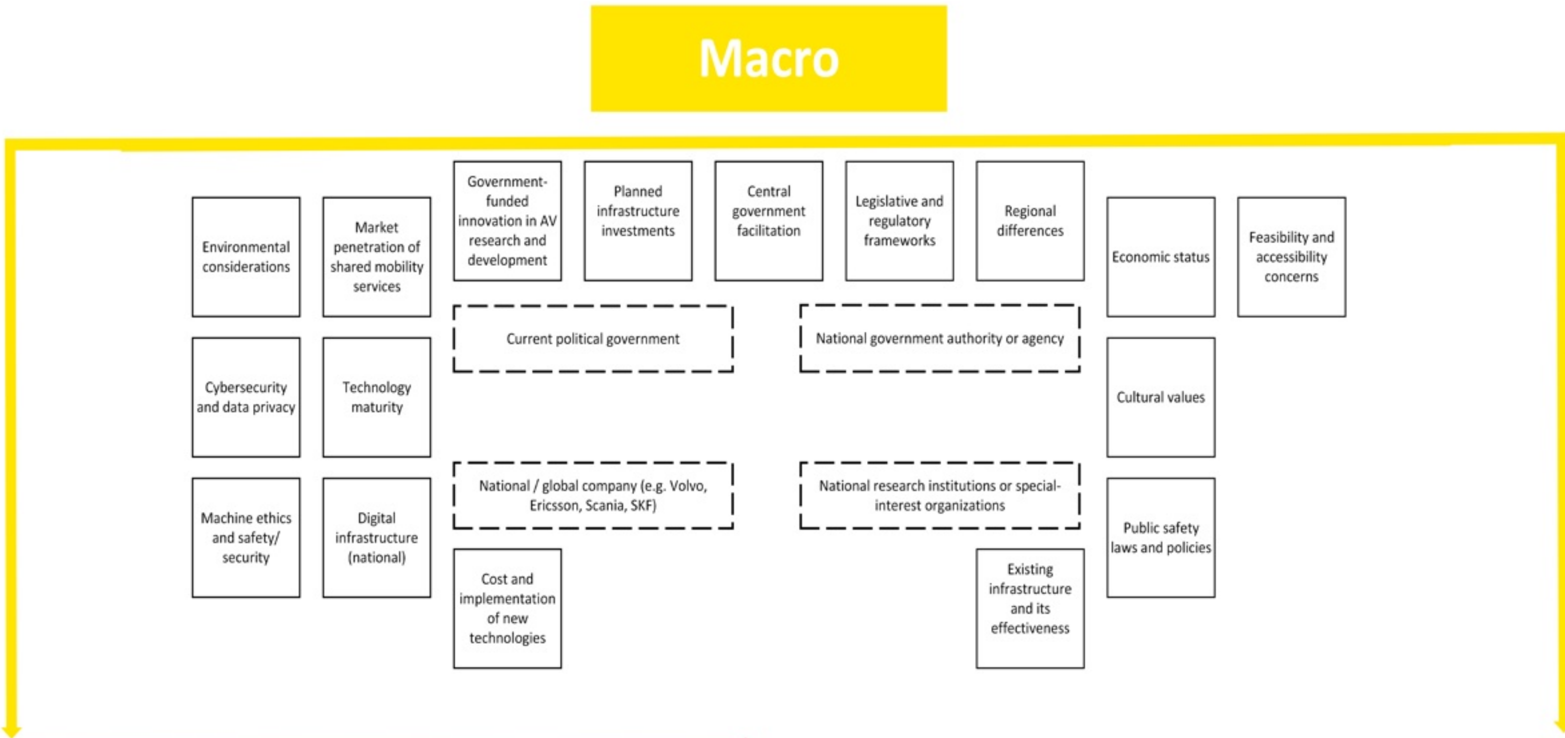

Figure 4 Macro level factors. The first iteration of the multilevel analytical model for implementation of autonomous public transport, given identified factors from the literature review.

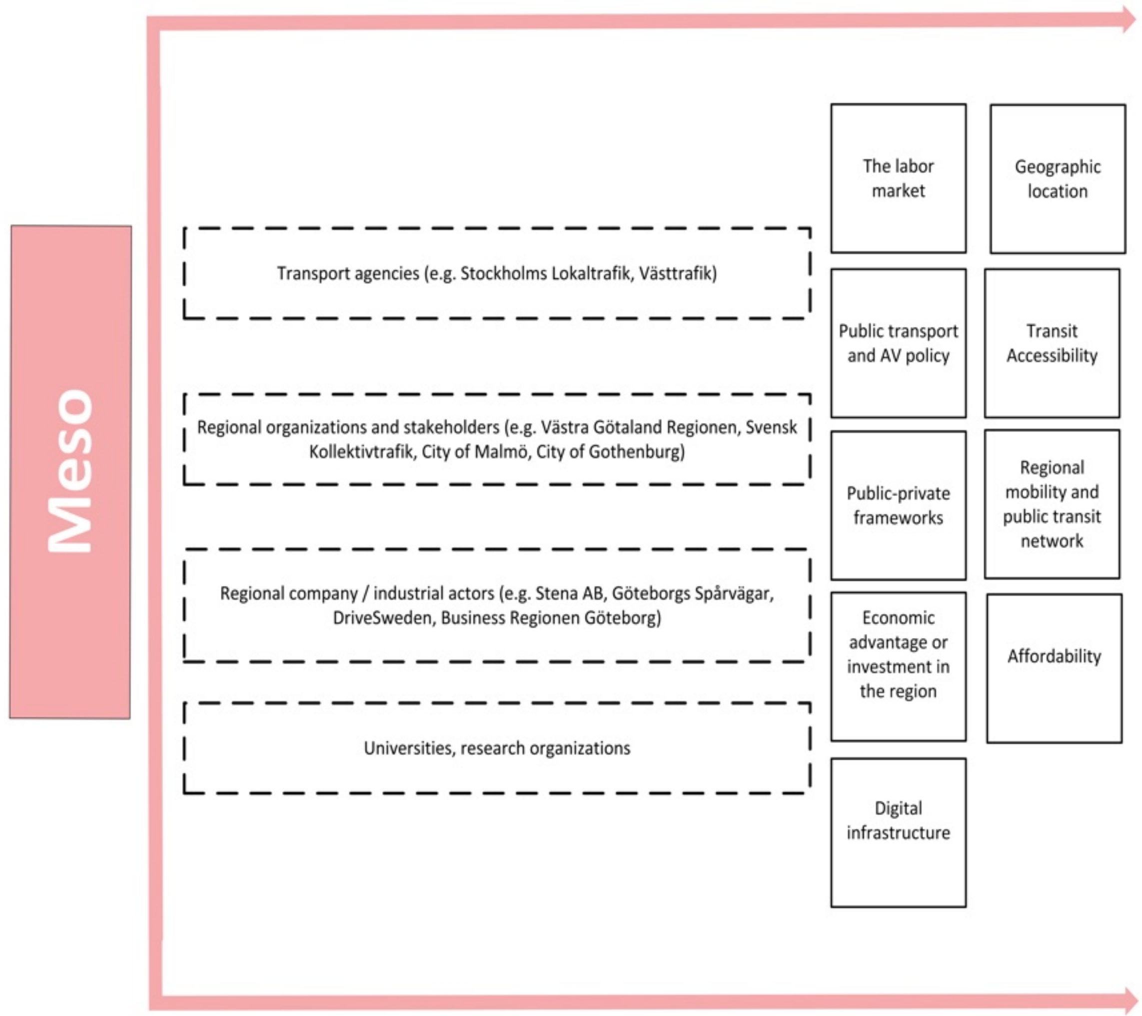

Figure 5 Meso level factors. The first iteration of the multilevel analytical model for implementation of shared, autonomous public transport, given identified factors from the literature review.

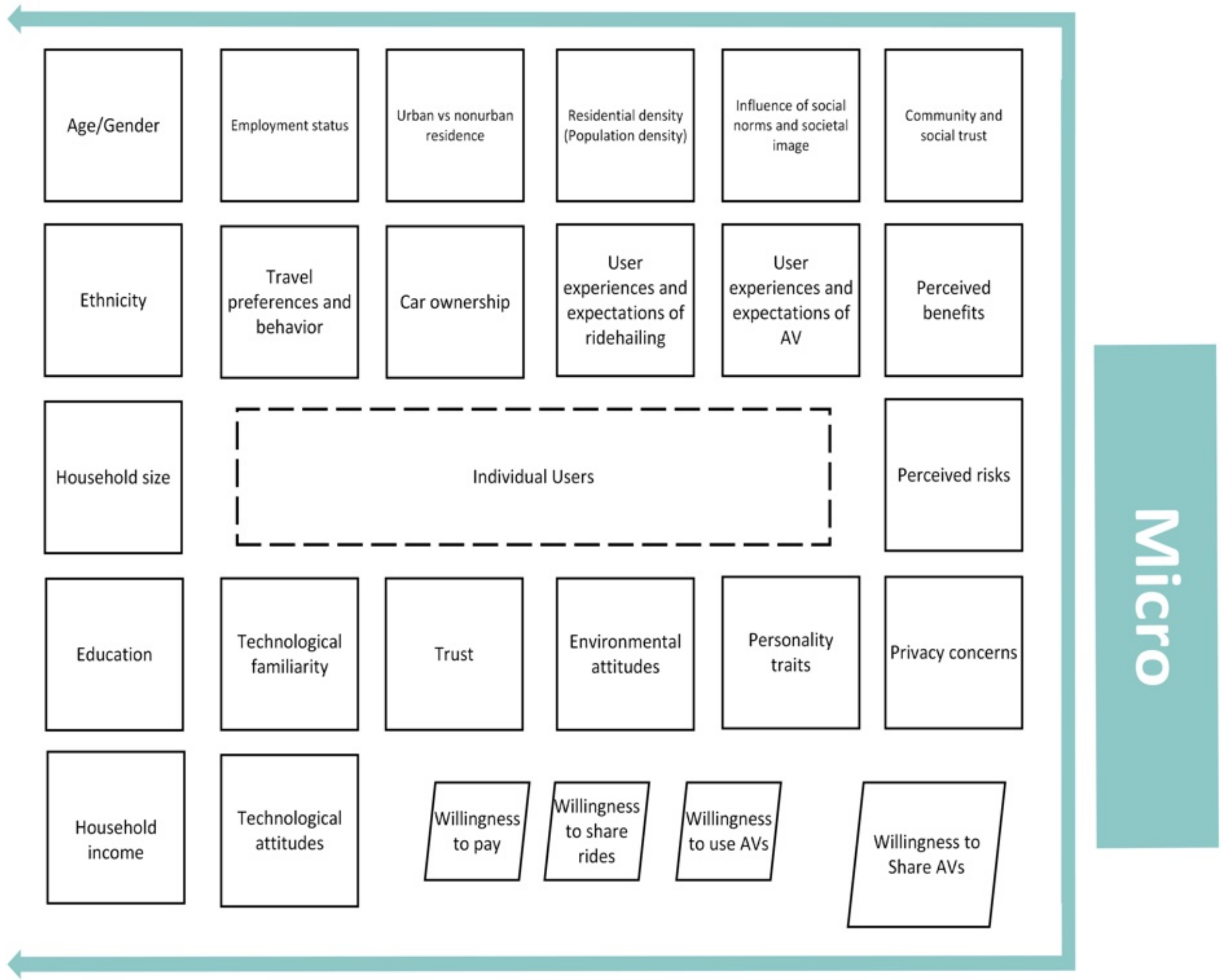

Figure 6 Micro level factors, with the three latent constructs included. The first iteration of the multilevel analytical model for implementation of shared, autonomous public transport, given identified factors from the literature review.

4. The Research Process

This chapter first explains the structure of the doctoral research project and the assumptions that informed the methodological choice. An overview of the methodology is provided, thereafter followed by descriptions of the included empirical studies.

4.1. Overview of the Research Process

Initially, this research began with a focus on micro-level factors, specifically examining individual users' behaviors, attitudes, and experiences related to the use of SAVs for public transport. The goal was to understand the personal barriers and enablers that influence the readiness for SAPT. By concentrating on these micro-level dynamics–such as trust in autonomous technologies and personal barriers to ridesharing–the research sought to assess individual-level readiness for shared autonomy. As my research progressed, it became clear that broader macro- and meso-level factors, such as stakeholder engagement, policy frameworks, and infrastructure, also played significant roles in shaping the successful implementation of SAPT. This realization led to the expansion of the research scope and the adoption of a triangulated methodology that better captures the complex interdependencies across all levels of SAPT implementation. An overview of the studies can be seen in Figure 7.

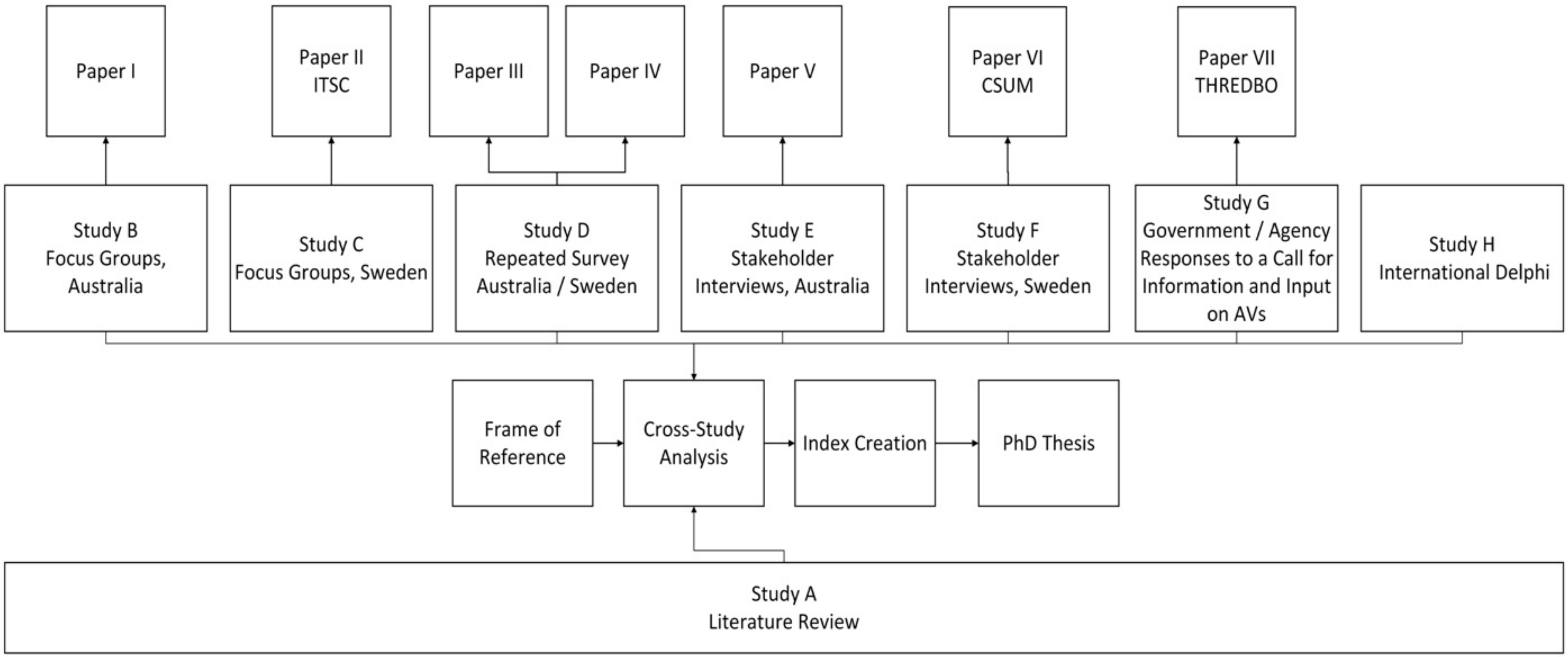

Figure 7 The structure of the research project, the studies, their associated journal articles and the conference papers produced. The eight key studies ranged from literature reviews and focus groups to stakeholder interviews across multiple countries. Together this work contributes to the overarching goal of synthesizing the findings for the *Societal Readiness Index for Shared Autonomy*.

The studies were carried out during a period of four years, 2019 – 2023. Data collection during the COVID-19 pandemic in 2020 significantly impacted the project's methodology, particularly affecting data collection on shared mobility as that was an extremely sensitive topic among both stakeholders and prospective users. As a result, the research shifted towards digital methodologies for data collection and analysis.

4.2. Triangulation

Triangulation is a research strategy often used in qualitative research to enhance the validity and depth of findings by integrating multiple perspectives. According to Denzin (1978) and Patton (1999), triangulation involves combining various methodologies, data sources, or theoretical perspectives to provide a more comprehensive understanding of a phenomenon and to verify the accuracy of findings. Denzin (1978) and Patton (1999) proposed four different types: method; investigator; theory and data source. Method involves using multiple data collection methods, such as interviews, observations, and surveys, to examine the same phenomenon. Investigator involves multiple researchers or evaluators examining the data. Theory triangulation incorporates multiple theoretical frameworks to interpret the data. Data source triangulation involves using various sources of data, such as information from different groups, settings, or time points, to study the same phenomenon. The work of Kaulio and Karlsson (1998) added a fifth: location triangulation, which involves gathering data in different settings to capture diverse perspectives and understand the impact of context on user behavior and requirements.

The empirical studies involved data collection from multiple international markets, i.e. *location triangulation*, specifically focusing on Sweden and New South Wales, Australia. These countries were chosen for their strong commitments to new mobility models and technologies. Both areas have demonstrated a commitment to sustainable mobility solutions, supported by strong policy frameworks and significant infrastructure investments (Becker and Axhausen, 2017; Jiang et al., 2022).

The work has also involved *data source triangulation.* To capture a diverse range of perspectives, I engaged different stakeholder categories, including policymakers, transportation authorities, and users. This allowed me to gather critical insights on the technical and societal readiness for SAVs from both organizational and user-level perspectives. The intention was to include national level stakeholders, and I made attempts to directly contact politicians and policymakers. However, this proved to be more challenging than expected and I was able to get direct input from only one, Trafikverket, the Swedish Transport Administration which is the governmental agency responsible for the long-term planning of the Swedish transport system.

Multiple data collection and analysis methods, i.e. *methodological triangulation*, were employed to ensure data cross-validation. Both quantitative and qualitative methods were used to cover all three levels. Using these methods, I ensured that my findings were corroborated across different scales, contexts, and data sources. As Kaulio and Karlsson (1998) emphasize, triangulation not only enhances the reliability of findings but also provides a more comprehensive picture of complex systems by addressing areas of convergence and divergence across different methods–and hopefully, ultimately contributing to a more accurate depiction of the factors that influence the successful implementation of shared autonomous public transport.

4.3. Choice of Research Context

To identify confirmed and widely applicable factors, it was necessary to collect data across multiple markets, particularly in countries with strong commitments to new mobility models and technologies. Therefore, the research covers Sweden and New South Wales, Australia as case studies. Both areas have demonstrated a commitment to sustainable mobility solutions, backed by supportive policy frameworks and significant investments in infrastructure, which are crucial for studying the adoption and impact of new technologies (Becker and Axhausen, 2017; Jiang et al, 2022).

Sweden, with strong policies on environmental sustainability, has been a pioneer in promoting electric vehicles and cycling, whereas Australia offers diverse perspectives due to varying urban densities and car dependency (Broadbent et al, 2024; Lim et al, 2023; Rajper and Albrecht, 2020). Australia has embraced transportation network connection companies (TNCs) like Uber, thus educating their populations on ridehailing and shared ridehailing services (Mulley and Nelson, 2019), whereas Sweden greatly restricted TNCs (Oppegaard et al, 2020). In Australia, shared on-demand mobility is commonplace, yet in Sweden, it effectively does not exist as a commercial product. Both sites were chosen as sites of study because they were of interest to representative stakeholders–Keolis, a public transport operator; Transport for New South Wales, a state-level transportation authority; Vinnova, a Swedish national innovation and research funding agency; and Research Institutes of Sweden (RISE), a nationally-owned research institute–and because both sites were, at the time of the project's conception, heavily investing in AV pilots.

Of the empirical studies, five are derived from Australian and Swedish sources; the literature review and the Delphi study were more broadly international in scope.

4.4. Overview of the Studies

The studies and their analysis included a formal identification process of searching for factors, organizing confirmed factors and comparing literature and empirical study findings to one another. I also used internal and implicit discussions with other researchers and practitioners about how those factors may connect, impact, or affect others in the system. These discussions, sometimes confirmatory and sometimes argumentative, were always generative. By engaging with others focused on transportation, I gained valuable perspectives that clarified how shared mobility, AVs, and autonomous public transport are perceived and developed.

The studies addressed the three research questions by examining a variety of factors influencing societal readiness for shared autonomous vehicles from the three levels of micro, meso, and macro perspectives, contributing to the overall understanding of the dynamics at play and allowing me to find answers for the three research questions. Table 1 displays the connection between the research questions and my studies.

Table 1 The studies, their research methods, which questions they were designed to answer, and which questions they incidentally contributed to answering.

Study	***Description***	***Methodology***	***RQ1 (Micro)***	***RQ2 (Meso)***	***RQ3 (Macro)***
Study A	Literature Review	Qualitative	✓	✓	✓
Study B	Focus Groups, Australia	Qualitative	✓	✓	
Study C	Focus Groups, Sweden	Qualitative	✓	✓	
Study D	Repeated Survey, Australia and Sweden	Quantitative	✓		
Study E	Stakeholder Interviews, Australia	Qualitative	✓	✓	
Study F	Stakeholder Interviews, Sweden	Qualitative	✓	✓	
Study G	Government Reviews, Sweden	Qualitative		✓	✓
Study H	International Delphi	Quantitative and Qualitative	✓	✓	✓

Study A was the literature review (reviewed in greater detail in Chapter 3 of this thesis). The literature review examined prior research in the topics of AVs and on-demand ride-hailing to identify potential factors into the user acceptance, stakeholder perspective and policy directions towards societal readiness for SAPT. The study's literature was researched from Elsevier, SAGE, MDPI, Taylor and Francis' databases of open-access journals, and Google Scholar. The tools used for organizing the literature, such as Mendeley and Research Rabbit, facilitated this categorization and helped refine and enhance the literature review process. The findings of confirmed factors from the literature were categorized into the three levels— micro, meso, and macro, which gave the foundational knowledge for the thesis.

Study B and **Study C** were focus groups run in Australia and Sweden. Focus group methodology was chosen specifically as this is an acknowledged qualitative research technique that reveals insights difficult to obtain from other methods, such as close-ended questionnaires (Krueger and Casey, 2009). According to Krueger and Casey (2009), focus groups provide a natural environment where participants influence and are influenced by others, yielding data not possible with other approaches. Participants were able to freely disclose their experiences, opinions, thoughts, and feelings without constraint, which was considered essential when discussing with potential users for a service that does not currently exist. These studies served to gather data that could explore factors primarily at the micro level, although participants had feedback and insights that also related to the meso level.

Study D, a web-based survey, was developed to confirm factors that contribute to the willingness of potential users to use SAVs revealed in Studies A, B, and C. The survey methodology enabled collection of a large volume of data across the geographically and culturally distinct contexts of Sweden and Australia in order to quantify the impact of various predictors on the willingness to use SAVs. The survey included various question types, such as multiple-choice and Likert scales, to measure respondents' attitudes, knowledge, and behaviors towards SAVs. This study identified factors at multiple levels, informing strategies for promoting SAV implementation into public transport systems. The approach allowed for statistical testing derived from the qualitative findings and provided a quantifiable measure of how demographic factors, previous mobility experiences, and attitudes towards shared mobility influence the willingness to use shared AVs, offering a broader validation or rejection of trends that emerged from the qualitative data.

To capture perspectives from the meso level, **Studies E** and **F** consisted of interviews with a total of 27 experts and stakeholders in New South Wales, Australia and throughout Sweden. By interviewing stakeholders from transit agencies, public transport operators, vehicle manufacturers, municipal workers and policymakers, these interviews were designed to capture insights that could be used for better understanding factors at both the meso and macro levels. Participants were recruited using chain referral sampling. The emphasis was on recruiting interviewees representing transport operators or the transport authority, since these were groups that traditionally have a history of business-to-consumer customer relations in the public transport sector. The expert interviews were conducted in person, over the internet (i.e., Skype) and by telephone.

To accurately capture the national, or international perspectives that form the macro level, I performed two studies, **Study G** and **Study H**, and complemented these findings with the factors of time and national cultural differences from the repeated, international survey that formed **Study D**.

To collect more information on the macro level, **Study G** involved analyzing the Swedish national government's call to action and request for stakeholder perspectives and information about AVs over two separate occasions. The first occasion was in 2021, with "The question of responsibility in automated driving and new rules with the aim of promoting increased use of geofences", which had two goals: firstly, to consider a division of responsibility in the case of automated driving, and secondly, to consider rules promoting and increasing the use of geofences for road vehicles. The second occasion was a memorandum in 2023, proposing a new regulation on fully automated vehicles, to meet the requirements of the European Parliament and of the Council as regards uniform procedures and technical specifications for type approval of automatic driving systems in fully automated vehicles. Ninety entities–regional municipalities, original equipment manufacturers, energy companies, research institutes (including RISE, my employer), public transport agencies, technology developers, communication agencies and even the courts–were given the opportunity to respond to the proposal and explain their interests and position on the topic of AVs.

Study H was a modified Delphi methodology study, which was applied to gather and synthesize expert opinions from transportation professionals, urban planners, and industry manufacturers in multiple countries across three rounds of web-based surveys, culminating in an interactive online workshop. This approach effectively addressed the research questions by building consensus on critical issues where empirical data was scarce, and refining and prioritizing the factors influencing the adoption of SAVs (cf. Skulmoski et al., 2007). The participants were asked to give insights on potential factors on all three levels– micro, meso and macro.

By integrating qualitative insights from focus groups, expert interviews, and the Delphi study with quantitative data derived from extensive surveys and the iterations of the Delphi waves, the research captured a detailed picture of user attitudes, organizational perspectives, and broader societal implications. This methodology not only highlighted the diverse factors at play across different levels—micro, meso, and macro—but also revealed the intricate interplay between individual experiences, technological advancements, and policy frameworks.

4.5. Cross-study Synthesis

After the studies were completed, an analysis and synthesis of all the affirmed factors across the studies was conducted, involving discussions with other researchers and practitioners and time for reflection. The factors identified in each study were carefully compared; if new factors were identified, they were incorporated into the framework. The categorization of these factors was done based on their influence at different levels to ensure a structured understanding of their role in the implementation of SAVs. Additionally, the connections between these factors and the relevant actors, such as policymakers, industry stakeholders, and users, were analyzed and added to the multilevel analytical model. This process not only enriched the multilevel analytical model (introduced in Chapter 2), but also provided a more detailed understanding of how various factors interact to shape the implementation of shared autonomous public transport.

In examining where connections might lie between factors and actors, a combination of empirical evidence from the studies and informed assumptions was used. Where direct evidence was provided by the studies, these connections were confirmed through empirical findings. In cases where no explicit evidence was available, logical assumptions were made based on established theoretical frameworks, prior research, and the observed dynamics within the sociotechnical system. Similarly, careful consideration was done to examine how factors at one level influenced or interacted with factors or actors at other levels. This analysis revealed interdependencies between factors, highlighting the complex, dynamic relationships that exist across the multilevel framework.

4.6. Drafting the Societal Readiness Index for Shared Autonomy

Having completed the multilevel analytical model (presented in detail in Chapter 6), I used the confirmed factors, their relationships, their considered strengths, and evidence of their interdependencies to develop a first draft of the *Societal Readiness Index for Shared Autonomy*. Creating this index required a methodical approach to identifying relevant factors from the multilevel analytical model and using those as a basis for selecting different indicators.

I was inspired by the process and methodological guidelines proposed in the "Handbook on Constructing Composite Indicators: Methodology and User Guide" (OECD, 2008). This resource was instrumental in guiding the selection of indicators that are both relevant and representative of the multifaceted aspects of societal readiness for autonomous transport, as well as readily available to support measurement and evaluation.

The specific process followed the three-phase approach outlined by Walters, Marsh, and Rodrigues (2022) in their work on the CARTI method, which stands for the CAEV Rural Transport Index. Their methodology includes three main phases: (1) Defining index goals, (2) Indicator selection, and (3) Index construction, with specific steps that ensure a structured progression from identifying goals to consolidating indicators. In structuring SRISA, I applied part of this methodology. This involved Phase (1), Steps I and II, and Phase (2), Step III, (Figure 8), including defining SRISA's index goals based on development domains and confirmed factors, as well as assembling and refining potential indicators drawn from the literature and studies. The factors were refined based on feasibility criteria to ensure the index included only the most relevant, measurable, and impactful indicators. The process is further developed in Chapter 7.

Scheme	Step	Description	Outputs
1. Defining index goals	I	Structure decision problem based on research aims and identified development domains	Results inform step II and step III
	II	Define goals and need/capacity element requirements	Index Goals and index requirements
2. Indicator selection	III	Assemble collection of indicators from existing literature relevant to Stage 1 problem identification and goals	Existing indicators, their measurement methods and original sources

Figure 8. CARTI methodology-inspired for the development of the SRISA. The CARTI methodology includes three main phases and 11 steps. In this thesis, I performed steps 1-3.

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5. Findings

The fifth chapter of this thesis describes the eight studies conducted to answer the research questions, the main findings from each study, as well as the implications for the multilevel analysis model. It offers deeper insights into the empirical data collected on the factors identified in both Sweden and New South Wales, Australia. By examining these findings closely, one can better understand the practical implications for stakeholders and policymakers aiming to implement SAVs into existing public transport networks, thereby contributing to the broader goal of sustainable urban mobility.

5.1. Study A Literature Review

Study A was a literature review (reviewed in greater detail in Chapter 3 of this thesis).

5.1.1. Aim

The literature review sought to examine prior research not only on AVs and on-demand ride-hailing, but also on a broader range of mobility innovations, user expectations towards shared mobility, and technological readiness. Given the limited number of AV pilots and their diverse implementation contexts, the review explored the topic as a synergy of multiple systems: public transport, on-demand ridehailing and dynamic ridepooling, and autonomous vehicle technology.

5.1.2. Method

The literature was sourced from databases such as Elsevier, SAGE, MDPI, Taylor and Francis, and Google Scholar. Keywords like "autonomous," "demand responsive," "shared autonomous vehicles," "ridesharing," "dynamic ridepooling," and "user acceptance" were used to identify relevant studies. Articles were organized using Mendeley and Research Rabbit, which also facilitated cross-referencing and identifying duplicates. Peer-reviewed articles were prioritized, and the literature review process is detailed in Figure 9, below.

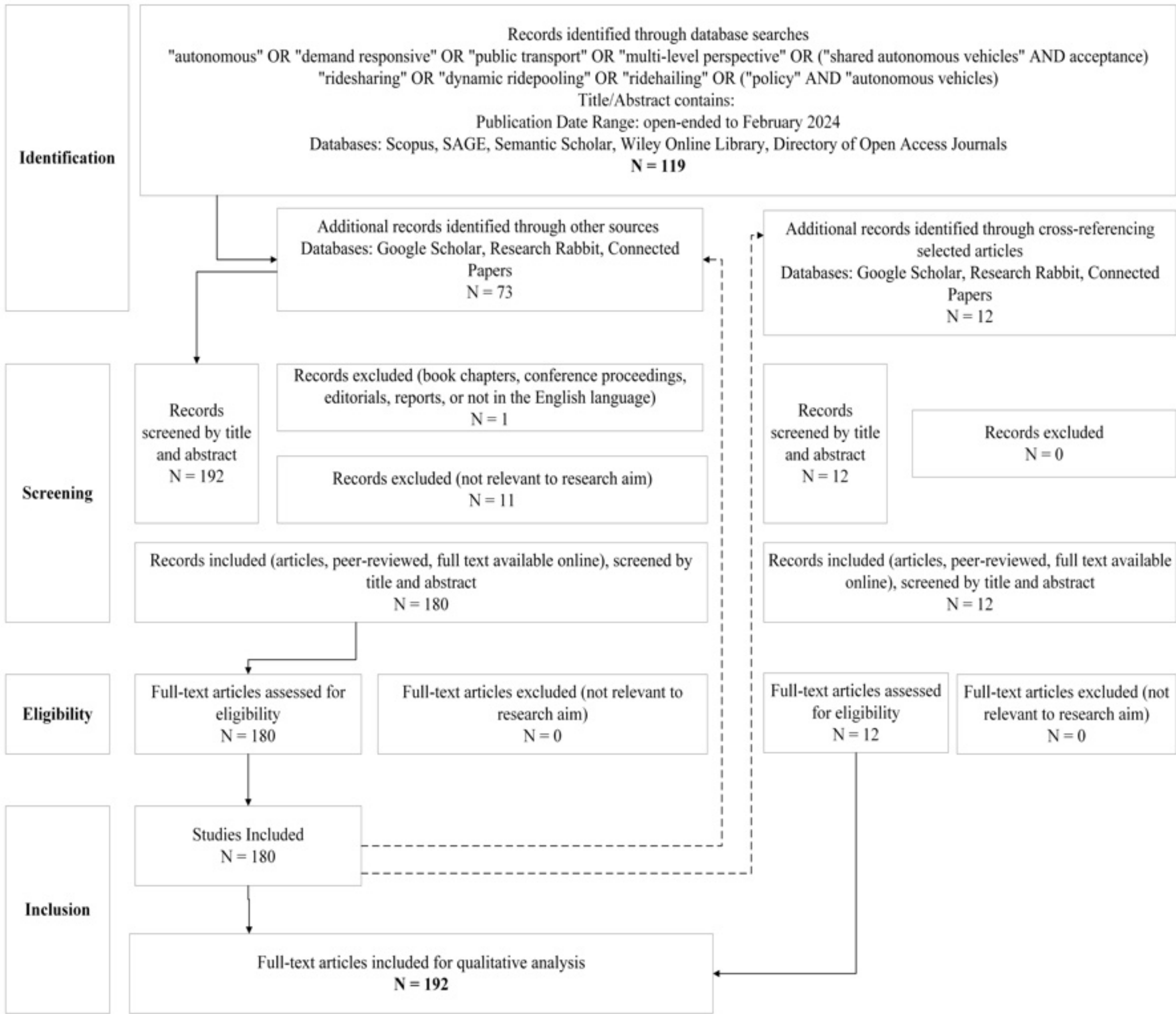

Figure 9 PRISMA Flow Diagram for a literature review, detailing the process of identifying, screening, and including studies in the review.

With all the eligible articles in place, articles were then sorted in terms of the factors explored and their research findings. This allowed for another grouping of these articles into micro, meso, and macro categories. To update these categories further, my literature organizational tool (Research Rabbit) had a feature which allows for mapping articles and suggesting similar content. While previous research databases and search engine preferences explored dates until February 2024, exploring new articles through this feature helped to specify the search in terms of suggested authors, previous work, and later work that helped in the synthesis of the thesis' literature review. The analysis categorized the factors potentially influencing shared, autonomous public transport into three levels: macro, meso, and micro. Each level contains specific themes that were identified through the (comprehensive) literature review. To determine whether a factor was classified as micro, meso, or macro, thematic analysis was used based on the context and scope of influence described in the literature.

Factors categorized at the macro level were those with broad societal, economic, and regulatory impacts, often involving national or international policies, large-scale economic investments, and cultural attitudes affecting entire populations. Examples of macro-level factors included policy and regulation themes such as cybersecurity and data privacy, legislative frameworks, economic and infrastructure investment like national infrastructure investments, and social and cultural impacts such as national cultural values.

Meso level factors were identified as those affecting specific regions, communities, or organizational structures. These typically involved regional infrastructure, economic conditions, and localized policy frameworks that would directly impact the implementation of SAVs in a specific region. Examples of meso-level factors included infrastructural factors like accessibility, regional mobility, digital infrastructure, and economic and policy factors such as economic advantages and public transport policies.

Micro level factors are those that directly impact individual users or small groups, including personal characteristics, attitudes, and behaviors influencing how individuals perceive and interact with SAVs. Examples of micro-level factors included sociodemographic characteristics such as age, gender, income, and education, psychographic characteristics like environmental attitudes and social norms, and behavioral characteristics (defined in Chapter 3 as “actions and factors that cover demonstrated and learned behaviors”), such as car ownership, travel preferences, and user experiences with ridehailing and AVs.

The categorization process also involved interpreting the context provided by each study. For instance, if a study discussed national policy impacts on AV adoption, it was categorized as a macro factor. If another study focused on regional infrastructure development, it was classified as a meso factor. Studies examining individual behaviors and attitudes towards SAVs were categorized as micro factors. This contextual interpretation ensured that each factor was appropriately classified based on its scope and influence.

5.1.3. Findings

(As the first study of this thesis, these findings formed the foundation of the multilevel analysis. Thus, they considered one and the same in this reflection.)

At the macro level, effective policy frameworks, strong cybersecurity measures, and clear legislative guidelines were considered by the authors in the literature study as enabling factors for AVs, which could mean that they are also enablers for the implementation of shared autonomous public transport. National environmental policies and public safety laws significantly influence the implementation of AV technologies, either facilitating or hindering their adoption depending on the rigor and implementation of these policies. Economic and infrastructure investments also play a crucial role, with central government facilitation and innovation investment proving essential in driving SAV adoption. For example, countries like the Netherlands and Singapore, which have advanced shared mobility infrastructures and supportive policies, exhibit higher societal readiness and acceptance of SAVs. Conversely, regions with less developed infrastructure or lower prioritization of environmental and technological advancements face more significant barriers to adoption. Social and cultural factors are also presumed to significantly influence the implementation of shared AVs; national cultural values, such as strong environmental policies and a societal emphasis on sustainability, contribute to higher readiness and acceptance of SAVs. Economic statuses are also recognized to play a crucial role; wealthier nations with strong economic conditions are generally better positioned to invest in and adopt SAV technologies. Furthermore, cultural attitudes towards innovation and technology can vary greatly, impacting the integration of SAVs. For instance, countries with a forward-looking approach to technology and high public trust in technological advancements tend to show greater acceptance. Conversely, regions where there is skepticism towards new technologies or lower prioritization of environmental and technological advancements face more significant barriers to the adoption of AVs and thus the implementation of SAVs for public transport.

At the meso level, infrastructural factors such as accessibility, regional mobility, and public transport networks are assessed as critical. Regions with well-developed public transport systems and digital infrastructure are likely better positioned to support the deployment of AV technologies. Geographic location likely also plays a significant role, with urban areas showing faster adoption due to higher population densities and more complex transportation needs. Rural areas, despite facing challenges, offer unique opportunities due to fewer existing transportation options. Economic and policy factors at the meso level include economic investments, public transport policies, and collaboration between public and private sectors. Regions with substantial economic investments and supportive policies are more likely to develop and implement AV technologies successfully. The affordability of AV services and the impact on the labor market were also found to be crucial considerations, influencing both user willingness to adopt these technologies and the broader economic implications.

At the micro level, sociodemographic characteristics such as age, gender, income, and education are believed to significantly impact user acceptance and utilization of SAVs. Younger individuals and men are generally more accepting of SAVs, while higher income and education levels correlate with greater acceptance. Interestingly, highly informed individuals may exhibit more skepticism towards AV technologies. Psychographic characteristics, including positive environmental attitudes and social norms that favor technology adoption, generally encouraged a greater willingness to use SAVs and SAPT. The perceived benefits of SAVs, such as increased safety, efficiency, and convenience, positively influence user willingness to adopt these technologies, while perceived risks, particularly related to safety and security, pose significant barriers.

Behavioral characteristics such as car ownership and current travel preferences assumingly also affect the willingness to use shared AVs. Users who have positive experiences with existing technologies and services, such as ridehailing and car-sharing, are more likely to accept SAVs. And, while not strictly factors themselves, the latent constructs of willingness to pay, share, and use AVs are critical indicators of potential adoption, and thus were the focus of much of the micro-level research from the literature review.

5.1.4. Implications for the Multilevel Analytical Model

Study A reveals factors in policy, regulatory, economic, social, infrastructural, and demographic areas–by applying the multilevel analytical model to the literature review, I was able to reveal a large number of factors and categorize them across macro, meso, and micro levels. The findings support the assumption that each level plays a unique role, especially in terms of regulation and user acceptance, which appear highly influential at the macro and micro levels, respectively.

The different articles also discussed or inferred a high degree of cross-level influence, especially between meso and macro levels. For example, the role of national infrastructure and digital investments is shown to affect regional capabilities, which therefore impacts operational effectiveness at the meso level.

The literature review also revealed a significant number of factors at the micro level which confirms that there has been intense interest at individual behavior and decision-making when it comes to the use and acceptance of shared mobility services, and the use and acceptance of AVs, respectively.

5.2. Study B Focus groups with potential users in Australia

Study B centered around focus groups with potential SAV users in New South Wales, Australia and is described in **Paper I**.

5.2.1. Aim

Study B aimed to investigate users' willingness-to-share, based on experiences from autonomous vehicle trials and on-demand pilot programs in New South Wales (NSW), Australia. The goal was to understand which factors contributed to high or low willingness to share. NSW was selected because its transportation authority, Transport for New South Wales (TfNSW), funded several innovative on-demand public transport services and AV demonstrations, making it a prime location for this study. At the time of the study, TfNSW had 17 active on-demand van or bus transport services, most of which were pilots, along with three AV pilots.

5.2.2. Method

Data collection involved four focus groups with 19 participants in total, held throughout Sydney and Newcastle. Participants were categorized as experienced or potential users of dynamic ridepooling services. Experienced users were currently using Keoride, an on-demand public transport service operated by Keolis Downer and promoted by TfNSW, launched in November 2017 in the Northern Beaches and Macquarie Park areas. Potential users were those living in areas where autonomous shuttle pilots or commercial dynamic ridepooling services (like UberPool or Ola) were available. These participants, while not using Keoride, were familiar with similar commercial dynamic ridepooling services and could potentially use on-demand public transport.

To analyze the qualitative data from the focus group interviews, a combination of deductive and inductive analysis of themes was used. The audio recordings were transcribed in full, and the transcriptions broken down into categories for conceptual analysis. First, an initial list of categories, i.e., pre-defined codes, was generated based on the literature on dynamic ridepooling, ridehailing, carpooling, and similar shared mobility experiences. A second set of pre-defined codes was developed; the codes were then used to label segments of interview data to depict the content of each segment. However, the codes were not sufficient to cover all the content of the focus group interviews. Thus, in a third step, further codes were developed using a more inductive approach.

To provide insight into which factors or issues were the most concerning for different users, the coded material was further examined to determine what themes had emerged, which were the most frequent throughout all four focus groups, and which ones were the most frequent in a particular focus group as well as the rationale behind them. Through thematic analysis of the focus group discussions, factors such as perceived benefits (cost, comfort, convenience), safety, community culture, and trust in authority emerged as influential to the willingness-to-share.

5.2.3. Findings

All participants had used commercial, dynamic ridepooling services because they were cheaper than traditional taxis, provided greater flexibility, or offered a more comfortable experience. Yet enthusiasm for either commercial dynamic ridepooling or on-demand transport dropped significantly in all four focus groups when presented with a scenario of using such services in an autonomous vehicle.

A clear difference emerged between potential users and experienced users. Potential users, whose experiences with commercial ridehailing were inconsistent, valued perceived benefits such as vehicle amenities and comfort as key factors for their willingness to use on-demand transport or share rides. They felt less safe, comfortable, or trusting of other passengers or drivers, often perceiving a lack of community atmosphere. Conversely, experienced users from the on-demand transport groups felt confident in the service, partly because it was branded by a public transport authority. They exhibited a sense of community and trust in the service, believing that other riders understood the premise, thereby creating a perception of a community of like-minded riders.

Three themes emerged across all focus groups: cheaper trips, better comfort, and increased convenience motivated the use of shared mobility services. Participants felt public transport was not always convenient or comfortable; however, experienced users of on-demand public transport appreciated significant improvements over public buses and commercial dynamic ridepooling services. The experienced users' satisfaction stemmed from their consistent and shared experiences with drivers, vehicles, and other riders, fostering a sense of community and trust in the public transport agency.

When potential and experienced users were presented with the possibility of using a driverless, shared, on-demand service, their willingness dropped significantly–

even if they had been previously enthusiastic proponents of dynamic ridepooling or on-demand transport. One of the biggest findings from the Australian focus groups was "sharing anxiety," defined as the discomfort or reluctance to share rides with strangers, particularly within the context of autonomous and driverless vehicles. This anxiety stems from a mix of concerns about safety, journey quality, personal space, and a perceived lack of authority or control within the vehicle due to the absence of a driver. Without a driver, passengers worry about their own and others' behavior, with some fearing that a lack of authority could lead to unsafe or uncomfortable interactions.

Experienced users spoke warmly about the personal attention and high-quality service from van or bus drivers. Conversely, potential users had low opinions of drivers from services like Uber or Ola, citing concerns about well-being and safety. Participants, especially women, emphasized how the presence of a driver impacted their sense of safety. Some individual users mentioned how their perspectives were influenced by their multicultural background (e.g. if they were an international student studying in Sydney but was used to shared rides and dynamic ridepooling in India).

Both groups stressed the importance of knowing "who is in control" within the vehicle. The absence of a driver removed an important element, leading to an "authority vacuum" and heightened insecurity about the journey. The presence of a driver is often taken for granted, and users only recognize its importance when faced with its absence.

5.2.4. Implications for the Multilevel Analytical Model

The study was designed to address RQ1 and understand micro-level factors. However, I found interdependencies between user experiences at the micro level, and influences from meso or macro actors or factors.

The participants from the downtown Sydney focus groups expressed distrust of state and national governments, while participants from Newcastle were strongly distrusting of Uber as an international, non-local organization. This demonstrates that while trust in organizations is experienced by the user at the micro level, it is still shaped by macro-level policies and frameworks. Regulatory frameworks, one of the factors identified in Study A, would support high standards of service quality and safety, which would support the credibility and reliability of public transport providers, thereby fostering user trust in SAVs.

Participants who were disappointed with commercial dynamic ridepooling emphasized the need for high-standard vehicle amenities, comfort, and overall service quality, whereas participants who had experienced on-demand transport simply wanted more of the service, which would have required a significant infrastructure investment on the part of Transport for New South Wales. This indicates that regional planners and service providers must focus on developing and maintaining superior infrastructure to support the adoption of SAVs to satisfy user expectations, which speaks to the importance of regional infrastructure at the meso level, and service quality, a form of perceived benefits, at the micro level. Additionally, the study found that a sense of community (an aspect of trust) and shared understanding among users significantly influenced their willingness to share rides; participants from less diverse communities had a stronger sense of "kinship" with other riders, even though all were still effectively strangers.

At the meso level, the study showed the need for regional transport authorities and service providers to address user concerns and facilitate acceptance through transparent communication; the experiences and feedback about low levels of trust in companies like Uber and the government from participants showed that organizational strategies should focus on building trust through transparent communication, prompt and clear customer service, and the gradual implementation of SAV services.

At the micro level, users' personal experiences with ridepooling–both positive and negative–greatly influenced their willingness to adopt SAVs. Participants with commercial dynamic ridepooling were motivated by advanced technology and features; participants with on-demand transport wanted greater customer service and enjoyed a sense of community. Micro level factors such as previous experiences, personal comfort, and perceived safety need to be addressed to encourage adoption. Cultural context was also shown here as the possibility for an individual user to have multiple cultural influences aside from the dominant, macro-level cultural values. The study revealed that users valued the perceived benefits of vehicle amenities and comfort as key factors for their willingness to use on-demand transport or share rides; addressing "sharing anxiety" and the "authority vacuum" would be crucial for stakeholders and policymakers.

5.3. Study C Focus groups with potential users in Sweden

Study C centered around focus groups with potential users of AV pilot technology in several cities within Sweden. The study is described in **Paper II**.

5.3.1. Aim

Like the Australian focus groups (Study B), the Swedish component of data collection commenced with a detailed investigation into the acceptance of shared, autonomous vehicles among participants exposed to AV pilots in Sweden, emphasizing shared mobility and public transport scenarios. The objective was to explore individual attitudes, acceptance levels, and willingness to use AVs within these contexts, employing focus groups for qualitative insights from users who had been either used or lived nearby to existing AV pilots in Sweden, with a specific focus on shared mobility and public transport contexts.

5.3.2. Method

Like Study B before it, focus groups were chosen as a qualitative research technique to facilitate in-depth discussions and gather qualitative insights related to shared AVs in public transport settings. Given the nascent stage of on-demand shared mobility and limited AV pilots in Sweden, this qualitative approach was at this stage chosen over broader survey methods (which was the primary methodology of Study D).

In Study C, there were 25 participants in total, who represented various age groups, genders, and socio-economic backgrounds (i.e., different education levels). Participants in Stockholm, Linköping and Gothenburg were recruited through exposure and use of the existing AV pilots in those cities; participants in the focus groups in Trollhättan were given an exclusive demo ride on a NEVS vehicle during the session. These shuttles were Navya Armas (Figure 8), EasyMile EZ-10s, or NEVS Pons, all of which are short format, Level 4 vehicles[13] going on prescribed routes. Most participants (22 out of 25) had used one of the autonomous shuttles in their nearby pilots at least once. One thing that is important to note is that in Sweden, even though Level 4 autonomous vehicles have no steering wheel and can be monitored or stopped remotely, Swedish Transport Authority regulations insist that a human "driver" is on board the vehicle at all times.

The focus group discussions were held in English and followed a semi-structured format, allowing participants to express their opinions, share personal experiences, and engage in interactive dialogue. Specifically, the discussions focused on smaller-format vehicles (see Figure 10, below) such as a bus, minibus, or something like a car and their potential autonomy and excluded larger vehicle formats like trains or trams.

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[13] SAE J3016 defines autonomous ability in vehicles from Level 0 (no driving automation) to Level 5 (full driving automation). Level 4 autonomous vehicles are seen as vehicles that can operate completely autonomously in specific conditions or environments without human intervention, but still have the option for human control.

Figure 10 The Navya Arma used in the Gothenburg pilots, accommodating approximately 12 persons in the vehicle. Permissions for photo granted by RISE.

As in Study B, thematic analysis was employed to identify recurring themes, patterns, and insights within the collected data. The analysis involved coding, categorizing, and organizing the data to extract meaningful information related to user acceptance and preferences for shared AVs in public transport settings; the same codes in Study B were applied in Study C. The segments were then labeled with codes to represent their content. To gain insights into the most concerning factors or issues for different users, the coded material was further examined to identify recurring themes and explored the rationale behind these perspectives.

5.3.3. Findings

In a shared, autonomous vehicle for public transport context, such a service builds on behaviors often found in on-demand ridehailing, dynamic ridepooling, and public transport. While many countries have embraced dynamic ridepooling (as seen in commercial services like UberPool or transit-based ones like Keoride), Sweden's primary context is app-based taxis where users ride alone. Compared to the previous focus groups in Australia (Study B), participants in Study C were largely unfamiliar with dynamic ridepooling and displayed initial apprehensions about shared mobility.

Several prominent themes emerged from the exploration of Swedish participants' views on shared and autonomous rides. As the concept of dynamic ridepooling is not widespread in Sweden, it was challenging for some participants to imagine themselves using such a service. This absence leads to skepticism, which can dissuade potential service providers from offering dynamic ridepooling services; I termed this “causal ambiguity”, because it was unclear if participants’ reluctance to use shared ride services were because the services did not exist, or if the services didn’t exist because potential users were so skeptical. Participants did acknowledge the potential cost savings and environmental benefits of sharing rides. However, contrary to prior research, cost-effectiveness alone was not the primary motivating factor. Instead, Swedish respondents were highly motivated by environmental concerns.

Cultural differences and priorities in sharing vehicles with strangers also emerged as a significant theme. Participants generally expressed no major reservations about sharing their mobility rides with strangers, as they already do this in public transport settings. However, they were hesitant about sharing in some contexts, such as smaller vehicles. Both Swedish-born participants and foreign students or immigrants noted that Swedish culture is characterized by a preference for privacy and reserved behavior, which could impact the acceptance of sharing smaller vehicles with strangers. A mix of cultural differences and causal ambiguity led to one of the most interesting exchanges of the group:

> K-F-22 (facial expression getting increasingly happy): "*Well, me and my boyfriend. We didn't know what 'UberPool' was. So, it was like, we got into the car. And the driver, he said like, 'Oh, we will stop somewhere on the way to become a few people.' And we were like, 'Okay, this is so weird, what's going on?' And then they came. And then I looked at the app, and I Googled it, and I was like, 'Okay, now I get it.' So, we're headed the same way for a lower price. And then they were really nice and gave us recommendations for what to do in Paris. We actually used that the whole trip*."
>
> Moderator: "*So how would the rest of you feel about using something like that? Would you ever use a service like that?"*
>
> K-F-22 (with facial expression falling): "*Oh, no. It would never work in Sweden*."

Safety concerns were another prominent theme. Participants who had experienced an autonomous vehicle pilot in Kista, Stockholm, commented that the shuttle moved too slowly, to the point where one could potentially outrun it. This led to distrust that a vehicle needing to operate that slowly could be safe at higher speeds. Additionally, potential users expressed concerns about sharing a space with unknown persons, particularly in the AVs they had experienced. These differences in concern and perception may be related to the amount of personal and public space available in different modal types.

5.3.4. Implications for the Multilevel Analytical Model

Like Study B's focus groups, the participants discussed micro-level factors, but their discussions and perceptions affirmed macro and meso-level factors as well.

For example, technology maturity was affirmed when participants raised doubts about AV technology's ability to operate safely at higher speeds, which reflected concerns about the readiness of the technology. Cultural values were affirmed when the participants noted that their cultural tendency for privacy and reserved behavior as a Swedish trait which could hinder the adoption of shared AV services. Market penetration of ridehailing services became obvious when participants had mixed reactions and limited experiences with such services.

There was also some discussion about the role of public versus private sectors in offering shared mobility services; some participants believed that public initiatives might be better suited to implementing shared AVs than private companies, due to concerns about affordability and accessibility.

The focus groups revealed that Swedish participants had initial apprehensions and unfamiliarity with dynamic ridepooling and shared mobility services. Initially, the preferences for privacy were categorized as an affirmation of the factor*, social norms*; however, later studies made me rethink this finding as a different factor, *cultural context*.[14] The study also identified perceived environmental benefits and safety concerns as significant factors influencing acceptance, directly contributing to the micro-level analysis of perceived benefits and risks. Another micro-level factor that emerged was the low level of trust participants had in other people (particularly those with whom they imagined sharing their journeys), as mentioned in Study B by Australian participants. Building trust in technology and the organizations providing SAV services is considered crucial for enhancing acceptance and willingness to use shared autonomous vehicles.

Additionally, Study C highlighted environmental benefits as a personal motivation for using SAVs. This finding contributes to the idea that micro level factors could impact macro level factors such as environmental policies. Therefore, environmental focus and causes can play a significant role in policy formulation and public acceptance strategies.

5.4. Study D Multinational Survey

Study D was a multinational survey in Sweden and Australia reported in **Papers III** and **IV**.

[14] The discussion in Study H, the Delphi Study, led me to rethink the nuances between factors.

5.4.1. Aim

Study D was designed to investigate the factors influencing the willingness to use SAVs with unfamiliar people, focusing on the impact of four key factors: prior experience with shared mobility, prior experience with AVs, willingness to share rides, and willingness to use AVs. By recruiting participants from Australia and Sweden, I also wanted to examine whether or not national cultural differences contributed to the results. The study aimed to address gaps in existing research that have primarily focused on either technological or socio-demographic factors, leaving a need for a more comprehensive understanding of the determinants of potential users' willingness to use SAVs.

5.4.2. Method

A web-based survey was developed and distributed to participants in Sweden and Australia. The survey targeted adults from major urban centers, specifically Gothenburg and Stockholm in Sweden, and primarily New South Wales in Australia.

The study was carried out in a two-phase approach. Data collection occurred between May 2022 and June 2023, resulting in 3,666 completed questionnaires for the first wave. Due to data quality issues from the Australian contractor in the second survey wave, only Swedish Wave 2 data was analyzed separately. This wave involved over 1,900 respondents. The final sample included 1,819 complete responses and 121 partial responses, with incomplete responses being discarded.

The survey consisted of three main sections. The first section gathered data on age, gender, family background, and prevalent transportation modalities. Sensitive data like income was not collected, but respondents self-identified personality traits from six options: Realistic, Traditional, Progressive, Adventurous, Spiritual, and Environmentally conscious. The second section explored respondents' experiences with shared forms of mobility, such as public transport and car-sharing, and their willingness to take shared rides in ridehailing or public transport. The third section defined what an AV was with a visual artifact and text description, assessed participants' exposure to AVs, and asked about their willingness to share a journey in an AV with different types of people, such as family, friends, neighbors, and strangers. Due to a data collection error by our contractor, I was only able to create profiles for the Swedish Wave 2 data.

Data analysis was performed using SPSS software. The statistical analysis included cross-tabulations and multinomial logistic regression to model the relationship between several predictors and individuals' willingness to use SAVs with unfamiliar people. The predictor variables included country, previous ridehailing experience, previous AV experience, willingness to share rides, and willingness to use AVs. I also used crosstabulations and Decision Tree analyses, specifically Exhaustive Chi-squared Automatic Interaction Detection (CHAID). The decision trees were constructed to visualize interaction effects and hierarchical relationships among variables. Distinct profiles for potential users and potential refusers of SAVs in Swedish cities were created. The analysis focused on identifying key variables influencing willingness to share AVs with strangers, with top-node splitters indicating the most influential factors, such as demographic traits, previous ride-hailing experience, and concerns about health and safety. Multiple decision trees were generated thematically, each targeting specific categories ("Very Likely" or "Not at all likely" to share AVs). The risk estimate and standard error metrics indicated the accuracy and predictive power of the decision trees.

5.4.3. Findings from Wave 1

One of the first differences revealed in the findings of Wave 1 was that of familiarity with ridehailing services between the two countries. In Australia, 85.5% of respondents had previously used app-based ridehailing services, reflecting a high acceptance and penetration of such services; in contrast, 51.4% of Swedish respondents had no prior experience with ridehailing. Despite this, nearly 90% of respondents from both countries had no previous experience with AVs, indicating that AV technology is still relatively novel to the public in both regions.

When it came to sharing rides, Australians showed a higher reluctance, with 22.1% unwilling to share rides under any circumstances, compared to 11.2% of Swedes. On the other hand, Swedes demonstrated a greater openness to sharing rides, with 53.0% fully willing to share rides, in contrast to only 20.8% of Australians. In terms of willingness to use AVs, Australians were more open, with 48.4% expressing a willingness to try AVs, compared to 37.8% of Swedes. However, a notable percentage of respondents from both countries were uncertain or unwilling to use AVs, highlighting ongoing apprehensions about this technology. Both Australian and Swedish respondents showed a clear pattern of increased willingness to share AV rides with familiar individuals, such as family and friends, and decreased willingness as the familiarity with co-riders decreased. Only about 10% of Australian respondents and 12% of Swedish respondents were willing to share AVs with complete strangers.

Through the multinomial logistic regression analysis, I found that Swedish respondents were more likely than Australians to be "Not at all likely" to share AVs with unfamiliar people. However, this geographic difference, though statistically significant, was less impactful compared to other factors. It was “willingness to share rides” that emerged as the strongest predictor of whether a respondent was willing to share an AV with strangers. Individuals who categorically refused to share rides under any circumstance were the most unlikely to share AVs with strangers–a logical conclusion, and one that suggests that personal attitudes towards ride sharing are a major barrier to the adoption of SAVs. Having prior experience with AVs positively influenced willingness to share AVs, though this factor was less impactful than a general willingness to share rides.

5.4.4. Findings from Wave 2

Potential users are characterized as well-educated men who identify as progressive and environmentally conscious. These individuals are likely to use public transport, have some experience with AV technology, and are comfortable with technology influencing their mobility. They show a high tolerance for sharing their mobility journeys with others and are motivated by cost or environmental benefits. Adopters are also inclined to view AVs as a future form of autonomous public transport.

In contrast, potential refusers tend to be women with traditional or realistic personality traits, possibly with less formal education than a university degree. They are more likely to be private car users with little to no experience with AV technology and express concerns or discomfort with technology governing their mobility. Refusers demonstrate a lower tolerance for sharing mobility journeys with strangers, often due to safety or privacy concerns. Their reluctance to embrace AVs for shared transport could stem from skepticism about the technology's reliability, safety, and the absence of a human operator.

5.4.5. Implications for the Multilevel Analytical Model

At the macro level, the study reveals country-specific differences in familiarity and acceptance of ridehailing services and AV technology between Australia and Sweden. The study highlights that Australians have greater familiarity with ridehailing services compared to Swedes. However, Australians are more reluctant to share rides, while Swedes show a higher willingness to share rides. Despite the familiarity with ridehailing, both countries have minimal experience with AVs.

In micro-level factors, the strongest predictor for willingness to use SAVs with unfamiliar people was the existing willingness to share rides. Individuals who categorically refuse to share rides under any circumstance are the most unlikely to share AVs with strangers. Prior experience with AVs positively influences willingness to share AVs, although this factor is less impactful than a general willingness to share rides. The study also created distinct profiles for potential users and refusers of SAVs in Swedish cities. Potential users are characterized as well-educated men who identify as progressive and environmentally conscious, use public transport, have some experience with AV technology, and show a high tolerance for sharing mobility journeys. In contrast, potential refusers tend to be women with traditional or realistic personality traits, possibly with less formal education, more likely to be private car users with little to no experience with AV technology, and express concerns about the technology's reliability and safety.

Another meso-level factor that emerged was that of transit accessibility, or the opportunities and ease with which users can use public transport services in a region. It was indirectly demonstrated in the usage patterns of respondents; 81% of Australian respondents were primarily car users, while 58% of Swedish respondents were frequent users of public transport. This could be interpreted as the Australian respondents having poorer transit accessibility compared to the Swedish respondents, or else not so many would rely on private vehicle transportation.

Despite earlier literature and studies suggesting previous experience with ridehailing supported a willingness to share AVs, Study D found that familiarity with ridehailing services did *not* significantly predict the willingness to share SAVs. This suggests that exposure or previous experience alone does not necessarily translate into a readiness to embrace SAVs. On the other hand, positive public transport experiences emerged as a strong predictor of SAV adoption. On the surface this might be contradictory, as on-demand, shared autonomous vehicles combine elements of both services, yet only experiences from one of those services seemed interdependent with willingness to share AVs. This confirms a kind of meso-level effect on these micro-level factors, as it shows that public transport agencies play a critical role[15] in preparing society for shared, driverless mobility by enhancing the quality of public transport services and influencing user perceptions and acceptance.

5.5. Study E Australian Stakeholder Interviews

Study E, the interviews with Australian stakeholders, is described in **Paper V**.

5.5.1. Aim

Study B highlighted "sharing anxiety”, which significantly hinders the acceptance of SAVs. This anxiety arises from the prospect of sharing rides with strangers without a driver or authority figure present. Thus, Study E aimed to explore the how well understood "sharing anxiety" was among transportation experts involved with AV pilots in New South Wales, Australia.

[15] 20 for initiative.

5.5.2. Method

Qualitative, conversational interviews were conducted with 13 participants from October 2019 to February 2020. The participants included six transport operators, two representatives from Transport for New South Wales (TfNSW), two representatives from the Point-to-Point Transport Commission, two technology providers (autonomous vehicle manufacturers), and one academic. The interviews, ranging from 35 to 70 minutes, aimed to gather insights on three core questions:

1. What do transportation experts believe customers expect from future shared or autonomous public transport?
2. Who do transportation experts believe is responsible for encouraging or increasing willingness-to-share among the public regarding autonomous public transport?
3. How could transportation stakeholders increase societal acceptance of dynamic ridepooling in preparation for a shared AV future?

The interviews were recorded, transcribed, and analyzed using Atlas.ti qualitative analysis software. The coding followed a concept-driven approach, with initial codes based on literature and additional codes generated during the analysis.

5.5.3. Findings

The interviews revealed a general lack of awareness about sharing anxiety within the mobility industry; experts tended to focus more on technological acceptance of AVs than addressing the socio-technical systems and behavioral changes necessary for successful adoption of SAV.

The interviewees believed that customers have several key expectations from future shared or autonomous public transport. Customers need reassurance and education about the safety and reliability of using on-demand and shared AVs, bridging the familiarity gap to make users comfortable with these new technologies. Competitive pricing was considered a significant factor, with some interviewees saying that customers expected shared rides to be cheaper than private ones, so lower prices were a necessary incentive for the adoption of SAVs. Safety, reliability, and comfort were also significant concerns, especially regarding the behavior of other passengers in a shared space, making it essential to ensure a safe and pleasant experience. Additionally, the perceived benefit of convenience and ease of use were considered extremely important for disadvantaged groups in rural and suburban areas, which would require better integration with digital technologies and simplified processes.

The interviewed experts believed that multiple stakeholders share the responsibility for encouraging or increasing the public's willingness to share rides in AVs. Transport authorities were the ones primarily seen as responsible for shaping public attitudes and creating a supportive environment for shared mobility through deregulation and proactive policies; yet transport operators and technology providers were also seen to play significant roles in creating attractive, safe, and reliable services that encourage user adoption, needing to develop user-friendly and appealing service models to increase public acceptance.

5.5.4. Implications for the Multilevel Analytical Model

Since the experts believed multiple stakeholders bore responsibility for encouraging or increasing the public's willingness to share rides in AVs, this supported a relationship between meso-level actors on processes and factors at both the macro, meso and micro level.

At the macro level, Study E confirmed the importance of policy, legislative, and regulatory frameworks by highlighting stakeholders' belief that there is a strong need for supportive regulatory environments and proactive policies from transport authorities. The interviewees suggested that government incentives and support for dynamic ridepooling are necessary, confirming the importance of government-funded innovation investment and collaboration in AV research and development.

At the meso level, the interviews also highlighted the need for better integration with existing public transport systems, which can be interpreted as confirming the importance of another meso factor, transit accessibility. The recommendation for a standardized, unified interface for on-demand transport services touches on that factor as well as underscores the need for strong digital infrastructure. The interviewees also discussed competitive pricing and affordability as ways to attract users (thus a micro-level factor), but being mentioned by stakeholders reflects meso-level concerns about the costs of implementing new technologies and services, confirming costs as a factor at the meso level as well as at the micro level.

The interviewees discussed rural and suburban areas (compared to urban ones) as potential places for pilot deployment of SAVs. Although this was an explicit discussion of a meso factor concept (geographic location), in this way, it also can be interpreted that the interviews confirmed the importance of considering the impact urban vs. nonurban residence has on individuals' decision-making at the micro level. And lastly, but certainly not least, concerns about sharing rides without a driver or authority figure highlighted the issue of an authority vacuum, which needs to be addressed to increase user confidence in SAVs; the concern over shared rides is part of the equation when users are considering perceived benefits and perceived risks, and if meso-level stakeholders are aware of that, they need to design service elements and safety policies that tilt the mental math in favor of shared rides.

5.6. Study F Interviews with Swedish stakeholders

Whereas study E, focused Australia, this study, Study F consisted of interviews with Swedish stakeholders and have been reported in **Paper VI**.

5.6.1. Aim

The study aimed to explore the attitudes and perspectives of Swedish transportation experts and stakeholders regarding SAVs for public transport. It sought to compare these insights, from the Swedish interviewees, with those from stakeholders in New South Wales, Australia in Study E, in order to understand the factors influencing societal acceptance and readiness for SAVs. The goal with this activity and comparison is to identify the best practices and policy interventions for introducing SAVs into public transport systems.

5.6.2. Method

The study employed a qualitative research design, utilizing semi-structured interviews with strategists, operators, academics, and regulators in Sweden. Fourteen experts participated, including mobility researchers, consultants, transport planners, agency project managers, transport operators, and project leaders from manufacturing companies, categorized into four role categories: service providers, researchers and academics, manufacturers and industry professionals, and public transport planners and authorities. The sampling process involved purposive sampling followed by snowball sampling to ensure a diverse range of transport professionals.

The interviews were recorded, transcribed, and analyzed using thematic coding to draw out insights and comparisons between the Swedish and Australian contexts, identifying key themes relevant to the study.

5.6.3. Findings

The findings of the study reveal several key themes. First, there are significant challenges for public transport to innovate, marked by a tension between the desire for innovation and existing bureaucratic obstacles within the Swedish public transport system and the way it is structured. For example, the long-term tendering process for public transport operations is perceived to hinder innovation due to its inflexibility, making it difficult for operators to try new services or pilot programs when they do not have any additional innovation funding. Additionally, Swedish stakeholders acknowledged “sharing anxiety” as a significant barrier to SAV implementation. This was in direct contrast to their counterparts in Australia, who were more dismissive of sharing anxiety as a barrier. Swedish stakeholders believed that sharing anxiety reflects a broader cultural resistance to sharing personal space without an authority figure present, which highlights the need for measures that build public trust and ensure safety in shared autonomous environments.

Most Swedish interviewees believed that public transport authorities and governmental bodies are primarily responsible for introducing SAVs and increasing public acceptance. The high public trust in Swedish public transport authorities could facilitate the adoption of SAVs if these entities are seen as the providers, using their established reputation to promote new mobility solutions. Regarding the best routes for introducing SAVs for public transport use, rural and low-density areas were identified as highly feasible environments due to the high car dependency in these regions and the lack of existing public transport options. Previous SAV pilots were criticized for being too small-scale and not useful enough to encourage significant user adoption, indicating a need for larger, more impactful trials. There was a call for more substantial government support and potentially incentivizing shared mobility through tax reliefs or refunds, aiming to create a more favorable environment for SAV introduction, and to overcome existing barriers to public acceptance and the implementation of autonomous public transport.

Moreover, the study showed that collaboration among various stakeholders, while essential, often slows down the process of innovation. This collaborative approach, which is typical and often lauded in Sweden, involves multiple levels of government and private sector partners. The complex web of partners seems to often lead to delays. Addressing this would require a well-coordinated strategy that includes both public education campaigns and policy support is emphasized to ensure the successful implementation of SAVs for public transport. The interviewees believed that public attitudes towards SAVs could be positively influenced by demonstrating their safety, reliability, and the perceived benefit of convenience, if there was a bold and proactive approach by the government, supported by targeted incentives and comprehensive pilot programs.

5.6.4. Implications for the Multilevel Analytical Model

The interviewees in Study F discussed the role of public transport authorities and governmental bodies in introducing SAVs, which confirms the importance of policy and regulation as a factor towards societal acceptance. Additionally, the interviewees' comments on the complicated and slow collaboration process in Sweden–unlike their counterparts in Study E–indicate that the interaction between public and private frameworks is also an important and confirmed factor. Safety, how it is perceived and who was responsible for ensuring it, was also mentioned in the interviews, which can be seen as confirming safety as a macro factor, as well as a micro factor. Some interviewees noted that there is significantly high public trust in Swedish public transport authorities and institutions, which they saw as a potential facilitator for SAV adoption. Both safety and public trust are concepts that can be encouraged and grown at the macro level and revealed at the micro level.

Many of the interviewees spoke at great length about national infrastructure, investment, and innovation; this supports the idea that substantial government support is needed for overcoming barriers to innovation. One such proposal (and factor) is that of central government facilitation for improving new technology adoption. This was discussed to hopefully address the collaboration quicksand the interviewees felt Sweden’s transportation ecosystem was trapped in, especially regarding SAVs. Furthermore, that stakeholders identified rural and low-density areas as ideal for SAV deployment supports the tentative multilevel analytical model’s listed factors (Figure 4, 5, and 6 from Chapter 3) of existing infrastructure and innovation funding as key factors, complementary to economic and policy factors like government incentives and funding.

In discussing sharing anxiety, the Swedish stakeholders anticipated significant issues at the micro level. This implies that the multilevel analytical model should give weight to individual attitudes and perceptions, particularly around sharing anxiety.

5.7. Study G Governmental Policy Reviews, Sweden

Study G involved analyzing the Swedish national government’s call to action and request for stakeholder perspectives and information about AVs, over two separate occasions.[16]

5.7.1. Aim

Study G was specifically designed for the exploration of meso or macro-level factors. The Swedish government's remiss provides insight into how a national government is approaching the regulatory challenges and opportunities associated with autonomous driving. By understanding these approaches, it becomes more evident how Sweden plans to handle issues like responsibility distribution, criminal sanctions, and the use of geofences.

[16] The first occasion of this legislation in action was in 2021, with “The question of responsibility in automated driving and new rules with the aim of promoting increased use of geofences”, which had the goal to firstly to consider a division of responsibility in the case of automated driving, and secondly to consider rules with the aim of promoting an increased use of geofences for road vehicles. The second occasion was a memorandum in 2023, proposing a new regulation on fully automated vehicles, to meet the requirements of the European Parliament and of the Council as regards uniform procedures and technical specifications for type approval of automatic driving systems in fully automated vehicles.

5.7.2. Method

The study employed thematic coding and frequency analysis to analyze the responses and positions of various stakeholders regarding the Swedish government's proposals on autonomous vehicles. Two key documents from the Swedish government were analyzed: the 2021 call for proposals on the responsibility in automated driving and geofences, and the 2023 memorandum proposing new regulations for fully automated vehicles. Ninety entities–regional *kommuns* (similar to the definition of municipality), original equipment manufacturers, energy companies, research institutes (including RISE, my employer), public transport agencies, technology developers, communication agencies and even the courts– were given the opportunity to respond to the proposal and explain their interests and position on the topic of AVs. Analyzing the responses from the Swedish organizations also required categorizing the stakeholders, which was done based on their roles and interests in the AV ecosystem. They were categorized as government agencies (regional and national transport authorities, law enforcement, and regulatory bodies); industrial actors (original equipment manufacturers, technology developers, communication agencies and energy companies); the public sector (municipalities, public transport agencies, research institutions, courts, and environmental organization).

Lastly, responses were systematically coded to identify recurring themes and concerns and to match them with confirmed, existing factors in the multilevel analytical model from earlier studies, or to create additional, newly confirmed factors. Key themes included role and mission confusion, cybersecurity and data privacy, legal frameworks, central government facilitation, safety, liability, economic implications, technological maturity, and environmental priorities.

5.7.3. Findings and Implications for the Multilevel Analytical Model

When analyzing how many times concepts emerged from the different responses, (see Table 2 below), it became clear that two were the most discussed: legal frameworks, and role and mission confusion.

The frequent mention of the legal framework suggests that there are significant regulatory challenges and complexities that stakeholders face. This could involve navigating existing laws, compliance with regulations, or the need for new legislation to address emerging technologies and practices. The frequent mention of role and mission confusion suggests that many organizations struggle with defining and understanding their specific place in the transportation system, particularly in how they could support or introduce new mobility services and technologies. This can lead to inefficiencies and overlaps in responsibilities, hampering overall effectiveness. In some ways, these concepts can be seen as interdependent factors– a strong legal framework leads to might give clarity that reduces role and mission confusion.

Table 2 Revealed factors by level and organization from the Swedish government remiss.

Factor	Meso level	Macro level	Count	Organizations
Role and mission confusion	✓	✓	13	City of Göteborg, DriveSweden, Einride, Mobility Sweden, Nobina, RISE, SKR, SMC, Svensk Kollektivtrafik, Trafikanalys, Trafikverket, Västtrafik, Region Stockholm
Legal framework	✓	✓	13	City of Göteborg, City of Malmö, Einride, Mobility Sweden, Polisen, RISE, SKR, SMC, Svensk Kollektivtrafik, Trafikanalys, Trafikverket, Västtrafik, Västra Götaland
Liability	✓	✓	6	City of Malmö, Einride, Mobility Sweden, Polisen, Swedish Transport Workers' Union, Transportstyrelsen
Cybersecurity and data privacy	✓	✓	5	City of Göteborg, Nobina, SMC, Transportföretagen, Västtrafik
Safety	✓	✓	4	Polisen, Swedish Transport Workers' Union, Transportföretagen, Volvo
Digital Infrastructure	✓	✓	2	Svensk Kollektivtrafik, Transportföretagen
Societal Benefit		✓	2	DriveSweden, Region Stockholm
Economic situation and labor market	✓		2	Svensk Kollektivtrafik, Transportföretagen
Permit process rigidity		✓	1	Region Stockholm
Regional mobility and public transport network	✓		1	Västtrafik
Infrastructure	✓	✓	1	RISE
Role of driver and road authority	✓	✓	1	Transportstyrelsen

When it came to macro factors, the responses emphasized the role of central government in facilitating the adoption of AVs. Einride (an autonomous truck manufacturer) and DriveSweden (a Swedish organization for sustainable transportation collaboration) pointed out the necessity of national-level coordination and incentives to drive innovation and implementation, and the Swedish Transport Workers' Union highlighted the importance of government support in ensuring a smooth transition for the workforce.

The environmental impact of AVs was discussed by the Swedish Environmental Protection Agency and the City of Göteborg–but only by them, and hence coming up far less often than expected, given that Sweden has a strong reputation abroad for putting a high priority on environmental causes and concerns. The Swedish Environmental Agency and City of Göteborg emphasized the potential for AVs to contribute to sustainability goals, however, they also cautioned about the financial costs of producing and maintaining AV infrastructure. The cost of implementing new technology was also mentioned by Region Västra Götaland (county council governing the territory Västra Götaland) and Transportstyrelsen (the Swedish National Transport Administration).

Safety concerns were paramount for many stakeholders, with the Police specifically pointing out that legislative frameworks were lacking to address future infractions and unsafe conditions for AVs. Many stakeholders, including Einride and the City of Göteborg, called for comprehensive legislation to address liability issues, regulatory compliance, and the role of drivers in autonomous systems.

For meso factors, many stakeholders expressed concerns regarding the lack of clarity in roles and responsibilities in the AV ecosystem. This confusion extended to who should be accountable in various scenarios involving AVs. For example, Västtrafik (agency responsible for public transport services in Västra Götaland) highlighted the need for clearer guidelines on the division of responsibility between vehicle operators and manufacturers. Similarly, Trafikanalys (a government agency for transport analysis) and the Swedish Association of Local Authorities and Regions emphasized the importance of defining the roles of different government agencies and private entities in managing AVs.

Cybersecurity and data privacy emerged as critical concerns among stakeholders, with several organizations, including Nobina (a multinational public transport operator) and Sveriges Motorcyklister (an association for Swedish motorcyclists), highlighting these issues. Economic considerations, particularly the financial burden on public and private sectors, were discussed by Region Västra Götaland and The Swedish Public Transport Association, who also mentioned the need for government incentives to support the sociotechnical transition to AVs.

5.8. Study H International Delphi Study

Study H focused on identifying factors across the three societal levels; the micro, meso, and macro level, for the implementation of shared, autonomous public transport. The study has been reported in **Paper VII**.

5.8.1. Aim

The aim of Study H was to deepen the understanding of meso-level stakeholders' and actors' considerations regarding shared, autonomous public transport. The study sought to collect and distill expert opinions from transportation professionals, urban planners, and industry manufacturers across multiple countries to ask for their perspectives on meaningful factors that could impact the introduction and implementation of SAVs for public transport.

5.8.2. Method

Study H employed a modified Delphi methodology, a systematic approach to gather expert opinions through a series of questionnaires distributed over multiple rounds, tailored for achieving consensus among a group of experts. The Delphi method utilized involved three iterative rounds of surveys and an interactive, online workshop to refine expert opinions and achieve a consensus on the critical factors affecting implementation of SAVs for public transport. Each of the survey rounds had a specific focus and methodology aimed at refining and deepening the understanding of critical factors from various stakeholder perspectives. The initial wave of the survey established a baseline understanding of the factors influencing the implementation of autonomous public transport. Successive waves refined these factors, incorporating feedback and reducing the number of factors to those deemed most significant. The process included follow-up reminders to ensure participation.

Experts from diverse backgrounds, including transportation professionals, urban planners, and industry manufacturers, participated in these surveys. The final wave of the Delphi survey engaged 38 experts from various countries, providing a diverse set of perspectives on the integration of AVs into public transportation. Seven of these experts were able to participate in the online workshop.

5.8.3. Findings and Implications for the Multilevel Analytical Model

The study involved a diverse group of respondents from various regions, with the largest groups being from North America (40%), Europe (30%), and Asia (20%). Participants represented public agencies, academic institutions, consultancies, and industry manufacturers, providing a broad spectrum of perspectives. Across three waves of surveys, factors influencing the implementation of shared autonomous public transport were identified and refined. Initially, the factors revealed in Study A (the literature review) were discussed, but the participants narrowed the list down to 24 significant factors by the third wave.

At the micro level, expert respondents believed that the implementation of shared autonomous public transport hinges on individual beliefs and behaviors towards autonomous vehicles and current transport modes (such as the number of cars per household) and that personal experiences and perceptions would be crucial for guiding that acceptance. These micro level factors included exposure to AVs, familiarity with related apps, and overall attitudes towards new technology and public transport. (The strength of influence that previous experiences with ridehailing and shared rides has on willingness to share AVs has not been consistent across the studies; this will be discussed further in the next chapter.) However, experts in other studies from the literature review had similar conclusions as the participants in study H.

Safety concerns, frequency of service, convenience, and competitive pricing were also seen as meaningful by the respondents. This is a strong indication that stakeholders and expert actors view a positive user experience as necessary for the implementation of shared autonomous public transport.

Meso level factors involving the quality of existing public transport, regional policies, and population density were consistently seen as important across all three waves, but the meso level was the one to suffer the most “loss” across waves; respondents had more trouble reaching consensus on the importance of these factors than they did for the micro or macro levels. This could be interpreted to mean that organizational dynamics, such as the collaboration between transportation agencies, local governments, and industry stakeholders, is diverse and more difficult for even transportation experts to understand and reach consensus on. Statistical indicators, such as population density, were consistently seen as important, while finer demographic details like age ratios or major regional employers were eliminated in later survey waves. The meso level factors point to the need for regional authorities and transportation agencies to work collaboratively and develop clear policies that facilitate the implementation of autonomous public transport alongside and into existing transport systems.

At the macro level, two key factors consistently emerged as significant across all waves of the Delphi study: national laws and policies, and the economic status or gross domestic product of the country. These factors underscore the importance of having a supportive legal framework that facilitates the deployment and operation of autonomous public transport systems. National policies that promote technological innovation and provide regulatory clarity are essential for creating an environment conducive to the implementation of autonomous public transport.

Additionally, the economic strength of a country plays a critical role, as higher GDP levels enable the necessary investments in infrastructure, technology, and public education to support the implementation of autonomous public transport.

The Delphi workshop confirmed the findings from Wave 3 of the survey, although some previously discarded factors from Wave 1 were reintroduced during the discussion. These factors and others that the participants discussed as the most significant for the implementation of SAVs for public transport are summarized in Table 3, below.

Table 3 While 24 factors remained at the end of the survey, 14 factors were explicitly discussed during the post-survey workshop. These factors are listed here.

Level	Factor	Rationale
Macro	Policy and Regulation	Provides the legal and political foundation needed for SAPT. Clear policies on safety, operations, and standards make it easier for entities to engage confidently in SAPT deployment.
Macro	Economic Status	Wealthier countries can make necessary investments in infrastructure, technology, and public education, enabling the success of autonomous transport systems.
Meso	Public Transport / AV Policy	Ensures alignment and structured integration of AV technology into existing transport systems and goals.
Meso	Regional Mobility and Public Transport Network	The structure and efficiency of regional transportation networks determine how well AVs can be integrated into existing transport systems to enhance regional mobility.
Meso	Population Density	Higher density allows shared vehicles to reach more users efficiently, with experts noting that urban areas benefit from economies of scale and ride-matching potential.
Micro	Car Ownership or Number of Cars per Household	Lower car ownership rates correlate with openness to shared mobility, as regions with fewer private vehicles are more likely to adopt SAPT as a convenient alternative.
Micro	User experiences and expectations of AV technology	Familiarity reduces hesitation; previous positive experiences or AV demonstrations can alleviate user concerns and increase comfort.
Micro	User experiences and expectations of ridehailing	Familiarity with shared mobility increases acceptance of SAPT, as users understand the convenience and benefits of on-demand services.
Micro	Technological Familiarity	Technological familiarity is crucial as SAPT often relies on app-based booking and navigation, making it easier for users to adopt the service.
Micro	Technological attitudes	Positive views on innovation correlate with openness to trying new mobility solutions, reflecting a readiness to engage with SAPT.
Micro	Travel preferences and behavior	Experts thought users with favorable attitudes toward public transport are more inclined to consider alternatives to private vehicles, making SAPT more appealing.
Micro	Convenience	Users who perceive SAPT as convenient and useful are more likely to adopt it, as perceived utility directly impacts willingness to use the service.
Micro	Safety concerns	Safety concerns are significant barriers; experts emphasized that addressing these concerns through visible measures and transparency can encourage adoption.
Micro	Competitive Pricing	Pricing must be financially attractive compared to other transport options. Competitive rates increase the likelihood of users choosing SAPT over private or traditional public transport options.

Some participants suggested that “environmental policy” was also a relevant factor, or potentially indicator, for the implementation of shared, autonomous public transport; but ultimately this preference for environmental policy stemmed from the belief that economic status was significant. The reasoning was that only countries with strong resources were able to prioritize environmental policy, and therefore see mobility innovations, such as autonomous public transport, as a worthwhile investment. This suggests that transport experts see countries with strong economic conditions and progressive legislative environments as better positioned to implement shared, autonomous public transport successfully.

Participants emphasized the need for government intervention to support shared, autonomous public transport implementation, as the private market alone may not prioritize such transitions. The workshop also explored the bi-directional relationships between individual, regional, and national factors, noting that these levels influence each other. However, attempts to map out the relationships between these factors proved challenging. One expert suggested that the lack of connections between certain factors might indicate unexplored relationships. Another participant observed that some factors appeared redundant or correlated with each other, particularly when viewed through the lens of different demographic groups. For instance, a person’s age and life patterns might influence their willingness to use public transport or share vehicles with strangers.

Another key point of discussion was who should be responsible for implementing shared AVs in public transport. While some participants believed that commercial operators might take the lead due to market forces, others argued that public transport authorities should drive the change. Examples, such as Norway’s plan to prohibit private car ownership (Minja, 2021; Rydningen et al., 2017), were cited as a way to ensure that the focus in urban areas was on public transport. The “private car ban” (as the “Car-Free Liveability Programme” was sometimes called) aligned well with the idea that AV fleet usage should be developed as a public good. Most participants agreed that strong government involvement at the regional or national level is critical for introducing SAPT to a receptive public, as it ensures that policies align with public interests.

Finally, several participants raised concerns about stakeholder collaboration, particularly in Sweden, where unclear chains of command between government authorities, private companies, and public transport agencies often hinder effective coordination. The challenge of distinguishing between professional opinions and personal perspectives was also noted, with many experts struggling to identify their role as meso-level stakeholders.

I also performed Chi-square tests on the respondents' professional backgrounds and their responses, which revealed one significant relationship–that between professional background and the importance of policy and regulations for AVs and public transport. The linear trend observed indicates that as respondents' professional backgrounds shift from public agencies towards consultancies and commercial OEMs, the perceived importance of policy and regulatory factors increases. Not only does this confirm policy and regulation as a significant meso level factor, but it also shows that experts from different parts of the transportation system will prioritize different factors or activities when making plans for implementing a shared and autonomous public transport system in their specific locales. This has implications for how stakeholders can interact with each other and collaborate on best courses of action.

The online workshop was held with the purpose of confirming the selected factors, which it did, but it also provided additional insights. Participants discussed the influence of *cultural values*. In the U.S., for instance, the prevalence of car culture was cited as a significant barrier to the acceptance of autonomous public transport, and the transportation experts believed that societal expectations such as obtaining a driver’s license could challenge efforts to shift to shared autonomous vehicles.

During the workshop, after forty-five minutes of discussion, it became apparent that even among transportation experts, there was a lack of consensus and difficulty in reaching a common understanding of which factors were truly meso-level. Some participants also had difficulties in distinguishing between professional opinions and personal perspectives among stakeholders, underscoring complications in the efforts to reach consensus. I came to term this lack of clarity as “role and mission confusion”; identifying it first in Study H; however, once this factor was revealed, it became obvious that it had emerged in Study G as well. Role confusion emerges when meso-level actors struggle to define their responsibilities in the SAV ecosystem. This lack of clarity creates inefficiencies and disrupts coordination, as stakeholders are uncertain of their specific roles, leading to overlaps or gaps in actions essential for creating shared, autonomous services. This was an important realization, because it points to the challenging environment for collecting accurate data as well as developing ideas for addressing issues like sharing anxiety.

6. Synthesis of Factors

The sixth chapter of this thesis looks at the findings across the eight studies and weaves them together for a comprehensive understanding of how they relate to one another and their interdependencies. Through this synthesis, the multilevel analytical model across macro, meso, and micro levels is further developed.

6.1. Potential Factors and Their Rationale

Altogether 49 factors[17] were identified in the literature review (Study A) and an additional four: role and mission confusion, authority vacuum, sharing anxiety, and cultural context were identified through the subsequent studies (Studies B-H). Some factors emerged across several studies, whereas others only appeared in a few. This could be interpreted to infer differences in the strength or influence of the factor but is here interpreted because of the explorative nature of the research approach. Further studies are needed to determine the weight of the respective factors.

It is important to note that the factors identified in Study A were based on studies primarily of the implementation and/or acceptance of shared mobility services, and/or the implementation and/or acceptance of AVs, whereas the number of studies on **shared** autonomous vehicles were few at the commencement of this work and there were even fewer on shared, autonomous **public transport**. The focus of Studies B to H was on SAV with a public transport context– SAPT specifically. However, most of the factors from Study A were affirmed in the subsequent studies and are therefore considered potentially relevant also for the implementation of SAPT.

In addition, the eight studies were designed to explore potential factors across the three levels; however, even if a study's focus was on exploring micro-level factors, occasionally meso- and/or macro-level factors were referred to and discussed. This was usually the first indication of intra- and interlevel dependencies. Altogether, this was considered affirmation of these factors as well as confirmation of the framework (described in Chapter 2), based on the premise that the implementation of SAPT is a sociotechnological system that needs to consider different types of actors, and which factors influence them at different societal levels.

The **macro-level factors**, the studies that affirmed them, and their argued rationale for inclusion in the multilevel analytical model can be found in Table 4. The 17 factors were introduced and organized thematically already in Chapter 3, Literature Review, in the following categories: policy and regulation factors, infrastructure

[17] And three latent constructs, but who is counting?

factors, and social and cultural impact factors. The macro level factors are heavily biased towards examining autonomous technology for future mobility from the technological perspective of its implementation. I believe this overfocus on the technical part of the sociotechnical system that is autonomous transport is the result of the assumption that users will embrace the technology no matter under what context it is introduced into the system, which I think is a dangerous assumption. (This thesis is a small step towards correcting that overfocus.)

Table 4 Macro-level factors, the studies that affirmed them, and their rationale for inclusion into the multilevel analytical model.

Macro Factors	**Rationale**	**Affirmed in Studies**
Public safety laws and policies	Laws specific to the operational challenges of SAVs and SAPT (like being able to handle safety issues between passengers) are necessary to ensure that these solutions are aligned with public safety and societal expectations.	A,B
Legislative and regulatory frameworks	Frameworks that are conducive to new commercial actors entering the transportation ecosystem, or policy interventions designed to make private car ownership more difficult, all demonstrate a country's willingness to use its legal system to affect transportation choices. Frameworks enable macro actors to take actions that permit meso actors to implement SAPT and increase the likelihood of their adoption by micro-level users.	A,C,D
Cybersecurity and data privacy laws and regulations	SAPT embodies AVs, which means technological safety and security are needed to make such mobility services run safely and reliably, yet every country has different laws concerning data sharing and cybersecurity. Having strong laws and regulations for the digital side of autonomous technology is vital to public acceptance.	A,E,F,G,H
Machine ethics and safety / security policies	This factor is needed to ensure that technological advancements are compatible with societal expectations and safety standards; not just that the vehicles drive safely, but they behave as expected and as desired. It is crucial given the inherent risks associated with AVs in public spaces, where their operations directly affect users, pedestrians, and other vehicles.	A,F,G
Environmental policies	A core assumption of this work is that AVs and shared mobility services together have the potential to reduce emissions by decreasing the reliance on private vehicles. Environmental policies support the responsible integration of these technologies into public transport, enhancing urban sustainability.	A,B,C

Feasibility and accessibility priorities	As a factor, it encompasses both the realistic implementation of AV technology and its reach across diverse populations. This accounts for not only technical and economic viability but also equitable access to mobility services.	A,G,H
Existing infrastructure (national)	The quality and adaptability of existing infrastructure significantly impact the feasibility and reliability of SAV networks. Effective infrastructure (for example, high quality roads) supports the integration of SAVs into existing transportation systems.	A,E,F,H
Digital infrastructure (national)	Digital infrastructure enables AVs to function properly as well as a networked system of rides to be managed, much like public transport fleets are today.	A,H
Technology maturity	This factor determines the reliability, safety, and user acceptance of AV technology and therefore can impact the adoption and implementation of SAPT. Mature technology reflects a higher degree of development, which inspires confidence in potential users and regulatory bodies alike.	A,H
Planned infrastructure investments (national)	Planned infrastructure investments at the national level allows for the development and upgrading of infrastructure to accommodate AV technology, which can include improvements to roads, connectivity, and vehicle-to-infrastructure systems, making SAPT more feasible.	A,D,H
Central government facilitation	Government support (typically in the form of a “one-stop-shop” office or authority that can answer questions from service providers and city officials alike) can develop and promote a cohesive strategy for SAVs and SAPT, ensuring both national interests and regional variations are considered in regulatory and operational frameworks.	A,E,F,G,H
Government-funded innovation in AV research and development	This factor accelerates technological progress and reduces financial risks for private companies. Through funding and collaborative efforts, governments can drive advancements in AV technology that make other systems –like SAPT – possible.	A,F,G
Cost and implementation of new technologies	Closely tied with technological maturity and government-funded innovation, the cost of technology will impact how quickly it is implemented and how widely it is used. (LiDAr sensors are a prime example.) Understanding the potential benefits allows national actors to balance set-up expenses with long-term societal gain.	A,E,F,H

Cultural values	A strong cultural openness to shared transportation or shared services can foster (or be used to foster) wider acceptance of SAVs. However, these values often exist at a national level, or they don't; changing cultural values can be a complex and slow undertaking.	A,E,F,H
Economic status	Economic status influences both governmental and individual capacity to support and invest in AV technology; countries with stronger economies can afford to subsidize or invest in new transportation solutions, which speeds up the implementation of SAPT.	A,E,F,H
Market penetration of shared mobility services	The existing presence of shared mobility services, such as ridehailing or car-sharing, sets the stage for the introduction of SAVs by familiarizing the public with shared transit options. A strong market penetration indicates a country's population is already used to some shared mobility services and could signal readiness for more advanced shared autonomous systems.	A,B,C,D,E,H

The **meso-level factors**, while more nebulous to define, revealed the importance of regional infrastructure, existing public transport systems, and local governance in influencing the progress and implementation of shared autonomous public transport (Table 5). Two factors placed at the meso-level were revealed in Study A (and only Study A): *labor market* and *geographic location*. They were not affirmed in any of the Studies B to H; even so, I chose to keep them as part of the multilevel analytical model given that they still can influence the public transport system as a whole. For example, the public transport industry has suffered from a lack of availability of bus drivers, which should be considered a component of evaluating the labor market. Groshen et al. (2018) estimates that implementing autonomous technology would eliminate over a million driving jobs over the course of 30 years, and different skills and roles would emerge to address the deployment and maintenance of autonomous transport systems. That there are organizations, companies, and entities for whom this would be a significant shift means there are meso (or macro, if the company is big enough) actors who have reasons to slow down the transition, just as there are actors who may be forced by the labor market to implement autonomous technology.

The factor of *role and mission confusion* emerged as a significant barrier at the meso level; it was the only new factor revealed at the meso level after Study A. Role and mission confusion emerges when meso-level actors struggle to define their responsibilities in the SAPT system, disrupting efforts to coordinate as stakeholders are uncertain of their specific roles, leading to overlaps or gaps in actions essential for creating shared, autonomous services. However, I believe role and mission confusion is essentially a barrier that can be addressed through strengthening the macro factor of central government facilitation. The meso level, therefore, presents an area in need of focus and intervention where better coordination and infrastructure development are necessary to bridge the gap between policy and user acceptance. (These interlevel dependencies will be explored in greater detail later in this chapter.)

Table 5 Meso-level factors, the studies that affirmed them, and their rationale for inclusion into the multilevel analytical model.

Factor	**Rationale**	**Affirmed in Studies**
Geographic location (regional geography)	The geographic characteristics of an area, including its urban or rural nature, affect transportation planning, vehicle technology, infrastructure needs, and users' travel needs and behavior. For example, in extreme areas and climates, SAPT may not be feasible.	A
Economic investment or advantage	Regions with greater economic resources and investments in technology are more likely to lead in the adoption and development of AV technologies.	A,E,F
Labor market	The presence and stability of job opportunities can impact the demand for public transport options and the acceptance of autonomous solutions for commuting.	A
Digital infrastructure (regional)	Digital systems that support AV operations, such as connectivity and data analytics platforms, are essential for the efficient management of AV fleets and for routing requests or building trips for users.	A,F
Public-Private frameworks	Encompasses collaborative structures and agreements between public and private entities. These frameworks, including public-private partnerships (PPPs), enable resource sharing, risk distribution, and regulatory alignment, fostering an environment where SAV technology can be effectively integrated into existing public transport.	A,F,G,H
Role and mission confusion	Unclear roles among stakeholders at the meso level (e.g. transport agencies, city officials in terms of, e.g., who should be responsible for introducing new mobility?) can hinder effective collaboration and implementation efforts, necessitating clear guidelines and alignment from the macro level.	F,G,H
Regional mobility and public transport network	The structure and efficiency of regional transportation networks determine how well AVs can be integrated into existing transport systems to enhance regional mobility.	A,B,C,G
Public transport and AV policy	Policies that integrate AVs with public transport strategies can enhance the effectiveness and acceptance of AVs as part of the broader public transport system.	A,E,F,H

Transit accessibility	This factor looks at the accessibility of a regional transport network. By addressing the accessibility needs within public transportation systems, SAV usage can help bridge mobility gaps, supporting equitable access to transportation for diverse populations.	A,B,C,F,G,H
Affordability	If the cost of using SAPT is high relative to the average income in a region, lower-income populations may not utilize it, jeopardizing the region's investment and reducing the implementation of the system to a greater public.	A,B,C,E,F

And lastly, at the **micro level,** 30 factors were revealed and affirmed, including four that had not emerged during the literature review, i.e. Study A (Table 6). These included sociodemographic, psychographic and behavioral factors that emerged as potentially influential factors for the implementation of shared autonomous public transport. Notably, familiarity with similar technologies and positive user experiences emerged as significant in shaping perceptions and behaviors toward SAPT. Familiarity with ridehailing or shared mobility systems did not correlate directly with willingness to share AVs with unknown persons in both Australia and Sweden. However, when users have had positive experiences with public transport or on-demand services, those experiences seem to increase willingness to share AVs with unknown persons.

Sharing anxiety and the concept of an *authority vacuum* were particularly prominent findings, reflecting user concerns about sharing space with strangers in the absence of a (human) driver. Additionally, the factor of *community trust* emerged from the focus groups, highlighting that the idea of the "familiar stranger" was significant to users in giving them a sense of security and safety when riding with strangers. Lastly, *cultural values* emerged from Study H as meso-level actors discussed how not only their own experiences from other countries impacted their expertise, but how this might translate for users at the micro level; similar to the influence of social norms, cultural values highlights cultural differences and influences that might be outside of a particular group's social norms (for example, a refugee community).

Table 6 Micro level factors, the studies that affirmed them, and their rationale for inclusion into the multilevel analytical model.

Factor	Rationale	Affirmed in Studies
Age/Gender	Sociodemographic factors such as age and gender influence individual preferences and acceptance of AV technology, and by extension, SAPT. In Study B, female focus group participants in Australia talked extensively about their concerns about public transport, which would influence their willingness to use SAPT.	A,B,C,D,F
Education	Educational background impacts an individual's understanding and acceptance of AV technology, affecting how they perceive the benefits and risks associated with AVs (Gerte, Konduri, and Eluri 2018; Dias et al. 2017).	A,D,H
Employment status	Employment-related mobility needs and the impact of AVs on commuting patterns are important factors in how AVs are perceived and used. Nair and Bhat (2021) examined the relationship between employment patterns and commuting habits, suggesting that higher educational levels and certain employment sectors favor specific transit options.	A,B
Household size	The size (and composition) of a household can determine transportation needs and preferences, influencing the acceptance of SAVs for family or group travel.	A,D
Household income	Household income impacts the financial resources individuals have available to put towards their mobility needs, influencing the constructs of *willingness to pay* and *willingness to share.*	A,B,C,E
Travel preferences and behavior	An individual's existing travel preferences and behaviors can influence their willingness to use shared AVs as part of their transportation choices.	A,B,C,D
Car ownership	A high level of car ownership often indicates a preference for private transportation, potentially reducing an individual's openness to shared services; it can also indicate a user's subscription to the "social norms" around them. Ownership patterns may change with the introduction of AVs, affecting individual mobility choices and the overall transportation landscape.	A,D,H
Social norms	People tend to conform to the behaviors and standards that are perceived as acceptable or typical within their community, often seeking to align themselves with group norms for social acceptance or to maintain a positive societal image. In some countries and cultures, this factor can be very strong and shape individual behavior. Social acceptance and the perceived image of AVs can significantly affect their adoption and usage, with societal norms influencing individual and collective behavior towards AVs.	A,B,C,F

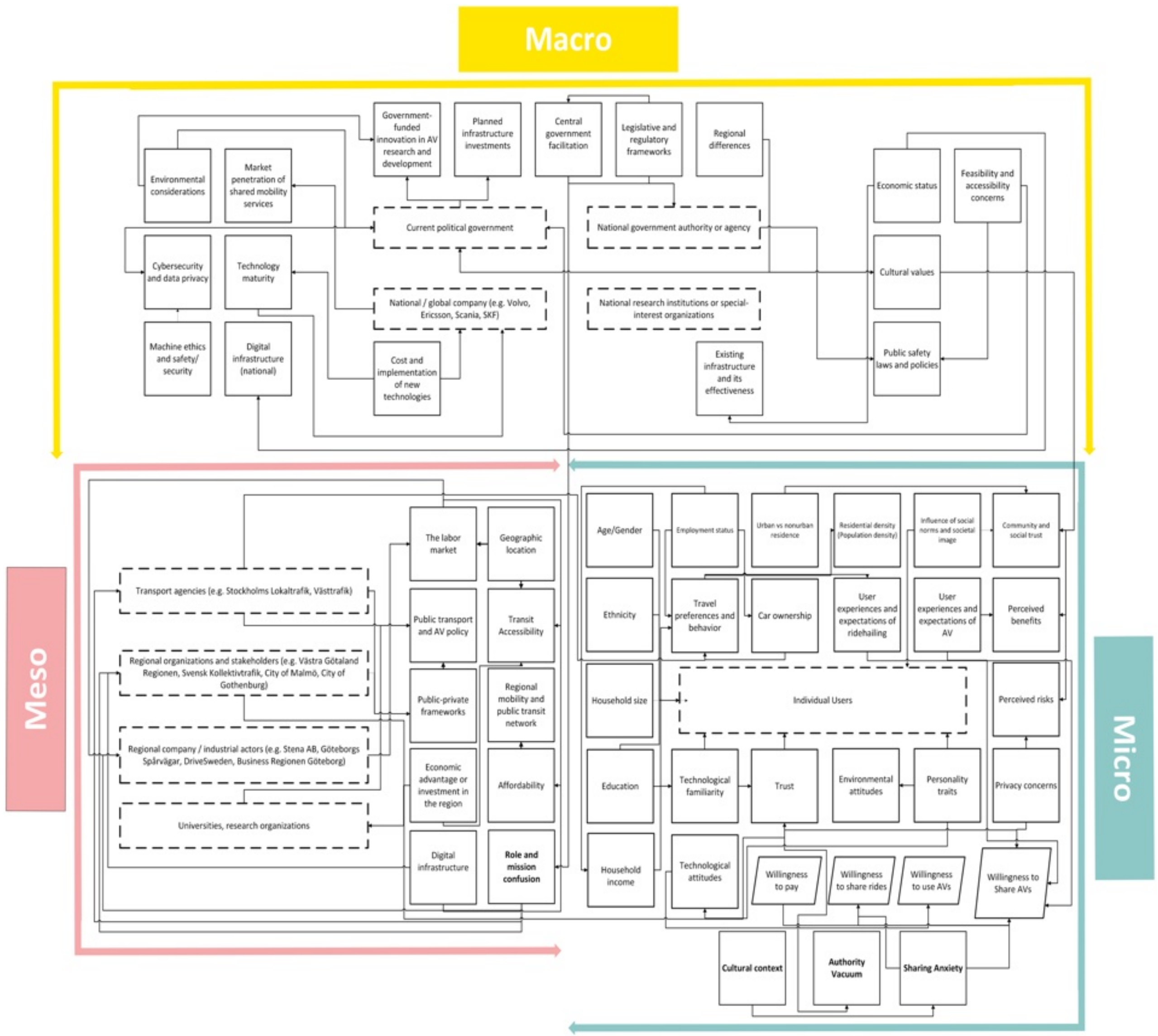
Cultural context	Variations in an individual's cultural background can affect their attitudes towards technology, privacy, and mobility, which in turn can affect their perspective and use of shared mobility, AVs and SAPT, which could lead to accepting or rejecting the macro-level cultural values.	B,C,H
Environmental attitudes	Attitudes toward environmental conservation can influence the acceptance and preferred use of AVs, particularly if they are perceived as greener alternatives to traditional vehicles.	A,B,C,D,H
Technological attitudes	Technological attitudes can be shaped by past experiences, knowledge, social influences, and the perceived benefits or risks of using technology. Attitudes towards technology and innovation can affect how individuals perceive and use AVs or on-demand mobility services, which will impact how quickly they are adopted and can be implemented into society.	A,D,H
Personality traits	Personality traits influence how individuals perceive and interact with technology, as well as with other people. Personality traits govern likes and dislikes which, in turn, steer the choices that individuals make. Differences in personality can affect how people perceive and interact with AV technology, as well as if they want to share their mobility journeys with people they don't know, influencing their overall willingness to use SAPT.	A,D
Safety concerns	Individual users' perceptions of personal security and physical safety will be part of their decision-making when choosing to use SAPT. Is the technology ready? Are there security measures in place against unruly co-passengers? This factor is affected by other factors (trust, technology maturity) and can, in turn, impact willingness to use SAPT.	A,B,C,D,H
Perceived benefits	Social acceptance and the perceived image of AVs can significantly affect their adoption and usage, with societal norms influencing individual and collective behavior towards AVs.	A,B,C,D,H
Perceived risks	Users' concerns about potential risks (which could range from data privacy and the length of time of the journey, to exposure to illness in a public setting) affect their decision-making when it comes to choosing a mode of transport. SAPT presents some unusual risks compared to other forms of mobility, given that it is driverless.	A,B,C,D,H
Privacy concerns	Privacy concerns are especially significant in the context of AV adoption, where the potential for data breaches and surveillance exists. High levels of privacy concerns impact public trust and acceptance, requiring strong protective measures.	A,D,H

Trust	Individuals' trust in the technology, its providers, the regulatory environment, and the people in their community (with whom they would be sharing their journey or using the service) is essential for the successful implementation of SAPT.	A,B,D,E,F,H
Authority vacuum	The lack of an obvious, human authority figure in a driverless vehicle is a type of safety concern. Addressing authority vacuum is paramount in the acceptance and use of SAVs, with higher safety consciousness potentially leading to greater trust and implementation of SAPT.	B,C,D
Sharing anxiety	Sharing anxiety, or the discomfort with sharing space with strangers, could slow the adoption of SAVs in public transport. If potential users feel uneasy about riding in shared autonomous vehicles, particularly in smaller, confined spaces, they may be reluctant to use a SAPT service, preferring private or personal transport options.	B,C,D,F,H
Technological familiarity	Familiarity with and understanding of AV technology, on-demand ridehailing, or dynamic ridepooling can influence how comfortable and willing individuals are to use AVs in shared contexts.	A,B,C,D,H
User experiences and expectations of AV technology	User experiences with and expectations of AV technology directly influence its acceptance and the effectiveness of its implementation into daily transportation systems.	A,B,C,D,H
User experiences and expectations of ridehailing	Positive experiences in ridehailing can increase willingness to use SAPT, but negative experiences with ride quality or social discomfort could hinder acceptance.	A,B,C,H
Ethnicity	Ethnic backgrounds can influence users' cultural attitudes towards technology, their transportation preferences, and their willingness to share mobility journeys. There is not much research done on the potential "racism" and conflicts that could occur due to users' concerns about co-riders of other ethnic groups, but Zhao et al. (2017) highlighted issues of prejudice and safety concerns, particularly among female users, which affect the potential adoption of shared rides. This has strong implications for SAPT.	A
Residential density (Population density)	Higher densities may facilitate more efficient use of AVs in urban areas given the economies of scale and the higher potential to match rides for sharing, while lower densities in rural areas present different challenges and opportunities, like less competition with other modes of transport.	A,H

Urban vs non-urban residency	Affects transportation behaviors and preferences, reflecting differences in infrastructure, accessibility, and cultural attitudes towards various modes of transport. Those living in nonurban areas face challenges such as longer travel distances and less frequent public transportation services, leading to a greater reliance on personal vehicles and higher fare sensitivity. Differences in infrastructure, accessibility, and transportation needs between urban and nonurban areas may affect the deployment and use of AVs.	A,B,C,H

Building on the findings of factors identified across the three levels, the next figure (Figure 11) presents an evolved version of the multilevel analytical model. This updated model adds the newly revealed factors from the studies— role and mission confusion, authority vacuum, sharing anxiety, and cultural context. Revisiting the findings in Study H allowed me to add another dimension to the analysis of these factors, using the transportation expert participants' discussions as a starting point for analyzing interdependencies between factors and levels. The model offers a comprehensive perspective on the factors affecting the implementation of SAPT, but in this figure, does not demonstrate previously discussed connections and intra- and interdependencies (those are highlighted later on in this chapter).

Figure 11 An evolved version of the model first shown in Chapter 3 after Study A, displaying the revealed and affirmed factors across the different levels. Factors revealed in Studies B-H are in bold.



6.2. Interdependencies Between Factors and Levels

Study H, the Delphi study, was distinct among the research described in this thesis; unlike other studies, which were designed to focus on factors in one specific level, Study H directly engaged a panel of experts and practitioners to evaluate factors across all three levels. Not only did it reveal a new factor, that of *role confusion*, but the post-survey workshop allowed me to observe in real time how meso-level participants perceived (however briefly or incompletely) the larger multilevel system of transportation.

The Delphi survey and its workshop gave my first evidence that the previously identified factors (Table 3 in Chapter 5) were significant for the implementation of SAPT. Some of those factors were also affirmed in multiple other studies; policy and regulation, role confusion, trust, user experience and expectations of AVs, sharing anxiety. The workshop also offered evidence of cross-level interdependencies.

The transport experts and practitioners emphasized that national legislation, a macro level factor, set the foundational regulatory environment that could either empower or constrain regional planning efforts at the meso level. In turn, these regional frameworks and infrastructure decisions directly affected individual user behaviors and preferences at the micro level.

Individual attitudes and behaviors at the micro level, such as willingness to share rides, could feed back into meso-level policy decisions if public demand or resistance was strong enough; if enough of the public wants a product or service, governments generally look for ways to make them regulated, but available. Similarly, infrastructure investments at the meso level, such as dedicated lanes for autonomous vehicles, were argued to be often initiated by national funding programs at the macro level.

Cultural values added another layer of complexity to cross-level interdependencies. Cultural factors, such as societal norms and the degree of individualism or collectivism (that being the second of Hofstede's five cultural dimensions; Hofstede, 2007), can vary significantly across regions, influencing how factors at one level impact the others. For instance, in collectivist societies, social norms (macro-level cultural factors) may exert a stronger influence on individual behaviors (micro level) than in individualistic societies, where personal preferences tend to prevail. This suggests that the effectiveness of certain policies or approaches could differ depending on regional cultural values.

Using these insights as a starting point, I explored the connections between other factors at other levels. Where the initial idea of a multilevel model assumed a hierarchical perspective (as originally discussed in Chapter 2), after completing the various studies, a different form emerged in my understanding of the relationships between the levels, as illustrated in the figure below (Figure 12).

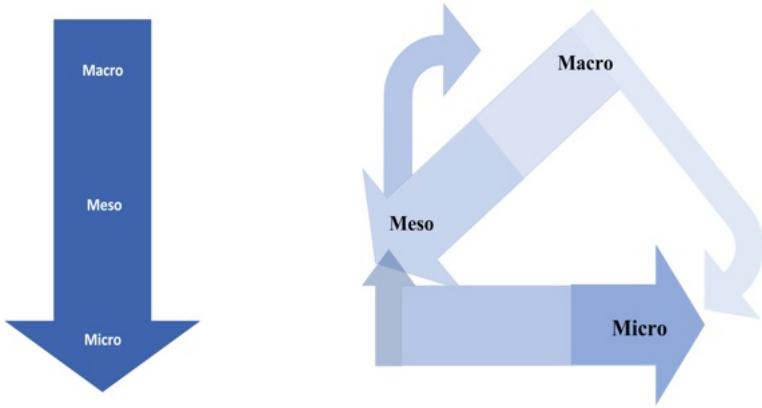


Figure 12 On the left, the hierarchical version of multilevel interaction (as originally shown in Chapter 2); on the right, a more nuanced version of the levels and their interaction and interdependencies.

The following described interdependencies are only those connections I feel are best evidenced in the findings of my work.

6.3. Macro-level factors and their Meso and Micro Interdependencies

Cultural values are seen to play a significant role in implementing SAPT. As mentioned previously, Hofstede's framework on cultural dimensions explains how cultural variations, such as collectivism versus individualism, affect attitudes toward shared mobility. Thus, national cultural attitudes presumably impact individual openness to shared transport solutions (micro level) and influence regional policy approaches to SAPT (meso level).

Legislative and regulatory frameworks provide a foundational structure for SAPT deployment. These frameworks guide the development of infrastructure and influence public trust by ensuring safety and environmental protections. Study A revealed the importance of this factor and its influence at other levels, noting that "effective legislation can help manage the societal impacts of AVs, facilitate infrastructure adjustments, and ensure that technological advances benefit society at large" (Marletto, 2019; Milakis et al., 2017). This means legislation helps align SAV technology with public welfare goals, which determines how actors at the meso-level can carry out national laws and programs aimed at increasing individual acceptance of the proposed transport system at the micro level.

Another macro factor with interlevel dependencies is that of economic status. Wealthier countries have greater financial capacity to invest in essential infrastructure, public education, and technology, which enhances the feasibility of

SAPT systems regionally and supports affordability at the individual meso level. Study A referenced Spickermann et al. (2014), noting that nations with robust economic conditions can better support SAV infrastructure, enabling increased accessibility and adoption. A country that is in a recession or dealing with other major financial concerns cannot prioritize SAPT services, which is currently an expensive undertaking.

Yet another macro-level factor is that of technological maturity. Mature technologies lead to more reliable systems, fostering public trust and encouraging adoption. Several of the respondents in the focus groups, i.e. Studies B and C, mentioned that they were unsure how ready the AVs they had seen were for real-world conditions. This perceived lack of technological maturity impacted their perceptions of safety, benefit, risk, and willingness to use AVs.

Perhaps one of the most significant macro-level factors was that of central government facilitation. By providing centralized guidance and resources, having a single entity for managing regulations, permits, and national objectives empowered meso-level actors such as regional transit authorities and mobility companies to navigate the complex regulatory and operational landscape of SAPT. This macro-to-meso support is evident in Study E, where Australian national policies established critical frameworks and legislation that clarified roles and mitigated the existence of the meso-level factor “role and mission confusion” among regional authorities. This national level of assistance could help regional actors design and implement SAPT systems that are perceived as reliable and trustworthy by the public, which can go on to impact micro-level factors such as trust and perceived benefits. What happens without this link between macro-level facilitation and meso-level stakeholders was further starkly demonstrated in Study G and Study H, which highlighted how the lack of central government facilitation caused confusion and delays among stakeholders and policymakers. An illustration of this relationship is shown in Figure 13.

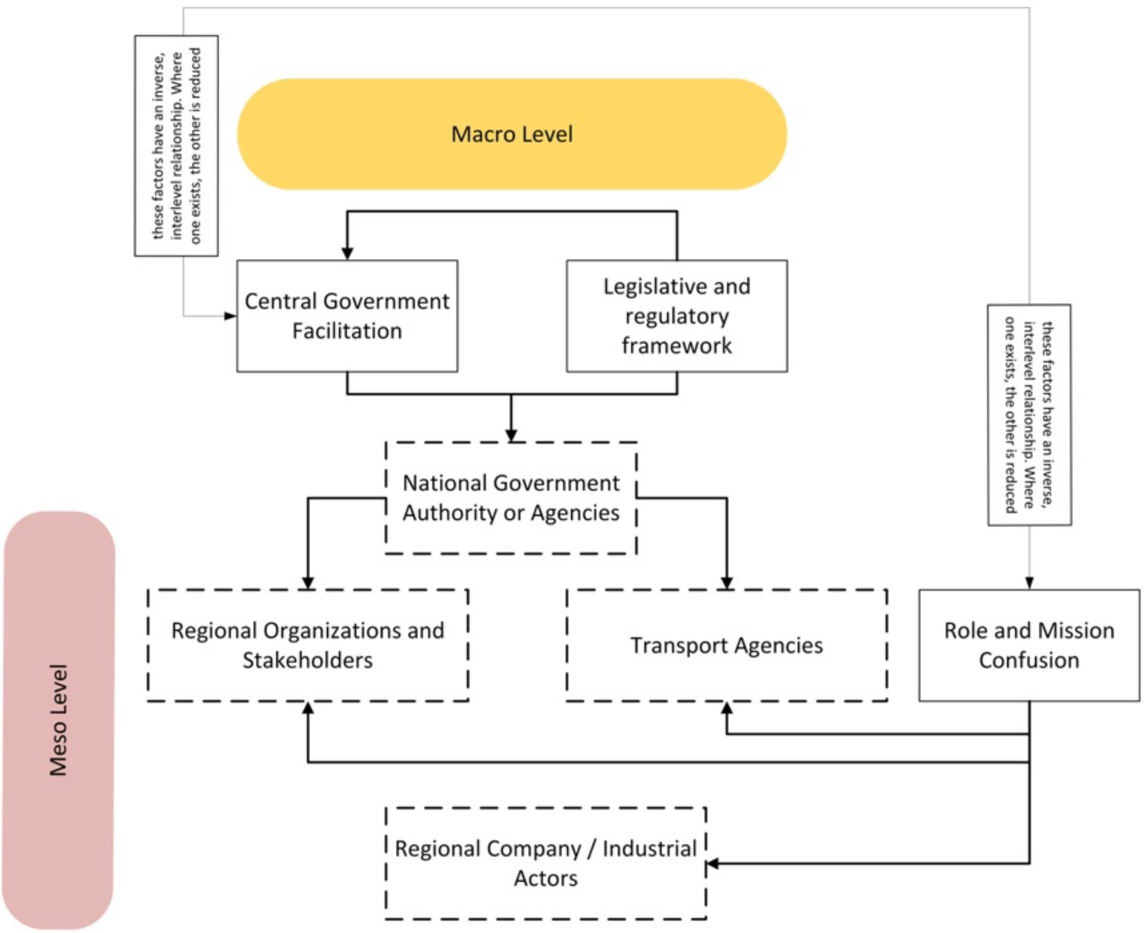


Figure 13 This image demonstrates how central government facilitation affects factors in other levels, primarily regional actors and the factor of role and mission confusion. (Note: This image does not display the entirety of the macro level or meso level.)

6.4. Meso-level factors and their Macro and Micro Interdependencies

Meso-level factors, such as public-private frameworks, regional mobility networks, digital infrastructure, and role clarity, are considered inherently complex due to their dual role in both adapting national policies to local contexts and shaping user experiences. These factors are not only influenced by macro-level government policies and strategic investments but are argued to also directly impact micro-level user acceptance by affecting accessibility, trust, and usability. This complexity was reflected by practitioners and experts in Studies E, F, G, and H.

The meso-level factor of public-private frameworks, i.e. environments that are designed to enable public-private partnerships, is assumed crucial for translating macro-level legislative intentions into practical, regionally adapted solutions that encourage public-private collaboration. These frameworks not only bridge the gap between national policies and local needs but also facilitate partnerships that can effectively foster user acceptance at the micro level. Study E illustrates this through the contrasting experiences of Australia and Sweden; while public-private collaborations in Australia were largely fruitful, facilitating smoother SAV deployment, Swedish stakeholders encountered practical challenges due to regional regulatory barriers and shared responsibilities. These experiences underscore that the success of public-private frameworks is context-dependent and requires tailored approaches to foster cohesive and efficient eventual implementation.

Study H also emphasized that regional mobility networks directly impact micro-level user engagement, as access to reliable transit influences public acceptance of SAVs. When regional transit systems are well-integrated, cover a large area, and function reliably, the participating experts surmised they facilitate positive user experiences and therefore encourage acceptance at the micro-level. Another meso-level factor that could impact regional mobility networks is that of digital infrastructure–not only part of most public transport systems today, it contributes to the macro-level factor of technological maturity and is part of what ensures public trust in AV systems. Adequate digital infrastructure is considered essential for delivering the reliability that both users and policymakers expect from AV technology; Studies F and G emphasize that digital infrastructure is crucial for maintaining public trust and aligning AV functionality with national technology goals.

Identified in Studies G and H, *role and mission confusion* emerges when meso-level actors struggle to define their responsibilities in the SAPT system. This lack of clarity creates inefficiencies and disrupts coordination, as stakeholders are uncertain of their specific roles, leading to overlaps or gaps in actions essential for creating shared, autonomous services. This critical issue extends to both macro and micro levels.; as stated earlier, central government facilitation reduces the likelihood of role confusion impacting the transport system. Yet when that macro factor is absent, this meso factor emerges where no clear directive exists for how meso-level actors should collaborate with macro actors. Additionally, role confusion indirectly impacts the micro level by creating a less stable environment for users. Without clear responsibilities assigned to transit agencies, local governments, and private operators, the system's reliability, and thus, the confidence of the public, can suffer. This would increase safety concerns, experience of authority vacuum, and sharing anxiety. This factor's connectedness to the macro level was already illustrated in Figure 13 (above); I illustrate its connectedness to the micro level below in Figure 14.

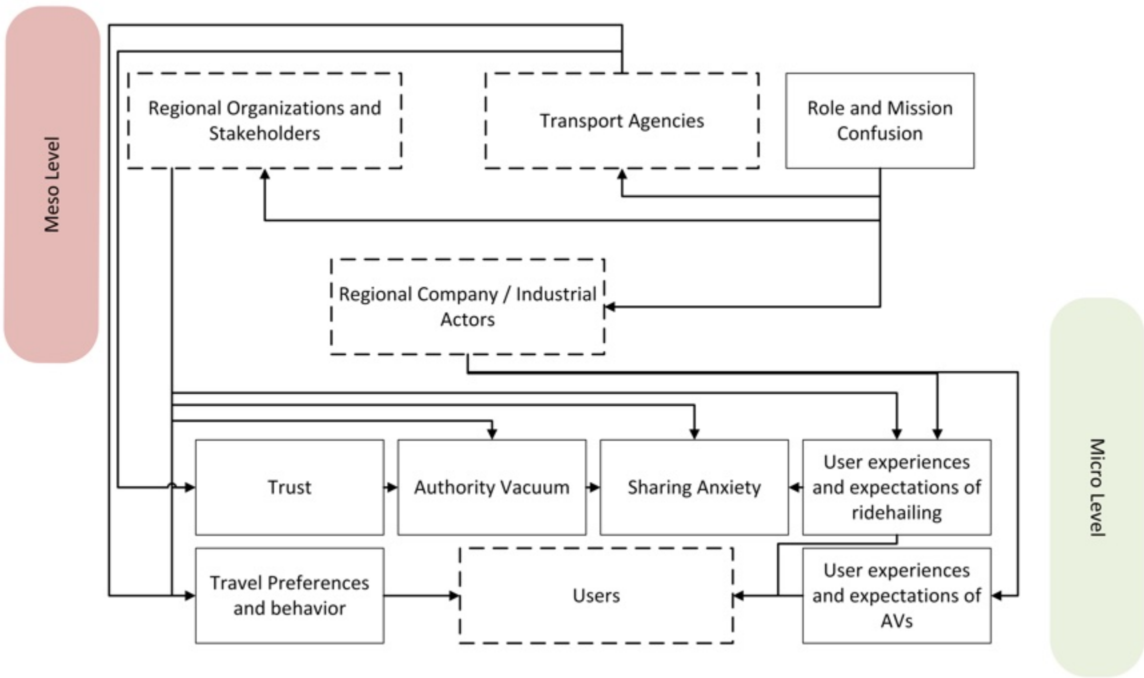


Figure 14 This image demonstrates how central government facilitation affects factors in other levels, primarily regional actors and the factor of role and mission confusion. (Note: This image does not display the entirety of the macro level or meso level.)

6.5. Micro-level factors and their Macro and Meso Interdependencies

In contrast to the macro and meso levels, which had numerous factors and actors, the micro level includes many factors but essentially, only one actor– that of individuals, or users. While there are varying types of individuals, this infers that all users are subjected to, or must consider, far more factors than at any other level. I propose that users are influenced by external factors from other levels. Users are directly responsible for making personal decisions about whether to trust, use, and accept SAVs; widespread implementation of SAVs for public transport ultimately depends on individual acceptance of the technology, service, and concept. If users are not convinced that SAVs meet their safety, privacy, and convenience expectations, the entire system fails to gain traction. This highlights that the success of macro- and meso-level factors, actions, and policies is contingent upon their ability to address micro-level concerns and ensure a positive user experience. And yet, the studies did not reveal micro-level factors that could be argued to have a directional impact on factors at the macro or meso level. Many of the factors in the micro level were intraconnected, influencing each other and then by extension, the user.[18] It is possible other studies would have revealed factors that had stronger interlevel dependencies or directionality. A depiction of these connections to the micro level factors is shown below in Figure 15.

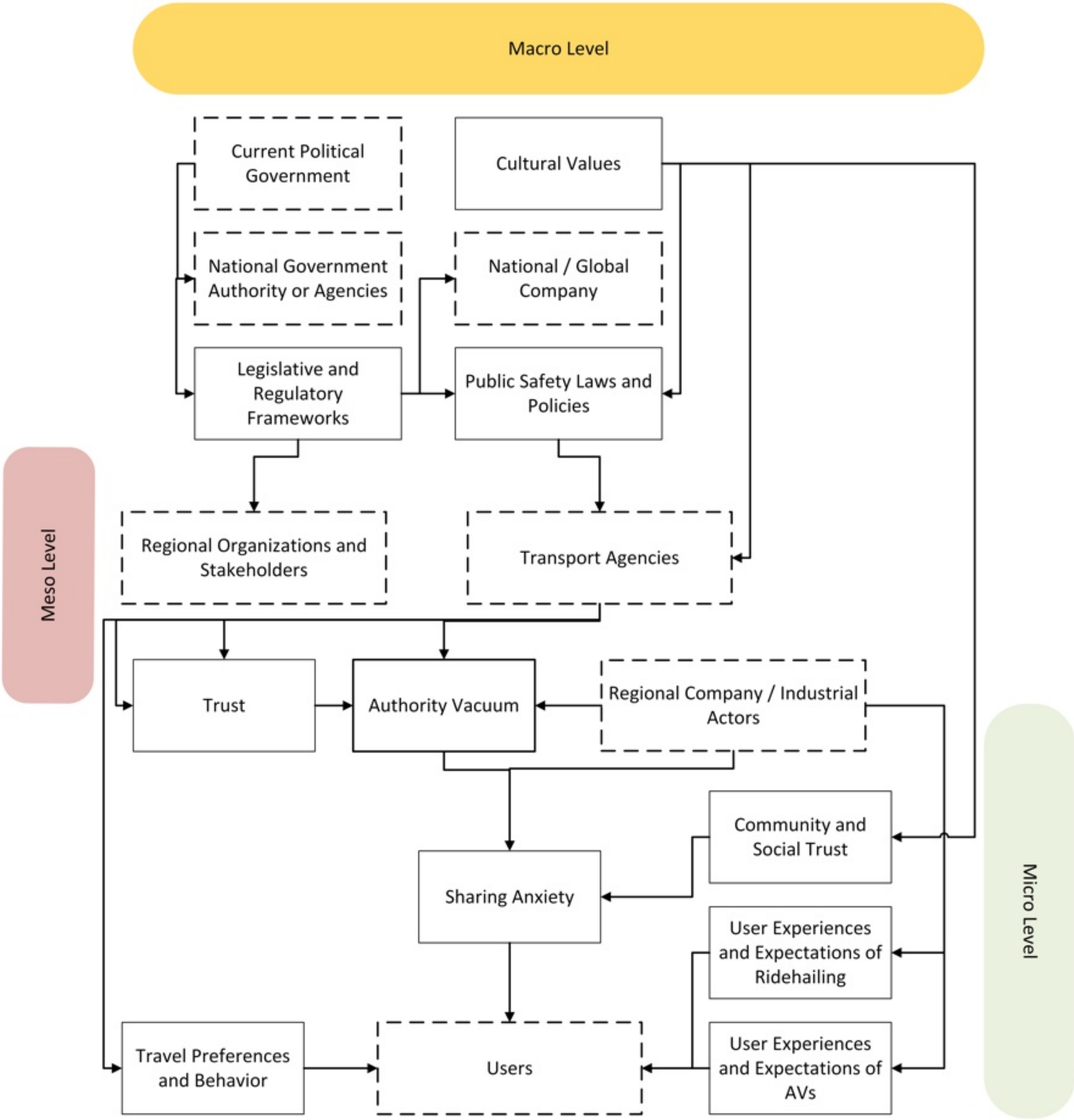


Figure 15 This image illustrates how actors and factors from the macro and meso levels impact factors and users in the micro level. (Note: This image does not display the entirety of all three levels, nor all the factors in the model.)

Personality traits influence perceived benefits and risks, which are also connected to trust and privacy concerns, showing how an individual's personality may impact their overall trust and perceived safety of SAVs (Fyhri and Backer-Grøndahl, 2012;

[18] One could make the argument that micro-level actors, users, can influence meso and macro-level actors through voting or consumer decisions, or that the existence of negative factors like sharing anxiety can prompt stakeholders at other levels to take action, but I do not examine users as voters in this work.

Johansson et al., 2006). This was confirmed in Study D, where traits like openness to new experiences, risk aversion, and environmental conscientiousness were linked to varying levels of enthusiasm or skepticism about using SAVs, affecting how users responded to the concept of shared, automated mobility. Study D explicitly showed that a more risk-averse person might perceive greater safety concerns, even when presented with strong safety measures, while a more tech-savvy individual may focus on the perceived benefits, such as convenience and sustainability. The relationships between these factors are dynamic: perceived benefits might increase a user's willingness to overlook minor inconveniences, but a lack of trust may undermine their overall acceptance of SAVs.

For instance, sharing anxiety was shown to directly contribute to users' willingness to share rides, which is seen as a precondition of the acceptance of SAVs–it was found in Study D to be a stronger predictor than previous experience with ridehailing services. To ameliorate sharing anxiety and therefore increase willingness to share rides, meso-level actors would need to take actions that impact the micro level such as tailor routes, pricing models, and service options to enhance comfort and privacy for users, ultimately making SAVs more user-friendly and encouraging higher adoption rates.

Trust also stood out as essential– partly because it covers a variety of contexts such trust in service providers, in government entities, and in fellow riders, which all emerge from the individual user but are addressed in different ways. Users must trust not only AV technology but also service providers and their fellow rides. Safety measures are needed for adoption to be viable; without trust, sharing anxiety and reluctance increase. The actors responsible for addressing trust (in all its contexts) are meso or macro actors, such as vehicle manufacturers, public transport agencies, government agencies (that regulate technology), or organizations that contribute to safety and order. These actors must create a physical and regulatory environment that directly addresses user anxieties around safety and privacy, reassuring the public of the reliability and security of SAV systems, which can strengthen user confidence.

Two micro-level factors that I suggest have an intradependent relationship are user experiences and expectations of ridehailing, and User experiences and expectations of AV technology. Both have been widely anticipated to influence the adoption of shared autonomous vehicles as familiarity with app-based, on-demand services might logically ease the transition to autonomous shared mobility. Study H, with insights from expert participants, underscored this assumption, positing that previous ridehailing experience could positively impact SAV adoption by fostering user trust and acceptance. Experts argued that users already comfortable with ridehailing services might view SAVs as an extension of this familiar service model, reducing resistance to autonomous shared transportation. This expert view aligns with macro-level policy strategies that focus on leveraging existing mobility trends to increase SAV adoption; this could be achieved by creating a legislation or providing financial incentives that form a welcoming environment for shared mobility services (such as dynamic ridepooling), which would increase the market share of ridehailing services (macro-level) while adding to the number of people who are familiar with the service (technological familiarity and user experiences with ridehailing, both micro-level factors).

However, Study D's findings challenged this assumption by revealing that prior ridehailing experience did not necessarily impact users' willingness to adopt SAVs. In both Australia and Sweden, Study D found no significant correlation between users' familiarity with ridehailing and their openness to SAVs. Instead, attitudes around willingness to share emerged as the stronger predictor of willingness to use SAVs with strangers, highlighting a more fundamental micro-level factor tied to social norms and comfort with shared spaces. This finding suggests that, at the meso level, regional transit authorities and service providers may need to prioritize addressing sharing anxiety rather than relying solely on users' previous exposure to ridehailing services. Additionally, these insights indicate that macro-level policies focused solely on leveraging ridehailing familiarity might fall short if they do not also tackle broader societal attitudes toward sharing.

Regarding willingness to share rides; this was a (type of) latent construct. Since very few of the participants in either focus groups or the surveys were able to experience shared, autonomous rides, this was a factor I could not easily observe. However, I measured responses and statements from potential users on their stated preferences and feelings about the concept, and found it was directly impacted by the following factors:

- Sharing anxiety relates to the concerns and discomfort individuals may feel about sharing rides with strangers. It can significantly impact their willingness to participate in ride-sharing services.
- Trust in the public transport system (the provider, the technology, and the government authorities, and other users) plays a role in determining whether individuals are willing to share rides. If trust is high, people are more likely to engage in shared mobility options.
- Perceived risks include concerns about safety, privacy, and other potential risks associated with sharing rides. High perceived risks can lower the willingness to share rides.
- Perceived benefits, the twin to perceived risks, refers to the advantages that users see in dynamic ridepooling, such as cost savings, convenience, or environmental benefits, can positively influence their willingness to share rides.

These connections highlight that a user's willingness to share rides in a SAPT context, is influenced by a combination of psychological comfort (sharing anxiety), trust in the system, the technology, and others, the balance of perceived risks versus benefits, and the overall user experience.

7. Index Creation

This chapter describes the initial steps in the creation of a tentative Societal Readiness Index for Shared Autonomy; using factors that were confirmed from the studies summarized in Findings as its basis. It explains how the factors are used to construct a descriptive and prescriptive tool for stakeholders and practitioners who want to prepare a group or region for shared, autonomous public transport.

7.1. Defining Index Goals

In this thesis, societal readiness refers to the extent to which a society is prepared to accept, adopt, and sustainably implement new technology or innovations across various levels—from individual users at the micro level to national policy frameworks at the macro level. If regional stakeholders consider SAVs to be part of the solution and therefore aim to make SAPT a reality, then there is a need for tools to ensure that they can do so effectively. The primary aim of the *Societal Readiness Index for Shared Autonomy* is to be formative — descriptive *and* prescriptive. It is not meant to be solely a measure of whether a region is "ready" or "not ready”, but rather a tool to provide stakeholders with insights into specific factors, such as governance, infrastructure, social attitudes, economic readiness, and environmental sustainability that can be linked to clear program or policy interventions.

For example:

- A region scoring low on governance may use the findings to initiate regulatory reforms or establish collaborative frameworks with private mobility providers.
- A region lagging in infrastructure readiness might focus on targeted investments in digital and physical systems, such as 5G networks or EV charging stations.
- Insights into social attitudes could prompt a city to introduce shared, on-demand rides that are *not* driverless first, for people to adapt to the nature of the system before using autonomous technology.

Thus, given that a region wants to pursue shared, autonomous public transport, SRISA’s goal is to be able to provide an understanding of how a region exists today, as well as a roadmap for progress and implementation of SAPT.

To look explicitly at societal readiness for shared, autonomous public transport, I examined factors that influence its implementation. One of the meso-level studies (Jiang et al., 2022), mentioned in Chapter 3, offers insights for developing a comprehensive and inclusive *Societal Readiness Index for Shared Autonomy*. Jiang et al.'s use of a multi-stakeholder and multi-criteria assessment highlights the importance of involving diverse perspectives in evaluating regional readiness for connected and autonomous vehicles; their study affirms that readiness for autonomous vehicles is not a one-dimensional measure, but must account for the distinct priorities and needs of various actors across different levels.

These assessments are crucial for understanding the existing transportation system and for making strategic recommendations to create the ideal environment for the implementation of shared, autonomous public transport

7.2. Applying Prior Work to Index Creation

As mentioned in Chapter 4, the Research Process, the creation of this index was inspired by the CARTI method. Chapters 1 to 6 of the thesis have provided input to the steps 1-3.

In Chapter 1, Introduction, the thesis articulates the research aims and objectives, aligning with the CARTI method's Step 1. The introduction describes the need to assess societal readiness for shared autonomous public transport systems, thereby structuring the decision problem. The chapter outlines the core assumptions, research aims, and questions, setting up the decision problem: understanding the factors that influence the successful implementation and adoption of SAVs across three societal levels. Chapter 3, Literature Review, begins identifying and categorizing tentative factors for the implementation of shared autonomous public transport; these identified factors are crucial for setting the goals and understanding what the index aims to measure, and begins Step 2 in the CARTI method.

In Step 2 of the CARTI method, the task is to define the specific goals that the index aims to achieve and, in the specific case, to identify the necessary needs and capacities for implementing shared autonomous public transport systems. Chapter 5, Findings, affirmed factors and exposed connections or interdependencies that were further explored in Chapter 6, Synthesis. Understanding how the factors impact each other, and the system, is critical for defining the goals of the index. For instance, if strong digital infrastructure is crucial for successful SAV deployment, then one of the goals of index could be to assess and promote the development of such infrastructure in regions looking to adopt these technologies.

Chapters 3, 5 and 6 contribute to Step 3 in the CARTI process, the step that details using existing literature to assemble indicators. Chapter 3 was the literature review, exploring factors already identified by other authors and work for related cases and contexts; Chapter 6 further develops the findings by suggesting specific factors and rationales for those factors. This information was used for developing criteria for selection of indicators for the SRISA. These factors can be translated into obtainable, measurable indicators, which is crucial for operationalizing SRISA, and ensuring that the index is built on relevant data.

7.3. Evaluation Criteria

Step 3 of CARTI method involves Indicator selection. In the CARTI, they used a system called ELASTIC (Evaluative and Logical Approach to Sustainable Transport Indicator Compilation) as a structured approach for selecting sustainable transport indicators. ELASTIC included three main criteria: measurability, ensuring indicators are reliable, clear, and easy to measure; availability, making data accessible and affordable through direct or model-based collection; and speed of availability, allowing data to be frequently updated to reflect current conditions (Castillo and Pitfield, 2010; Walters et al. 2022). With inspiration from the ELASTIC criteria, and to ensure that only the most relevant and actionable factors were included in the proposed index, a structured evaluation was carried out using four feasibility criteria,

- Relevance: Does the factor reflect an aspect of societal readiness for SAPT?
- Measurability: Can the factor be easily measured in a meaningful way?
- Data Availability: Are there existing datasets or surveys to support this factor?
- Existing Index: Is this factor already part of an existing, reputable index that can be leveraged?

Based on these criteria, the factors listed in Table 4 (Chapter 6) were systematically evaluated.

7.3.1. Factors Deemed Unsuitable for SRISA

Certain factors were excluded from the SRISA because their relevance to societal readiness is either indirect, context-dependent, or impractical to measure effectively within the scope of a readiness framework.

Household size, for instance, while potentially influencing transportation needs and preferences, is variable across regions and provides lack of actionable insights specific to SAPT, making it unsuitable as a readiness indicator. Similarly, cultural context, though influential in shaping attitudes toward technology and mobility, overlaps with the macro-level factor of *cultural values*, and so it would be redundant to include it in the index. *Personality traits* may influence individual attitudes toward SAPT but are inherently subjective and lack societal-level measurability. These traits are more appropriate for focused micro-level studies but not suitable for inclusion in a readiness index that addresses broader societal implementability. *Perceived benefits and risks*, while likely influential for user acceptance, are contingent on specific service design features, limiting their utility as standardized indicators for societal readiness. Lastly, the concept of an *authority vacuum*, describing the unease users feel in a driverless vehicle without a clear human authority figure, while significant from a psychological perspective, is too closely tied to service design and perhaps the vehicular space itself to be included in a societal readiness index. However, its complex nature does allow it to be covered, indirectly, by other factors (and their indicators) that are included in SRISA.

7.3.2. The Case for Sharing Anxiety

Authority vacuum was one of the four "new" factors revealed after the literature review. Another one of those new factors was *sharing anxiety*. They are closely related concepts, and they share similar difficulties when being considered for feasibility for the SRISA. However, despite being similar concepts, they still differ enough that they should not be considered the same factor. Therefore, I want to make the argument that *sharing anxiety*, unlike authority vacuum, *should* be considered for SRISA.

Sharing anxiety refers to the discomfort or reluctance that individuals may feel when using shared transportation services, particularly when it comes to sharing space with strangers in autonomous vehicles. While this factor plays a significant role in influencing user acceptance of shared, autonomous mobility, it technically did not meet the selection criteria outlined for SRISA. People's willingness to share rides is influenced by personal preferences, social norms, cultural background, and even psychological factors such as introversion or extroversion; sharing anxiety could have different meanings to different groups of people. This makes it challenging to create a universal measurement for sharing anxiety that applies across different regions and populations. There is no established global index or large-scale dataset that regularly tracks sharing anxiety in relation to shared autonomous vehicles. This means that custom surveys or interviews would be required to gather insights.

However, *despite* failing to meet the feasibility criteria, I suggest that sharing anxiety remains an important factor to consider in SRISA. Even though it is subjective and may require custom data collection, it is directly tied to societal readiness for shared autonomous vehicles for public transport. User concerns about sharing space with strangers can significantly influence the adoption of shared mobility services, and so while data collection would be resource intensive, it is nonetheless valuable to do the interviews or surveys that would give an understanding of how intense sharing anxiety is in a population. It is only through acknowledging this psychological and social hurdle that policymakers and transport planners can prepare and, for example design better outreach campaigns or implement strategies that make shared transport services more appealing to users.

7.3.3. Suitable Factors and the Choice of Indicators

After applying the feasibility criteria to the factors identified for the multilevel analytical model, 41 factors remained. With these factors as a starting point, I then began to search for appropriate indicators and data sources. Each potential indicator was assessed for measurability, so priority was given to indicators with clearly defined data points, such as the percentage of the population covered by high-speed internet, kilometers of dedicated transit lanes, percentage of population using ridehailing or ridepooling services, number of shared mobility companies in the country, or GDP per capita. Where possible, I looked for datasets that are regularly updated and publicly accessible, such as the World Bank Doing Business Reports, Global Legal Monitor, Hofstede's Cultural Dimensions, and OECD reports. For localized factors, I explored data from national transport ministries, regional statistical agencies, and policy archives like EUR-Lex. For factors without pre-established indicators – such as those that directly relate to AVs, which are not yet widespread – I explored related metrics that could act as indicators by proxy. In cases where direct data on public acceptance of AVs was unavailable, I proposed indicators like public transport usage rates or the adoption of ridehailing services. When attitudes or opinions on AV technology or willingness to share SAVs is needed, surveys and direct polling would have to be done.

7.4. The Index

The building blocks of the index, i.e. the factors, potential indicators and potential data sources are presented in Table 7.

Table 7 Macro themes, factors, and potential indicators and data sources for the *Societal Readiness Index for Shared Autonomy*.

Factor	Potential Indicator(s)	Potential Data Sources
Is the necessary legislation, regulations and policies in place for the implementation of SAPT?		
Public safety laws and policies *This includes laws specific to the operational challenges of SAPT (like being able to handle safety issues between passengers).*	Existence of laws and regulations that are designed for public safety in transport	- National transport agencies - Global Legal Monitor
Legislative and regulatory frameworks *Frameworks that are conducive to new commercial actors entering the transportation ecosystem, or policy interventions designed to making private car ownership more difficult.*	Existence of legislative and regulatory frameworks that are conductive to new commercial actors entering the transport system	- EUR-Lex (EU) - World Bank Doing Business Reports - Country-specific legislative archives (e.g. Congress.gov, Legifrance)
Cybersecurity and data privacy laws and regulations *Technological safety and security are needed to make mobility services run safely and reliably; SAPT requires much higher levels of digitalization and has more components (as a transportation service) where data security is paramount.*	Presence of regulations such as the General Data Protection Regulation (GDPR) in the EU or similar laws globally (e.g., CCPA in California, PIPEDA in Canada) Existence of national cybersecurity laws	- Global Cybersecurity Index - European Union Agency for Cybersecurity (ENISA) - Cybersecurity & Infrastructure Security Agency (CISA) - OECD Digital Economy Outlook
Machine ethics and safety / security policies *These regulations and policies are needed to ensure that technological advancements are compatible with societal expectations and safety standards.*	Existence of policies that address the compatibility between technological advancements and ethical and safety standards Regulations requiring human oversight or fail-safe mechanisms in AV operations to ensure safety Agreement to international guidelines and standards regarding AI ethics and safety	- EUR-Lex - OECD AI Principles - Country-specific legislative archives (e.g. Congress.gov, Legifrance)

Environmental policies *Environmental policies are based on priorities or goals a country has set, which should support the usage of AVs in SAPT in reducing, for example, single-occupancy vehicle travel.*	Existence of environmental policies targeting reduced emissions from transport	- EUR-Lex - National transport ministries - Country-specific legislative archives (e.g. Congress.gov, Legifrance) - UNEP Transport Policy Database
Feasibility and accessibility priorities. *This relates to national focus on equitable access to mobility services; AVs have the potential to increase the availability and inclusivity of public transport.*	Existence of policies focused on increasing accessibility to public transport for people who are differently abled	- National Disability Acts and Policies - EUR-Lex - National transport ministries - Convention on the Rights of Persons with Disabilities (CRPD) and reports by signatory countries - Country-specific legislative archives (e.g. Congress.gov, Legifrance)
Does the national infrastructure, physical and digital, have the necessary quality and adaptability for the implementation of SAPT?		
Existing infrastructure (national) *Road quality, digitally-connected intersections, speed monitors, and sensors that track the flow throughout the area are all useful for AVs; dedicated transit lanes are beneficial for public transport flow. How much of the infrastructure is already in place determines how much an area or region needs to change*	Kilometers or percentage of road networks with dedicated lanes for public transport or high-occupancy vehicles Number of electric vehicle charging stations per square kilometer (it is assumed AVs will be electric and some public transport already uses electric buses)	- World road statistics

Digital infrastructure (national) *Digital infrastructure enables AVs to function properly as well as a networked system of rides to be managed, much like public transport fleets are today.*	Percentage of the population or land area covered by high-speed mobile networks (4G and 5G) Proportion of intersections equipped with smart infrastructure, such as vehicle-to-infrastructure (V2I) communication systems, connected traffic signals, or automated traffic management systems Annual public spending (as a percentage of GDP) on national digital infrastructure	- Digital Economy and Society Index - Global Connectivity Index (GCI)
Planned infrastructure investments (national) *Planned infrastructure investments at the national level allows for the development and upgrading of infrastructure to accommodate AV technology, which can include improvements to roads, connectivity, and vehicle-to-infrastructure systems, making SAPT more feasible.*	Percentage of GDP or national budget dedicated to transport and digital infrastructure upgrades specific to AV and SAPT projects Inclusion of AV-specific infrastructure plans in national mobility strategies, such as smart mobility or intelligent transport system (ITS) policies	- OECD Infrastructure Spending Reports - National Transport Ministries - IMF Fiscal Monitor
Is there political and economic national support for pilots and/or projects involving SAPT?		
Central government facilitation *Government support develops and promotes a cohesive strategy for SAPT.* Role and mission confusion *Unclear roles among stakeholders at the meso level can hinder effective collaboration and implementation efforts.*	Existence of national strategies or policies explicitly addressing SAVs and SAPT integration Existence of a single organizational point of contact at the national level for beginning a pilot or service involving autonomous technology or shared mobility	- National transport ministries - National public transport agencies - Government Mobility Innovation Units - EUR-Lex - Country-specific legislative archives (e.g. Congress.gov, Legifrance)

Government-funded innovation in AV research and development *This factor accelerates technological progress and reduces financial risks for private companies. Through funding and collaborative efforts, governments can drive advancements in AV technology that make other systems–like SAPT–possible.*	Annual government spending on AV-related R&D as a percentage of GDP or total transport budget Specific grants or funding programs targeting autonomous and shared mobility projects Count of AV-related pilot programs, research collaborations, or innovation hubs funded or co-funded by the government Tax credits, subsidies, or matching funds provided to private companies for autonomous or shared mobility services	- OECD Science, Technology and Innovation Outlook - World Bank Public Expenditure Reviews - National budgets and reports - IMF Fiscal Monitor - National innovation hubs - Government transport agencies
Economic status *Economic status influences both governmental and individual capacity to support and invest in AV technology; nations with stronger economies can afford to subsidize or invest in new transportation solutions, which speeds up the implementation of SAPT.*	GDP per capita as an indicator of economic strength	- World Bank - IMF
Is AV technology ready for the implementation of SAPT?		
Technology maturity *This factor determines the reliability, safety, and user acceptance of AV technology and therefore can impact the adoption and implementation of SAPT.*	Total number of miles driven autonomously during testing and deployment phases, as reported by manufacturers Number of certifications or approvals granted by national or international regulatory bodies for AV systems	- National transport agencies (such as NHTSA (U.S.) or the Swedish Transport Agency (they keep data on AV testing and deployment progress)

Cost and implementation of new technologies *The cost of technology will impact how quickly it is implemented and how widely it is used.*	Average cost per AV, including sensors, LiDAR, cameras, and AI systems Cost per kilometer of running AVs compared to conventional public transport systems with human-operated buses	- Statista Market Forecast - Allied Market Research on AV component costs - International Association of Public Transport (UITP) - World Bank Transport Division
Is the national culture favorable towards innovations?		
Cultural values *A strong cultural openness to shared transportation or shared services can foster (or be used to foster) wider acceptance of SAVs.* Collectivist cultures (cf. Hofstede) may show greater openness to shared mobility solutions.	Score based on Hofstede's Individualism-Collectivism Index National attitudes toward sharing economy services (e.g., ride-pooling, co-working spaces)	- Global and regional studies (e.g. Hofstede's dimensions of culture, World Values Survey) - National and regional surveys on mobility and transportation attitudes - Reports from shared mobility providers (e.g. usage statistics for ridepooling, car-sharing, or bike-sharing)
What is the market penetration of shared mobility services?		
Market penetration of shared mobility services *A strong market penetration indicates that a country's population is already used to some shared mobility services and could signal readiness for more advanced shared autonomous systems.*	Percentage of the population that have access to and use shared mobility services (ridepooling, car-sharing, bike-sharing) The number of on-demand ridehailing (TNC) companies in a country Total revenue or market share of shared mobility services in the transportation sector Growth rate of shared mobility service adoption over the past five years	- National transport surveys - Statista - Company directories (Crunchbase) - Industry reports (Allied Market Research or McKinsey) - International Transport Forum reports

Table 8 Meso themes, factors, and potential indicators and data sources for the Societal Readiness Index for Shared Autonomy.

Factor	Potential Indicator(s)	Potential Data Sources
Are the regional geographic conditions feasible for the implementation of SAPT?		
Geographic location (regional geography) *geographic characteristics of an area, such as whether it is urban or rural, have a direct impact on the feasibility and design of shared autonomous public transport (SAPT). Urban areas often support dense transit networks, while rural areas may require alternative solutions due to lower population density and longer travel distances.*	Percentage of the population living in urban versus rural areas Presence of extreme weather conditions or geographic challenges (e.g., mountains, deserts)	- OECD Regional Database - Eurostat - National statistical agencies - National meteorological and geographical agencies - World Meteorological Organization
Does the local economic context have the necessary resources to support SAPT programs and implementation?		
Economic investment and advantage *Economic disparities influence transportation equity. Rural and low-income areas, often experiencing higher levels of poverty and exclusion, face challenges in accessing transportation innovations like AVs.*	Regional GDP or per capita income levels Presence of tech hubs or industries investing in AV technology development	- OECD Regional Database - Eurostat - National statistics agencies - company directories (Crunchbase) - International Association of Science Parks
Labor Market *The presence of industries like technology or automotive sectors in a region may accelerate the adoption of AVs by fostering access to skilled labor and technological infrastructure. A stable and thriving labor market supports the demand for reliable public transport options.*	Regional unemployment rate (as an indicator of job stability and economic activity) Percentage of workers using public transport as their primary commuting method	- OECD Employment and Labour Market Statistics - World Bank employment data - National statistics agencies, - National and regional transportation authorities - National household travel surveys

Affordability *If the cost of using SAPT is high relative to the average income in a region, lower-income populations may not utilize the service, thereby jeopardizing the region's investment.*	Overall cost of Living Index Cost of yearly Transit Pass as percentage of Disposable Income Investment per capita in SAPT infrastructure	- Government census and economic reports for data on disposable income, income inequality, and public transport costs - Consumer Price Index (CPI)
Does the regional infrastructure, physical and digital, have the necessary quality and adaptability for the implementation of SAPT?		
Regional mobility and public transport network *Strong networks with reliable and frequent services indicate regional commitment and is related to economic advantage and infrastructure. This factor also reflects the adaptability of regional transport systems to user demands, geographic constraints, and shifting mobility patterns. In certain contexts, a strong public transport network may be a barrier for implementing SAPT (because there is too much investment in one form of infrastructure or mobility); in others, the lack of public transport network might make it easier to introduce SAPT because the only other alternative for residents is a private vehicle.*	The total area of the region (in square kilometers) served by public transport Passenger kilometers traveled: The total distance traveled by passengers on public transport, typically measured annually Modal split of passenger transport: The percentage share of each mode of transport in total land-based transport, expressed in passenger-kilometers (pkm) (passenger cars, buses and coaches, and trains) Percentage of population with access to public transport: The proportion of the population living within a specified distance (e.g., 500 meters) from a public transport stop or station Percentage of population with access to shared mobility services (car-sharing, bicycle pool)	- National and regional transit authorities - Eurostat - National travel surveys - Urban Accessibility Index (World Bank) - Statista
Public Transport and AV Policy *Policies regulating door-to-door services or limiting commercial stops can reduce inefficiencies and energy consumption while supporting integration of AVs into public transport.*	Existence of policies targeting public transport, autonomous vehicles, or both	- WEF Mobility Reports - EUR-Lex - national transport ministries - Country-specific legislative archives (e.g. Congress.gov, Legifrance)

Transit Accessibility *evaluates the inclusivity of a transport network, particularly for persons with disabilities or mobility challenges. It encompasses legislative, infrastructural, and planning decisions that prioritize equitable mobility. Accessible transit systems can significantly bridge mobility gaps and enhance societal equity.*	Percentage of the population within a 500-meter radius of a public transport stop Coverage density of public transport networks (e.g. kilometers of transit routes per square kilometer) Percentage of transit stops or vehicles compliant with accessibility standards (e.g. wheelchair ramps, audio-visual aids) Average wait time for public transport during peak and off-peak hours	- National and regional transport agencies - Urban Accessibility Index (World Bank) - OpenStreetMap (OSM) - Open data platforms (such as TransitFeeds)
Digital infrastructure (regional) *Digital systems of regional public transport often determine how users are able to access current systems. The digital infrastructure would need to be expanded to include and support AV operations, such as connectivity and data analytics platforms, are essential for the efficient management of AV fleets and for routing requests or building trips for users.*	Availability and density of 4G/5G towers in urban and rural areas Percentage of public transport systems using digital platforms, such as mobile apps for ticketing, real-time arrival information, and service updates Existence and usage of digitally enabled demand-responsive transport services Number of smart traffic lights, road sensors, and other IoT devices per square kilometer for monitoring and managing traffic flow	- Global System for Mobile Communications Association (GSMA) - Statista - National transit authorities - International Association of Public Transport (UITP) - Industry reports on Mobility-as-a-Service
Are there collaborative structures and agreements between public and private actors that can be positive for the implementation of SAPT?		
Public-Private Frameworks *promote risk-sharing, cost-sharing, and resource-sharing between public authorities and private entities. Australia benefited from clear collaboration structures that supported smooth deployment of SAVs, while Sweden faced practical challenges due to regulatory barriers and unclear responsibilities.*	Number of Active Public-Private Partnerships (PPPs) Funding Allocated Through PPPs The existence of clear legislation enabling PPP agreements	- National and regional databases on public-private partnerships (e.g., PPP Knowledge Lab, World Bank)

Table 9 Micro themes, factors, and potential indicators and data sources for the Societal Readiness Index for Shared Autonomy.

Factor	Potential Indicator(s)	Potential Data Sources
Does the socio-economic profile of the population seem conducive to introducing SAPT?		
Age/Gender *Sociodemographic factors such as age and gender influence individual preferences and acceptance of AV technology, and by extension, SAPT. In the studies I carried out, female focus group participants in Australia talked extensively about their concerns on public transport, which would influence their willingness to use SAPT.*	Age and gender distribution: Percentage of the population by age and gender	- National and regional statistics
Education *Educational background impacts an individual's understanding and acceptance of AV technology, affecting how they perceive the benefits and risks associated with AVs*	Education level: Percentage of population (national and regional) with college degrees	- National and regional statistics
Employment status *Employment-related mobility needs and the impact of AVs on commuting patterns are important factors in how AVs are perceived and used.*	Regional employment rate: Percentage of population who are employed Percentage of population who commute between home and work (corresponding)	- National and Regional Statistics
Household income *Household income impacts the financial resources individuals have available to put towards their mobility needs, influencing the constructs of willingness to pay and willingness to share.*	Median household income (regional)	- National and Regional Statistics

What are the populations' present travel preferences and behavior? PT? Sharing??		
Travel preferences and behavior *An individual's existing travel preferences and behaviors can influence their willingness to use shared AVs as part of their transportation choices.*	Percentage of population who use public transport for their everyday journeys Percentage of population who use shared mobility services for their everyday journeys Frequency of use of public transport, shared modes, and private modes	- National and regional statistics - Data from operators of ride-pooling, carpooling, and bike-sharing services
Car ownership *A high level of car ownership often indicates a preference for private transportation, potentially reducing openness to shared services; it can also indicate a user's subscription to the "social norms" around them.*	Number of cars owned per capita (in the region) Vehicle ownership rate: number of cars per 1000 residents	- National and Regional Statistics
Do the local social norms and attitudes support the safe introduction of SAPT?		
Social norms *People tend to conform to the behaviors and standards that are perceived as acceptable or typical within their community. In some countries and cultures, this factor can be very strong and shape individual behavior. Social acceptance and the perceived image of AVs can significantly affect their adoption and usage, with societal norms influencing individual and collective behavior towards AVs.*	Scores for dimensions such as *Individualism vs. Collectivism, Uncertainty Avoidance*, and *Long-Term Orientation* from Hofstede's Cultural Dimensions	- Hofstede's Cultural Dimensions, Technology Readiness Index - World Values Survey
Environmental attitudes *Can influence the acceptance and preferred use of shared mobility and SAVs if they are perceived as greener alternatives to traditional vehicles. (Persons who already take public transport should, in theory, take less convincing.)*	Percentage of the population prioritizing environmental concerns in transportation choices (e.g., preference for electric or shared vehicles, preference for public transport)	- National or regional travel behavior surveys (e.g., Eurobarometer) - Reports from organizations or transportation advocacy groups (e.g., Greenpeace, World Resources Institute)

Technological attitudes *Technological attitudes can be shaped by past experiences, knowledge, social influences, and the perceived benefits or risks of using (new) technology. Attitudes towards technology and innovation affect how individuals perceive and use AVs or on-demand mobility services, which impacts how quickly they are adopted and can be implemented into society.*	Percentage of the population who are positive to technological innovation. Percentage of population who believe technology makes a positive impact in their lives Percentage of population using social media Percentage of population with a smart cell phone and 5G subscription	- Regional survey data - World Values Survey - Gallup World Poll - GSMA Mobile Economy Report
Safety concerns *Individual users' perceptions of personal security and physical safety will be part of their decision-making when choosing to use SAPT.*	Number of traffic-related accidents, injuries, or security-related incidents reported per year (in the region) Number of assaults / incidents reported per year (in the region) Percentage of public that perceives public transport as safe	- Regional statistics - Eurobarometer - Transport authorities or national safety boards on accidents, crimes, or injuries in public transport
Trust *Individuals' trust in the technology, its providers, the regulatory environment, and the people in their community (with whom they would be sharing their journey or using the service) is essential for the successful implementation of SAPT.*	Percentage of the population expressing high or moderate levels of trust in the government or its institutions Percentage of the population expressing high levels of trust in neighbors or persons in their community Percentage of the population expressing high or moderate levels of trust in AV technology	- Public Opinion Surveys - European Social Survey

Sharing Anxiety *Sharing anxiety, or the discomfort with sharing space with strangers, could slow the adoption of AVs in public transport. If potential users feel uneasy about riding in shared autonomous vehicles, particularly in smaller, confined spaces, they may be reluctant to use the service, preferring private or personal transport options.*	Percentage of the population reluctant to share rides Frequency of reported incidents in shared mobility services	- Industry reports - Data from ridehailing or shared mobility companies - National survey data
Does the population have experience of technology ...? Is the population familiar with ...?		
Technological familiarity *Familiarity with and understanding of AV technology, on-demand ridehailing, or dynamic ridepooling can influence how comfortable and willing individuals are to use AVs in shared contexts.*	Percentage of the population with access to smartphones and mobile apps Adoption rates of ride-hailing and ride-pooling apps Frequency of use of on-demand mobility services	- Usage data from companies like Uber - industry reports from McKinsey or Deloitte - GSMA (Mobile Economy Report) - Data from municipalities or private firms conducting AV trials - National or regional travel behavior surveys
User experiences and expectations of AV technology *User experiences with and expectations of AV technology directly influence its acceptance and the effectiveness of its implementation into daily transportation systems.*	Number of AV pilots in country and/or region. Percentage of population who have used vehicles with automation level 1-4 Percentage of residents or citizens who have experienced AV pilots or demos	- Data post-pilot surveys or national travel surveys segmented by age, income, and education level
User experiences and expectations of ridehailing *Positive experiences in ridehailing can increase willingness to use SAPT, but negative experiences with ride quality or social discomfort could hinder acceptance.*	Number of ridehailing companies in country and/or region Geographic availability of ride-hailing services Percentage of population who use ridehailing	- National travel surveys - GIS data - Customer complaints data from ride-hailing platforms and transportation regulators

	Reported issues with ride quality (e.g., safety, cleanliness, or driver behavior) Demographics of ride-hailing users	

8. Summary and Discussion

The implementation of shared autonomous vehicles as part of public transport represents a transformative challenge requiring consideration of factors at macro, meso, and micro levels. This chapter answers the research questions and situates the findings within more recent literature.

8.1. The Research Questions and My Findings

At the beginning of this work, I stated my intention to answer three research questions, each focused on exploring factors that could potentially influence the implementation of SAPT at the micro, meso, and macro levels. Most factors identified in Studies B to H were first revealed in the literature review, i.e., Study A. These factors were derived from research primarily focused on either shared mobility, such as on-demand ridehailing or dynamic ridepooling, or AVs— but rarely both. However, since SAPT represents the co-evolution of shared mobility and autonomous technology, the affirmation of these factors in the literature review lends credence to the assumption that they are applicable within the SAPT context.

In addition to these previously identified factors, my research highlighted new factors, such as *role and mission confusion, authority vacuum, cultural context,* and *sharing anxiety*, which were not explicitly discussed in earlier studies. Given that Study A already reflects the majority of these revealed factors, I focus on comparing my findings to more recent work, particularly from 2023 onward, to contextualize my contributions within the evolving research on SAPT.

RQ 1: What are factors that potentially influence the implementation of shared autonomous vehicles as part of public transport at the macro level?

My investigations into the macro-level showed factors such as legislative frameworks, economic conditions, technology maturity, and central government facilitation as influential for SAV implementation as part of public transport. For instance, strong national policies and investments in infrastructure were found to directly influence regional actors' effectiveness in setting up AV pilots, by providing a cohesive, supportive environment that reduces ambiguity and role confusion among stakeholders (Studies E-H). The recently published *Global Guide to Autonomous Vehicles* by Dentons (2024) similarly emphasizes policy and regulation as foundational to AV implementation across various national contexts. The guide covers several countries (although not Sweden or Australia) and points out that countries with clear and proactive legislation experience fewer roadblocks in AV deployment. It notes that "a national framework would ensure consistency and limit the potential for legislative gaps," highlighting the need for cohesive national policies to support AV integration. The guide also confirms several other factors revealed in my studies and included in the multilevel analytical model, such as cybersecurity, and economic status, noting that GDP and economic stability directly impact a country's capacity to finance AV infrastructure and secure public engagement.

Macro factors such as cultural values impact the users at the micro-level, by establishing social norms that can influence their technological attitudes and transportation choices and the way users perceive benefits or risks.[19] In Sweden, cultural values on environmental protection and sustainability are strong motivators for macro-level policies and for micro-level decision-making. A recent study by Liew et al. (2023), conducted in Malaysia, similarly found that cultural values and social norms influence micro-level user attitudes and behaviors toward autonomous shuttle adoption. Furthermore, Liew et al. discuss how perceptions of benefits and sacrifices, such as safety concerns and the value of convenience, are influenced by the local cultural context— just like the factor identified by participants in Study H. This underscores the importance of addressing macro-level cultural dynamics to foster user trust and acceptance at the micro-level.

RQ2: What are factors that potentially influence the implementation of shared autonomous vehicles as part of public transport at the meso level?

The identified meso-level factors in my research, ranging from role and mission confusion to regional mobility networks, the labor market, and public-private frameworks, were overall fewer in number compared to those at the macro and especially the micro levels. While there is a clear awareness of the importance of regional actors or factors in autonomous public transport systems, there appears to be less research explicitly addressing meso-level factors of that system, compared to other levels. For example, considering the labor market's impact on the implementation of AVs and SAPT, a glance at recent literature shows there is still little work looking at the impact of driver shortages on the public transport market[20]. Yet interviews with public transit operators from Study E and Study F show that driver shortages are a growing concern, with significant implications for service reliability. According to Remy and Guseva Canu (2023) and their study on the working conditions of bus drivers, workforce shortages have led to service reductions and, in extreme cases, the complete cessation of operations in some areas.

This issue highlights the critical need for strategic interventions at both regional and organizational levels to ensure public transport systems remain operational and accessible. The public-private frameworks described by Australian stakeholders at

[19] See the Swedish word "flygskam", or "flight shame", as a local example.
[20] There is a growing body of literature on driver shortages in the logistics industry, just not public transport.

TfNSW in Study E illustrate what successful collaboration between public entities and private mobility providers can look like, empowered by central government facilitation. Yet the lack of public-private frameworks can exacerbate role and mission confusion, as discussed in Study F, and represents a significant barrier when responsibilities among regional stakeholders are unclear or poorly aligned. An evaluation of AV pilots in Europe (Nemoto, 2023) provides a thorough view of the roles, goals, and interactions of key actors involved in the introduction of automated minibuses into mobility systems, comparing meso-level stakeholders motivations and goals with other actors. Nemoto's (ibid.) analysis of stakeholder dynamics in the deployment of automated minibuses highlights an environment that has the potential for role confusion at the meso level, a finding that aligns with my research. For instance, in that work, public transport operators have a desired to employ autonomous minibuses as part of their innovation and competition strategy, prioritizing operational efficiency, whereas city governments are motivated by societal goals, such as reducing congestion and improving sustainability. This speaks to a potential misalignment in priorities, confirming my findings that reducing role confusion is essential for fostering effective collaboration and governance at the meso level.

As Carrese et al. (2023) emphasize in their systematic review of SAV integration into public transportation, the meso level is where infrastructure planning, policy alignment, and stakeholder collaboration converge, reinforcing my findings which lighted the importance of meso-level governance as the point where macro-level policy meets micro-level user needs. Therefore while the multilevel analytical model may have revealed fewer factors at the meso level, its importance is nonetheless supported by evidence and practice. It is the level where regional actors must navigate a complex interplay of national directives, local needs, and public expectations; it is the level where policy meets practice.

RQ 3: What are factors that potentially influence the implementation of shared autonomous vehicles as part of public transport at the micro level?

At the micro level, factors ranging from age and gender, perceived benefits of SAPT, and sharing anxiety play an important role in shaping individual user acceptance of SAVs. Bala et al. (2023) conducted a systematic review of studies on public acceptability and acceptance of shared autonomous mobility services, including ridepooling and autonomous public transit. Their analysis identified key psychological barriers such as reluctance to share rides with strangers due to safety and privacy concerns (which I term *sharing anxiety* in my research). Notably, they emphasized that the absence of a driver exacerbates these concerns (confirming *authority vacuum*) and creates a significant barrier to adoption. However, in their review, Bala et al. (2023) found that *experience with ridehailing* or similar shared mobility services can reduce apprehension. In my studies, experience with ridehailing did not seem to have a positive or negative effect— but previous experience with *public transport* did have a positive effect on willingness to share AVs with unknown persons. The difference in our findings may be due to the types of shared mobility services experienced by surveyed participants; Bala et al.'s work reviewed studies in several countries, whereas mine only covered Australia and Sweden, the latter which has a very different ridehailing and shared mobility landscape than Australia.

One of my studies, Study D, tried to create profiles of respondents and determine which qualities contributed to willingness to share AVs with unknown persons. Julsrud, Kallbekken, and Aasen (2023) performed a similar study using surveys and interviews with residents in Oslo, Norway, to investigate mobility practices and social acceptance shape SAV adoption. Like my work, their study shows individuals with shared mobility habits and environmentally conscious lifestyles are more likely to embrace SAV services. This underscores the necessity of fostering internal motivation through targeted measures rather than relying solely on imposed changes.

The work of Cai et al. (2023) also affirmed the importance of *trust* and *perceived benefits* in fostering public acceptance of SAPT, aligning closely with the my findings. Their study highlights that the economic, environmental, and safety benefits of autonomous buses and the buses' ease of use— items I grouped under *perceived benefits* —significantly influence public trust. In another study focusing on user acceptance of autonomous public transport, Yuen et al. (2023) employed survey data and theoretical frameworks such as the Unified Theory of Acceptance and Use of Technology (UTAUT). Their findings highlight the pivotal role of trust and perceived benefits, such as economic, environmental, and safety advantages, in shaping public acceptance. Their findings aligned with mine, highlighting the important role that trust and perceived benefits play into willingness to use SAPT. However, they— like many researchers before —still focus on technological acceptance and translate that into recommendations for meso-level stakeholders to improve service quality and design.

While I was able to affirm numerous factors at the micro level, both through the literature review and subsequent studies, three factors stood out: authority vacuum, cultural context, and sharing anxiety, as well as the factors that impact them, such as trust, perceived risk, and personality traits. These factors (and their relationships with other factors) indicate there are complexities determining the individual concerns around safety and privacy that form barriers to broad acceptance of shared, autonomous public transport at the user level.

8.2. Examining Interdependencies in a SAPT System

Most of the prior literature, derived from work that focused on either shared mobility or autonomous vehicles, tends to address either the macro, meso, or micro level in isolation. Few studies consider the full spectrum of factors across all three levels or explore the interdependencies between these factors. This highlights a gap in the literature and suggests a potential fourth research question: What are the interdependencies across the macro, meso, and micro levels that influence the implementation of SAPT?

Examining interdependencies across macro, meso, and micro levels showed connections that could influence the implementation of SAPT. First, central government facilitation at the macro level emerged as essential for reducing role confusion among regional actors at the meso level, enabling them to implement national policies effectively. Both Dentons (2024) and Riggs and Cornet (2024) also stressed the importance of cohesive national frameworks for AV adoption. Like Dentons (2024), Riggs and Cornet emphasize that such frameworks provide regional actors with the clarity needed to align local efforts with national goals.

Economic conditions at the macro level are argued to further influence SAV implementation by directly impacting regional investment in infrastructure, such as dedicated lanes and digital systems that support autonomous transit. Carrese et al. (2023) emphasized infrastructure as a priority in SAVs for public transport, highlighting that dedicated infrastructure requires substantial investment, which wealthier nations are better positioned to provide; similarly, Dentons (2024) discussed the economic stability required to finance AV infrastructure, suggesting that a robust national economy supports the infrastructure readiness essential at the meso level. Both studies reinforce my finding that economic status at the national level provides the resources necessary for sustainable infrastructure investments at the meso level.

The findings of Arowolo et al. (2024), based on a study conducted in Norway, examined Norwegian cultural values and on how macro-level influences like high individualism affected users at the micro level for adopting AVs. Having established that link, Arowolo et al. (ibid.) focused on governance strategies that meso-level stakeholders implement to address these issues, proposing "governing by doing" (pilot programs like deploying AVs with government employees to build trust) and "governing by enabling" (which emphasizes public-private partnerships to foster societal acceptance), preferably systematically combined. Their work affirms the importance of macro factors like cultural values and meso factors like public-private partnerships on factors that affect users, like trust or safety.

Another key interdependency revealed in my research was between technology maturity at the macro level and user trust at the micro level. As I have argued, Riggs and Cornet (2023) argue that technological innovation and societal acceptance are intertwined. In their work looking at automation readiness for autonomous transport in cities, they also emphasize public engagement and transparency, noting that educating users and building trust through mature, reliable technology are essential to fostering acceptance; however, not only does that mean the technology must be ready, but macro- and meso-level actors must be prepared to educate the future user base through, for example promotional campaigns, setting public expectations, and public demonstrations (ibid.). This interdependency illustrates that a strong technological foundation at the macro level significantly impacts meso and micro-level public perception and confidence.

One of the most important findings, sharing anxiety at the micro level, is not only directly affected by other factors at the micro level, but is likely affected by macro-level cultural values and national policies. Riggs and Cornet (2023) showed that meso-level actors understand that to offer SAPT, they need to prioritize gaining public support, offer public engagement, and launch pilots. This supports the idea that addressing sharing anxiety requires both broad policy alignment and targeted public engagement efforts, demonstrating that a macro-level action and meso actors impact the micro level. In fact, in Riggs and Cornet's study (and the EU project from whence it came[21]), they conceptually address the same foundational issues that are central to my thesis. Both studies examine the sociotechnical dimensions of AV readiness, emphasizing the need for collaborative governance – or as this thesis terms them, legislative frameworks, central government facilitation, and public-private partnerships – and the trust of the individuals that make up the public sphere. Their work, however, looks exclusively at city-level readiness, whereas my thesis looks at factors that can be more broadly applied. However, that their work aligns closely with mine reinforces the necessity of addressing these identified interdependencies across the three levels.

8.3. The Contribution of This Work

In Chapter 1, I made three assumptions: one, that SAVs represent the most effective and socially beneficial use of AV technology; two, SAVs are best suited or enabled through a public transport context, and could be on-demand when such features are desired; and third, that the implementation of SAPT requires a systemic understanding of technological, social, and institutional factors. Assumptions one and two can and should be questioned, given that AVs are still a nascent technology,

[21] The SHOW Project (Shared automation operating models for worldwide adoption), a Horizon 2020 project.

with little evidence of their sustainable benefits being realized, and full implementation may be resource intensive. My work does not intend to confirm or falsify these assumptions. However, my findings offer strong support for assumption three: SAPT implementation requires systemic, holistic understanding of both social and technological factors.

8.3.1. The Multilevel Analytical Model

The multilevel analytical model illustrates the complexity of implementing SAPT, providing a structured approach to analyzing factors across the macro, meso, and micro levels and highlighting how these factors interact to shape societal readiness. The model underscores that implementing SAPT is not merely a matter of deploying AVs **or** establishing shared service solutions; it requires addressing the unique challenges associated with **both** and emphasizes, both ideologically and with its findings, that behavior change is complex. Societal change— behavior change on a group level –is even more complex, and affecting it requires equal attention as is given to investigating technological acceptance in individual users.

Not only does the implementation of SAPT come with challenges such as technology maturity or infrastructure readiness, but shared service solutions also introduce complexities such as sharing anxiety (exacerbated by the potential for discrimination or conflict within the vehicle) and ensuring equitable access for all users. Looking at AVs as not just a technological development, but one that allows for shared journeys and makes an even more powerful public transport system has been the goal of the multilevel analytical model and this thesis; to display the complexity of the sociotechnical system as a whole, and to highlight, even create a call to action, for stakeholders in the transport system to address the factors of authority vacuum and sharing anxiety so that shared, autonomous public transport – if so desired – can be feasible. The multilevel analytical model captures these interdependencies and offers a tool for stakeholders to understand the dynamic interplay of factors influencing SAPT implementation.

Nemoto (2023) analyses the deployment of automated minibuses in European cities and examines factors influencing the implementation of automated minibuses, categorizing them specifically into barriers and enablers to highlight their impacts on this process. Nemoto's work provides a detailed exploration of factors influencing the implementation of automated minibuses through the lens of sociotechnical transitions. Her research highlights the role of stakeholders, their interactions, and perceptions, offering a stakeholder map that illustrates the diverse goals and priorities of actors such as public transport operators, manufacturers, software developers, policymakers, and citizens. Her study situates autonomous minibuses as a niche innovation with the potential to disrupt existing mobility paradigms and provoke a transition toward sustainable, shared, and intermodal public transport systems.

In contrast, my work offers a broader framework through the Multilevel Analytical Model. Unlike Nemoto's niche-centered approach, my model emphasizes the systemic interactions between technological, institutional, and cultural dimensions, such as the impact of sharing anxiety, authority vacuum, and behavioral change on the feasibility and acceptance of SAPT. Nemoto's contribution is particularly valuable in providing actionable insights into stakeholder dynamics and the immediate challenges of integrating automated minibuses into specific contexts. Her use of the multilevel perspective aligns with my work in acknowledging the complexity of transitions but differs in scope. While Nemoto evaluates how automated minibuses fits within existing sustainability goals and emerging niches, my work uses SRISA to assess societal readiness and identify critical pathways for scaling SAPT as part of a larger system transformation.

Both works complement each other: Nemoto's study offers practical mechanisms and a roadmap for transitioning automated minibuses (AM) from niche to regime by focusing on specific implementation barriers, enablers, and stakeholder dynamics.

8.3.2. The *Societal Readiness Index for Shared Autonomy.*

Both the model and SRISA reflect the complexity of implementing shared, autonomous public transport. The *Societal Readiness Index for Shared Autonomy* is intended to offer a multidimensional tool for assessing the readiness of cities or regions to implement SAPT. It is meant to evaluate readiness across macro, meso, and micro levels by analyzing factors such as technological maturity, public transport policy, cultural attitudes, central government facilitation, experiences and expectations of ridehailing, and trust. SRISA provides a structured approach to identifying strengths, weaknesses, and gaps in societal readiness, offering a clearer picture of the societal challenges that must be addressed. Beyond assessment, the index, once fully developed, tested and validated, aims to guide stakeholders by identifying actionable priorities and informing targeted interventions. By highlighting interdependencies between factors and demonstrating areas in which a region has strengths or weaknesses, it could support decision-making and helps stakeholders create strategies to address the specific challenges of their evaluated region or context.

As a tool or concept, SRISA is not entirely unique. Nemoto's work also created an index, but it differs slightly from the SRISA. Both the SRISA and Nemoto's index aim to provide structured tools for evaluating the impacts of autonomous mobility solutions, but they do so with different scopes: Nemoto's index focuses on providing a detailed assessment of how well automated minibuses are contributing to regional sustainability, while SRISA evaluates the societal readiness of cities or regions for the broader implementation of SAPT, addressing both systemic and cultural factors.

Another index, the Global E-Mobility Readiness Index (GEMRIX) emphasizes macro-level dimensions such as government policies, market readiness, and infrastructure investments, particularly in the context of electrification. While GEMRIX captures the economic and infrastructural conditions required for e-mobility, however, it does *not* delve into the societal and organizational aspects crucial for e-mobility implementation. Similarly, the KPMG Autonomous Vehicle Readiness Index (AVRI)– from which the SRISA drew heavy inspiration –evaluates countries' readiness for autonomous vehicles through metrics focused on infrastructure, policy, and technology. While AVRI provides a strong foundation for macro-level comparisons, it does not fully explore the social dynamics of user adoption or the interplay between different actors in the ecosystem and only later editions even acknowledged the human dimension at all. SRISA aims to address this type of gap by using the cultural and social dimensions that proved necessary in the Multilevel Analytical Model– such as public trust, sharing anxiety, and public-private frameworks, alongside technical maturity and economic status.

SRISA was conceptualized to balance and integrate the critical dimensions of economics, infrastructure, policy, and social readiness. It could, when fully developed, be a valuable tool for guiding SAV implementation for SAPT.

8.4. Reflections on the Methodology

Originally, like much of the previous work examining AVs and dynamic ridepooling (my proxies for SAPT), I began with a focus on understanding factors of user behavior, the micro level, only. The relevance and importance of the multilevel approach only became apparent to me after conducting the first field studies. This led to an overfocus of exploring factors at the micro level, an area which is already the subject of much focus in the field.[22] Had I the foresight to work with the multilevel approach and model from the beginning, I might have been able to collect more data as input, in particular for the meso level, either in the form of additional interviews or an expanded focus of questions within the repeated survey.

As for the macro level, I ran into significant difficulty getting interviews from national or macro-level actors such as policymakers or senior government officials responsible for AV or public transport policies. While the willingness was strong with me, the way forward to acquiring this data was unclear. The macro level is difficult to explore with firsthand sources unless one has a strong network and the

[22] I hope I have convinced the reader by now that at least, within that field, *sharing* is still understudied.

connections to secure interviews and responses from persons working at macro level institutions. Failing to capture data firsthand, what was left was what information macro actors publicly announce or produce regarding AVs or public transport. In this, I felt Study G was able to accurately capture the perspectives of the different macro and meso stakeholders. But it is a fair critique to say my thesis lacks a balanced weight of data collection across the three levels.

Nevertheless, employing triangulation to examine factors across macro, meso, and micro levels through different research methods proved to be an effective strategy for developing the multilevel analytical model. By collecting data through different methods (e.g., surveys, interviews, focus groups) or from multiple sources (e.g., users, policymakers, regional actors), triangulation allows for cross-verification. When findings are consistent across different approaches, this supports the accuracy and reliability of the conclusions; put simply, if different data sources or methods yield the same results, it suggests that the findings are not merely artefacts of a particular method or sample. This approach also facilitated a more nuanced understanding of stakeholder perspectives at various levels, from policymakers to users, allowing me to capture anecdotal perspectives and provided greater validity to factors identified consistently across methods.

8.4.1. Contradictions in Data

However, triangulation also presented specific challenges, particularly when handling contradictions between studies. For instance, focus group participants (in Studies B and C) said their previous experience with ridehailing or shared mobility contributed to their interest in shared autonomous public transport, yet survey data (Study D) showed that having previous experience had no statistical bearing on willingness to share AVs with unknown persons. Addressing these contradictions required careful interpretation and contextualization (perhaps it was due to their country of origin, as Australia has had experiences with ridehailing for several years longer than Sweden; perhaps in focus groups, people are more willing to agree with the questions asked by the discussion leader and are more “honest” in an anonymous survey).

Differences between data sources occasionally led to inconsistencies in findings. For example, in Studies B and C, focus groups highlighted concerns around the absence of a driver in SAVs, referred to as an "authority vacuum". Swedish participants valued a clear sense of control within vehicles and expressed skepticism about scenarios without a driver. This discomfort was partly attributed to the lack of a strong ridepooling culture or experiences in Sweden, where public transport systems are heavily used and seen as safe with perceived and accessible authority figures. In contrast, Australian participants also experienced discomfort with the absence of a driver, but their concerns were shaped more by sharing anxiety, a low level of trust in public transport operators and the local government, and distrust of non-local operators like Uber. While the authority vacuum was a shared theme in both groups, the root causes and feelings offered by participants differed, reflecting Sweden's emphasis on trust in structured systems versus Australia's heightened sensitivity to safety and privacy. Despite these challenges, I believe triangulation ultimately strengthened the work by highlighting areas where additional research or targeted interventions may be necessary.

8.4.2. Internal Validity

Overall, there is a question of the validity of my findings, since much of my data collection was derived from related mobility services, such as on-demand ridehailing, rather than directly from SAPT systems; some data came from on-demand public transport pilots, some data came from AV pilots that used autonomous technology but operated in very small-scale or limited forms. This limitation was influenced by the small number of AV pilots available to study during the timeframe of my research, particularly in 2021 at the height of the pandemic. In addition, much of the literature I examined then focused on on-demand ridehailing, dynamic ridepooling and autonomous technology separately, as cohesive deployments of these elements were scarce. However in 2024, there are now more AV pilots running (and more literature forthcoming), and the service design in these pilots are closer towards real-world deployments of autonomous, public transport. Using a truer SAPT pilot or service for study, such as the recent expansion of *Ride The Future* into an on-demand, autonomous transit shuttle (RideTheFuture, 2024), would enable researchers and stakeholders to better understand the influence of the identified potential factors on users' willingness to share AVs with strangers. Additionally, it would enable deeper exploration of which factors enable meso-level stakeholders to implement SAPT services effectively.

Some factors, such as technological maturity, trust, public transport and AV policy, and affordability, are well-supported by empirical evidence, validated through multiple studies and literature reviews, and contextualized within the SAPT framework. At the same time, the identification of relatively unknown or underexplored factors, such as authority vacuum and sharing anxiety, highlight the societal challenges that may hinder SAPT implementation. However, some limitations remain, including reliance on foundational assumptions and limited diversity in case studies. Expanding the scope of research to include more diverse case studies from other countries or regions, as well as testing the assumed and inferred relationships between factors, could significantly strengthen the internal validity of my findings and further refine the multilevel analytical model.

8.4.3. External Validity and Transferability

While external validity focuses on the generalizability of the research findings to other contexts or populations, transferability examines the adaptability of those findings, frameworks, and concepts to other specific cases or regions. This work has identified factors and presented support for their role in affecting the implementation of SAPT. Could the identified factors of the multilevel analytical model and SRISA be used as a basis for understanding factors that influence the implementation of SAPT in *other* countries and contexts, besides where the studies took place?

Considering that the scope of this thesis took place in two developed nations—Australia and Sweden —that fall comfortably within most definitions of "the West," there are valid questions about the transferability of the findings to other regions, particularly to countries with differing socioeconomic, cultural, and infrastructural contexts, such as those in Africa or Asia. It is evident that Australia and Sweden benefit from high levels of infrastructure and technological maturity. These factors were identified as key for SAPT implementation, which is why they appear in the multilevel analytical model and the SRISA. Many developing countries with low GDP have not been able to invest resources into digital and transport infrastructure to the same degree as their counterparts with higher GDP, which would hinder their own implementation of SAVs for either private or public use. Reliable internet, cellular networks, and basic transport systems are essential for the real-time data processing and connectivity needs of AVs but are often sparse in rural, remote, or developing regions due to their cost (Fagnant and Kockelman, 2015). The cost of implementing AVs may be prohibitive relative to other pressing needs, especially if these vehicles are perceived as a more expensive alternative to current public transport systems. Cervero and Golub (2007) suggest that transport innovations should address economic disparities by prioritizing affordable and accessible solutions that meet the daily needs of low-income populations, but in some countries, it may not be advisable to prioritize transport infrastructure over other concerns, such as healthcare or climate change resilience. Thus, while SAPT might well be a desirable public good, countries in the Global South may need to prioritize other aspects of their development before considering their readiness for more advanced self-driving technologies.

However, cultural values, cultural context and social norms clearly play an influential role in shaping perceptions of shared mobility. Studies that examined "herd behavior" (another phrase for "social norms") were relatively few at the time this PhD began, but more recent studies have included questions such as "Someone in my social media circle of friends shared information about AVs," as researchers attempt to develop models accounting for both environmental determinants (e.g., social media) and human determinants (e.g., the influence of social norms) (Zhu et al., 2020). It is worth noting that many of these studies on herd behavior and social norms originate in Asia, which could provide insight into the discrepancies observed in different cultural contexts. According to Hofstede's “individualism vs. collectivism dimension” (Hofstede, 2007), Asian countries tend to score higher in collectivism, meaning individuals are more likely to consider the behavior of others within their social group when making decisions, such as whether to adopt a new technology like AVs. Many parts of the Global South are characterized by collectivist cultures, where community-oriented solutions are highly valued. This communal mindset might enhance social acceptance of SAVs, particularly if they are introduced as community-serving, accessible options. However, concerns around sharing anxiety and safety in shared, driverless spaces may still require tailored approaches. Community engagement, gradual rollout strategies, and transparent communication on safety measures could be effective in addressing these apprehensions.

In contrast, both Sweden and Australia rank higher in individualism, where individuals may be more inclined to make decisions independently of their social circles (Hofstede, 2007). This suggests that cultural differences, specifically related to individualism, might explain the weaker role of social norms in these contexts compared to collectivist cultures. It could be the case that there exist more countries and areas in the Global South with the necessary cultural values and high trust in local community- factors that create a strong willingness to share AVs with strangers. The proof of this can be found in the community-driven forms of transport that were organized before digital information technologies, such as jeepneys, where sharing anxiety would seem to be non-existent (Phun and Yai, 2016). This suggests that these countries or communities in the Global South would have a strong advantage in implementing sharing autonomous public transport, but for the fact that these areas lack the economic resources and infrastructure to deploy and implement them. Where Sweden and Australia are infrastructure and resource rich, the users are hesitant to share; in Asia, users are willing to share, but their communities lack infrastructure or resources.

8.5. Applying the Findings

The Multilevel Analytical Model, though complex and perhaps not complete, future research may add or modify the factors as well as their interdependencies, it can still serve as a valuable benchmark for transportation providers and city planners or regional stakeholders to use when discussing future mobility services, particularly projects that include SAPT. It is not impossible that stakeholders would consider the implementation of SAPT as primarily a technology maturity issue or a matter of the public’s acceptance of AV technology. However, merely the image of the MLAM might be enough to make evident to project developers and policymakers the complexity and the social dimensions for which they need to be aware when introducing this type of technology into the public transport system. Some of the factors included in the model that were removed or not included in the SRISA, such as *ethnicity*, would still be valuable in MLAM. For example, having the *ethnicity* factor in MLAM is important when having workshops with urban planners and policymakers who are looking to address societal problems such as discrimination in public transport, though on different scales.[23]

Were the Societal Readiness Index for Shared Autonomy fully constructed, tested and validated, it could be applied to as a tool for regional stakeholders, who consider SAVs to be part of the solution and therefore aim to make SAPT a reality; the index could assess the region's readiness for implementing SAVs, using SRISA scores to identify strengths and highlight gaps that need attention, such as public trust or regulatory support. This focused approach would help planners concentrate their efforts on, e.g. policy improvements, help transit agencies and mobility operators understand which regions are most suitable for the deployment of autonomous mobility services.

The private sector, including car manufacturers, tech companies, and mobility services, could use SRISA to inform their business strategies. Companies could look at regions' readiness based on factors like infrastructure, regulations, and public attitudes, helping them decide where SAPT would be easiest to implement, guiding investment and development. The index could also show where societal readiness gaps exist, like low public trust, so companies could design pilot programs or campaigns to build confidence in their safety while regional governments could design programs or introduce new efforts that would address perceptions of public safety.

Some of the indicators in SRISA may prove difficult or time-consuming to obtain data for, particularly for groups from smaller municipalities with limited resources. Many of the factors, and consequently the proposed indicators, focus on the micro or user level and would require data collection through surveys or interviews targeting potential users. Despite the challenges of gathering such data, the influence of these factors is significant enough to justify prioritizing their inclusion in future assessments for regional and national stakeholders. I recommend that users of the index advocate for regional or national governments, institutions, and agencies to incorporate these data needs into their broader data collection efforts. Specifically,

[23] And one of my motivators for choosing to transportation as my field of study is that I truly believe public transport is one of the last bastions of public space, where society and diversity interact and coexist.

I strongly encourage national policymakers to include relevant questions in existing national surveys and polls conducted by other entities, such as Eurobarometer or the Swedish National Data Service. This integration would ensure consistent, high-quality data, while reducing the burden on smaller organizations or actors for acquiring the information.

In Studies A, B, and C, I investigated SAPT as an on-demand service with dynamic ridepooling as a proxy for participants. Participants in Studies B and C discussed the service design of SAPT, including the type and size of the AVs in the context of shared, on-demand mobility. In my other studies, I only highlighted the driverless nature of public transport, emphasizing the automation over service design. However, consistent across all studies were concerns about trust, safety, sharing anxiety, and perceived benefits, which emerged as critical factors influencing user acceptance of SAPT. Careful service design will need to consider the factors outlined in the multilevel analytical model and the SRISA to determine what SAPT ultimately looks like for a variety of future users. Nevertheless, what an actual shared, autonomous transport service will look like is based entirely on the region in which it will be deployed, the stakeholders introducing it, and the individuals who will be the prospective users.

9. Reflections

This chapter concludes the thesis by reflecting on the knowledge contribution in relation to overall aims, speculates on its implications for practice and suggests future avenues for further research and investigation.

9.1. Initial Reflections

At the beginning of this thesis I stated several core assumptions about SAVs being the most effective and socially beneficially use of AV technology, and therefore implementing SAPT is the most appropriate deployment of SAVs. The findings of this thesis reveal that the implementation of SAPT is influenced by numerous factors across macro, meso, and micro levels. At the macro level, factors such as economic status, infrastructure, central government facilitation and cultural values shape the overall feasibility and direction of SAPT in a country. At the meso level, digital infrastructure, public-private frameworks, role and mission confusion, and geographic location impact with what resources and how regional stakeholders can adapt policies to local contexts. At the micro level, individual acceptance of SAPT depends on user expectations, experiences, and trust, which is heavily influenced by cultural context and sharing anxiety. The cross-level interdependencies illustrate the complexity of implementing SAPT and demonstrate the necessity of addressing issues at all levels for a holistic approach. A technological focus alone will not suffice; instead, a socio-technical perspective that integrates societal readiness with technical maturity should become the standard.

9.2. Future development of this work

Building on these findings, this research has introduced two primary contributions: the multilevel analytical model, and the *Societal Readiness Index for Shared Autonomy*. While these tools provide a foundational framework for understanding and assessing societal readiness for SAPT, further work is needed.

9.2.1. Verification of Factors

The factors proposed in this thesis come with evidence to support their inclusion in the multilevel analytical model, but further verification could and should be done with policymakers, transit operators, technology developers to apply the model in pilot projects and evaluate whether the factors and the multilevel analytical model resonates with their experiences and priorities.

Another dimension to continue exploring factors is to examine rural areas or underserved communities. While the first AV pilots focused on urban deployments, in recent years more literature has emerged making the argument that AVs have greater potential in low-density, car-dependent regions that traditionally lack any form of public transport. This not only provides an opportunity for public transport to expand accessibility but understanding the factors and if they apply in these contexts would also address questions of equity and inclusivity.

Future research could benefit from more cross-country studies to validate the findings across a range of cultural and economic settings. Developing countries often face unique infrastructure and economic challenges, as well as distinct cultural dynamics, that could influence SAV acceptance and SAPT implementation in ways not observed in countries with highly developed infrastructure. However, to counter the assumption that developing countries are always “behind” developed ones, technological advances like mobile telephones allowed developing nations to leapfrog the step of infrastructure development for wired telecommunications (Gunasekaran and Harmantzis, 2007). It is possible that future investigations of the multilevel analytical model would identify opportunities for developing countries to do something similar with implementing SAPT ahead of traditional transportation infrastructure. Similarly, the influence of cultural factors such as individualism versus collectivism warrants further exploration, especially in regions where social norms may play a more significant role in transportation behaviors. Examining the cultural differences as defined by Hofstede (2007) in depth would allow researchers to better understand and address the nuances of SAV acceptance globally.

While this research has mapped the interdependencies between factors, future work could delve deeper into how these relationships evolve over time. For example, in societies with low cultural acceptance of shared mobility, sharing anxiety might be a major barrier. As cultural attitudes shift due to generational change or increased market penetration of ridehailing, sharing anxiety may diminish, opening new opportunities for SAPT implementation.[24]

9.2.2. Further development of SRISA

The SRISA index, although still a draft, provides a structured method for evaluating societal readiness. Its further development should focus on several key areas to enhance its usefulness and applicability.

A necessary next step is to have a process for weighting factors based on their relative importance in different contexts, such as urban versus rural areas or developed versus developing regions. Creating weighting for each indicator is a process that could involve expert panels, stakeholder surveys, or statistical methods

[24] The longitudinal effect was originally part of this work’s scope, but the COVID-19 pandemic had other plans.

to quantify how much each indicator influences societal readiness. Once weights have been assigned, the next step would be to test the index across a variety of geographic, cultural, and economic settings. For example, regions with limited digital infrastructure might require adjusted weights to reflect their unique context; testing in diverse areas would help identify where modifications are needed to make the index more universally applicable.

Another future step is to review completed and successful pilots from around the world; it is by studying these cases that specific prescriptive actions could be tied to corresponding SRISA scores, offering clear guidance to cities or regions seeking to implement SAPT. Linking the index to actionable policy recommendations is essential, allowing cities and regions to identify investments or interventions based on their readiness profiles. Finally, to make SRISA accessible and practical, it could be translated into a user-friendly digital tool, such as a dashboard or application. Policymakers, transit authorities, and other stakeholders could input data and receive tailored readiness assessments and recommendations. This digital platform would make SRISA easier to use in real-world planning, helping stakeholders address the most critical challenges for SAPT implementation.

9.2.3. Avenues for Future Research

Another valuable area for future research is to focus more specifically on meso-level actors' roles, responsibilities, and decision-making processes in implementing SAPT. Study H raised questions about the personal biases of meso-level actors, who sometimes struggled to separate their personal views from their professional responsibilities, and it is likely the same would occur with macro-level actors when interviewed. This phenomenon suggests that macro and meso-level decision-makers— who, in their roles, interact with the world as individuals –may experience internal conflicts that affect the way they approach the implementation of SAPT. Further research could investigate the internal decision-making processes of these actors to determine how personal attitudes impact organizational strategies and priority-setting, with the intention of revealing opportunities to mitigate these biases.

In these ways, future research can expand on the contributions of this thesis and support the development of more nuanced, culturally adaptable frameworks for SAPT implementation, ultimately contributing to a broader understanding of societal readiness for shared autonomous vehicles.

9.2.4. A Call for Bravery

The COVID-19 pandemic halted much of the mobility innovation, particularly around shared mobility, all around the world; Sweden and Australia were no exception. However, now that the pandemic has subsided and some normality has returned, trials and pilots involving autonomous technology have begun to emerge again; a few, like Waymo in California, never truly stopped (Lunden, 2020). Currently the United States and China lead in robotaxi commercialization, while China and Europe are advancing in roboshuttles[25]— one the first operational formats of AVs —and European partnerships with the manufacturers like Karsan and MAN represent the most ambitious full-scale autonomous bus trials and operations to date (Greifenstein et al., 2024). In Greifenstein et al. (2024)'s global benchmark study of the state of AV pilots, they estimate "robobuses", or autonomous full-scale buses, have greater barriers to entry at the market due to "technological and regulatory challenges"; however, I believe that it is also due to the pressure of commercial actors and the lack of commitment from the majority of macro-level actors to push for AVs in public transport. The case of Norway is the example that proves my point.

In Norway, AVs are being introduced as part of SAPT systems. Oslo has adopted some of the world's most aggressive sustainability measures (Nieuwenhuijsen and Khreis, 2016), including policies to phase out fossil-fueled cars (Miljødirektoratet, 2024). A key initiative is the ULTIMO project, described by Arowolo et al. (2024), which builds upon the earlier AVENUE framework to integrate AVs into Mobility-as-a-Service (MaaS) as a public utility. ULTIMO exemplifies one of Europe's most ambitious efforts to deploy autonomous technology at scale, particularly through its focus on user-centric design and public service objectives, with the plan to deploy 15 AVs in Groruddalen Valley, Oslo.

Central to ULTIMO's approach is the role of Oslo's public transport authority, Ruter. Ruter balances systemic policies with initiatives to foster meaningful user engagement and acceptance. This includes integrating SAVs into everyday routines and lifestyles in order to establish them as a sustainable mobility practice. ULTIMO highlights the importance of aligning technical innovation with societal goals to foster acceptance and maximize impact. The project's outcomes are yet to be fully realized, but Norway's example demonstrates the critical importance of trials and pilots in advancing SAPT systems. These initiatives provide a testing ground not only for technical feasibility but also for understanding sociotechnical challenges. Regular and thorough investigations are essential to address both meso- and micro-level concerns. At the meso level, this means assessing regional readiness and stakeholder collaboration. It requires examining how public and private actors can

[25] I affectionately call these vehicles (due to their shape) as "toasters". See Figure 10, Chapter 5.

coordinate efforts to support SAV deployment for public transport use, in the same way that TfNSW had created a strong, centralized government actor and strategy (Study E), and as seen in ULTIMO's collaborative governance model (Arowolo et al., 2024).

At the micro level, pilots must go beyond measuring user trust and technology acceptance. They need to tackle issues deeper psychological issues like sharing anxiety— the discomfort of sharing rides with strangers —and the authority vacuum, which refers to unclear roles and responsibilities in managing AV systems. The solution to these problems may be found in creative engineering of their interiors, or new models for remote customer service; what the eventual answer will be is yet unclear. However, addressing these social factors is how stakeholders can foster public confidence and ensure smooth implementation.

With future studies into the complexity of the shared, autonomous public transport system, and bolder interventions in the real world, together we might get somewhere.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, 50(2), 179-211.

Alemi, F., Circella, G., Mokhtarian, P., & Handy, S. (2019). What drives the use of ridehailing in California? Ordered probit models of the usage frequency of Uber and Lyft. *Transportation Research Part C: Emerging Technologies*, 102, 233-248.

Allu, S., Jaiswal, A., Lin, M., Malik, A., Ozay, L., Prashanth, T., & Duerstock, B. S. (2017). *Access to personal transportation for people with disabilities with autonomous vehicles* (Undergraduate coursework, Paper 1). Purdue University.

Amirkiaee, S. Y., & Evangelopoulos, N. (2018). Why do people rideshare? An experimental study. *Transportation Research Part F: Traffic Psychology and Behaviour, 58, 1055–1066..* https://doi.org/10.1016/j.trf.2018.02.025

Anderson, J. M., Nidhi, K., Stanley, K. D., Sorensen, P., Samaras, C., & Oluwatola, O. A. (2014). Autonomous vehicle technology: A guide for policymakers. Rand Corporation.

Arowolo, W., Beye, C., Zigah, E., El Hajj Sleiman, D., & van den Boom, N. (2024). *Multivariate evaluation of ULTIMO connected, cooperative and automated mobility (CCAM) ecosystem*. European Commission Report. https://hal.science/hal-04518624v1

Arowolo, W., Larsson, M., & Nicolaï, I. (2024). Governance of automated vehicles in the urban transport system: Insight from a willingness-to-use survey and Norwegian cultural context. *Transportation Research Interdisciplinary Perspectives, 24,* Article 101040. https://doi.org/10.1016/j.trip.2024.101040

Audouin, M. U. J. (2019). Towards Mobility-as-a-Service: a cross-case analysis of public authorities' roles in the development of ICT-supported integrated mobility schemes (No. 9098). EPFL.

Bachmann, F., Hanimann, A., Artho, J., & Jonas, K. (2018). What drives people to carpool? Explaining carpooling intention from the perspectives of carpooling passengers and drivers. *Transportation Research Part F: Traffic Psychology and Behaviour*, 59, 260-268.

Bagloee, S. A., Tavana, M., Asadi, M., & Oliver, T. (2016). Autonomous vehicles: challenges, opportunities, and future implications for transportation policies. *Journal of modern transportation*, 24, 284-303.

Bala, H., Anowar, S., Chng, S., & Cheah, L. (2023). Review of studies on public acceptability and acceptance of shared autonomous mobility services: past, present and future. *Transport Reviews*, 43(5), 970-996, DOI: 10.1080/01441647.2023.2188619

Bala, H., Anowar, S., Chng, S., & Cheah, L. (2023). Review of studies on public acceptability and acceptance of shared autonomous mobility services: Past, present, and future. *Transport Reviews, 43*(5), 970-996. https://doi.org/10.1080/01441647.2023.2188619

Bansal, P., Kockelman, K. M., & Singh, A. (2016). Assessing public opinions of and interest in new vehicle technologies: An Austin perspective. *Transportation Research Part C: Emerging Technologies*, 67, 1-14.

Barbour, N., Menon, N., Zhang, Y., & Mannering, F. (2019). Shared automated vehicles: A statistical analysis of consumer use likelihoods and concerns. *Transportation Policy, 80(September 2018), 86–93.*. https://doi.org/10.1016/j.tranpol.2019.05.013

Becker, F., & Axhausen, K. W. (2017). Literature review on surveys investigating the acceptance of automated vehicles. *Transportation*, 44(6), 1293-1306.

Broadbent, G. H., Metternicht, G., Wiedmann, T., & Allen, C. (2024). Transforming Australia's road fleet with electric vehicles: Strategies and impediments affecting net-zero emissions targets for 2050. *Case Studies on Transport Policy*, 101191.

Brovarone, E. V., Scudellari, J., & Staricco, L. *(2021).* Planning the transition to autonomous driving: A policy pathway towards urban liveability. *Cities, 108, 102996.*. https://doi.org/10.1016/j.cities.2020.102996

Cai, L., Yuen, K. F., & Wang, X. (2023). Explore public acceptance of autonomous buses: An integrated model of UTAUT, TTF, and trust. *Travel Behaviour and Society, 31,* 120–130. https://doi.org/10.1016/j.tbs.2022.11.010

Canitez, F. (2021). Transition to autonomous vehicles: a socio-technical transition perspective. *Alphanumeric Journal*, 9(2), 143-162.

Carrese, F., Sportiello, S., Zhaksylykov, T., Colombaroni, C., Carrese, S., Papaveri, M., & Patella, S. M. (2023). The integration of shared autonomous vehicles in public transportation services: A systematic review. *Sustainability, 15*(17), 13023. https://doi.org/10.3390/su151713023

Cervero, R., & Golub, A. (2007). Informal transport: A global perspective. *Transport policy*, *14*(6), 445-457.

Chan, H. Y., Ma, H., & Zhou, J. (2024). Resilience of socio-technical transportation systems: A demand-driven community detection in human mobility structures. *Transportation Research Part A: Policy and Practice*, 190, 104244.

Cheong, H. I., Macias, J. *J. E., Karamanis, R., Stettler, M., Majumdar, A., & Angeloudis, P. (2023).* Policy and strategy evaluation of ridesharing autonomous vehicle operation: a London case study. *Transportation Research Record, 2677(10), 22-52.*. https://doi.org/10.1177/03611981231160157)

Claudel, M., & Ratti, C. (2015). Full speed ahead: How the driverless car could transform cities. *McKinsey Quarterly.* Retrieved from. https://www.mckinsey.com/capabilities/sustainability-and-resource-productivity/our-insights/full-speed-ahead-how-the-driverless-car-could-transform-cities

Clayton, W., Paddeu, D., Parkhurst, G., & Parkin, J. (2020). Autonomous vehicles: who will use them, and will they share?. *Transportation Planning and Technology, 43(4), 343-364.*. https://doi.org/10.1080/03081060.2020.1762427

Clewlow, R. R., & Mishra, G. S. (2017). Disruptive transportation: The adoption, utilization, and impacts of ride-hailing in the United States. Institute of Transportation Studies. University of California, Davis. Research Report – UCD-ITS-RR-17-07.

Cohen, A., & Shaheen, S. (2018). Planning for shared mobility. American Planning Association. PAS REPORT 583. https://doi.org/10.7922/G2NV9GDD.

Cohn, J., Ezike, R., Martin, J., Donkor, K., Ridgway, M., & Balding, M. (2019). Examining the equity impacts of autonomous vehicles: a travel demand model approach. *Transportation research record,* 2673(5), 23-35.

Council, S. (2023). Hackers say the Tesla nightmare in Netflix's 'Leave the World Behind' could really happen. *SFGATE.* Retrieved from: https://www.sfgate.com/tech/article/tesla-nightmare-netflix-leave-world-behind-hack-18318903.php

Currie, G. (2018). Lies, damned lies, AVs, shared mobility, and urban transit futures. *Journal of Public Transportation,* 21(1), 19-30. Retrieved from: https://researchmgt.monash.edu/ws/portalfiles/portal/259718560/257045653_oa.pdf

Davis, F. D. (1989). Technology acceptance model: TAM. *Al-Suqri, MN, Al-Aufi, AS: Information Seeking Behavior and Technology Adoption*, 205, 219.

Davis, M. C., Challenger, R., Jayewardene, D. N., & Clegg, C. W. (2014). Advancing socio-technical systems thinking: A call for bravery. *Applied ergonomics*, 45(2), 171-180.

De Bruijn, H., & Herder, P. M. (2009). System and actor perspectives on sociotechnical systems. *IEEE Transactions on systems, man, and cybernetics-part A: Systems and Humans*, 39(5), 981-992.

Dedema, & Zhang, P. (2019). “Happy Rides Are All Alike; Every Unhappy Ride Is Unhappy in Its Own Way”: Passengers’ Emotional Experiences While Using a Mobile Application for Ride-Sharing. In *Information in Contemporary Society: 14th International Conference, iConference 2019, Washington, DC, USA, March 31–April 3, 2019, Proceedings 14* (pp. 706-717). Springer International Publishing.

Delhomme, P., & Gheorghiu, A. (2016). Comparing French carpoolers and non-carpoolers: Which factors contribute the most to carpooling?. *Transportation Research Part D: Transport and Environment*, 42, 1-15.

Dentons. (2024, May 29). *Global guide to autonomous vehicles 2024.* Retrieved from https://www.dentons.com/en/insights/guides-reports-andwhitepapers/2024/may/29/global-guide-to-autonomous-vehicles-2024.

Denzin, NK. (1978). *Sociological Methods.* New York: McGraw-Hill.

Dia, H., & Javanshour, F. (2017). Autonomous Shared Mobility-On-Demand: Melbourne Pilot Simulation Study. *Transportation Research Procedia, 22, 285–296.*. https://doi.org/10.1016/j.trpro.2017.03.035

Diels, C., Erol, T., Kukova, M., Wasser, J., Cieslak, M., Payre, W., Miglani, A., Mansfield, N., Hodder, S. and Bos, J. *(2017).* Designing for comfort in shared and automated vehicles (SAV): a conceptual framework. Designing for comfort in shared and automated vehicles (SAV): a conceptual framework. *1st International Comfort Congress.* Retrieved from*:* https://core.ac.uk/download/pdf/83949305.pdf

Dijkhuijs, T., Israel, F., & van Lierop, D. (2023). To Share or to Own? Understanding the Willingness to Adopt Shared and Owned Electric Automated Vehicles on Three Continents. *Future Transportation*, 3(3), 1108-1123.

DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American sociological review*, 48(2), 147-160.

Dogan, E., Costantini, F., & Le Boennec, R. (2020). Ethical issues concerning automated vehicles and their implications for transport. In *Advances in Transport Policy and Planning* (Vol. 5, pp. 215-233). Academic Press.

Doiber, M., Hackl, R., & Raffler, C. (2019). The potential of shared mobility services: Policy recommendations for urban planners and operators. *JPI Urban Europe*. Retrieved from https://jpi-urbaneurope.eu/project/e4-share

Dokic, J., Müller, B., & Meyer, G. (2015). European roadmap smart systems for automated driving. *European Technology Platform on Smart Systems Integration*, 39.

Dolins, S., Karlsson, M., & Strömberg, H. (2023). AVs Have a Sharing Problem: Examining User Acceptance of Shared Autonomous Public Transport in Sweden. *Proceedings of the International Transportation Systems Conference (ITSC)*.

Dolins, S., Karlsson, M., Smith, G., & Strömberg, H. (2024). Navigating the Future with A Modern Delphi: Identifying Factors Influencing the Introduction of Autonomous Public Transport. *THREDBO Conference Proceedings*.

Dolins, S., Karlsson, M., Strömberg, H., & Smith, G. (2024). Whose Job is Sharing Anyway? A Qualitative Study of Transportation Experts and Stakeholders in Sweden. *Proceedings of the 2024 International Conference on Sustainable Urban Mobility (CSUM*). *Springer*, forthcoming.

Dolins, S., Strömberg, H., Wong, Y. Z., & Karlsson, M. (2021). Sharing anxiety is in the driver's seat: analyzing user acceptance of dynamic ridepooling and its implications for shared autonomous mobility. *Sustainability,* 13(14), 7828.

Dolins, S., Wong, Y. Z., & Nelson, J. *D. (2021).* The 'sharing trap': A case study of societal and stakeholder readiness for on-demand and autonomous public transport in New South Wales, Australia. *Sustainability,* 13(17), 9574. https://doi.org/10.3390/su13179574

Döringer, S. (2021). 'The problem-centred expert interview'. Combining qualitative interviewing approaches for investigating implicit expert knowledge. *International Journal of Social Research Methodology*, 24(3), 265-278.

Efthymiou, D., Antoniou, C., & Waddell, P. (2013). Factors affecting the adoption of vehicle sharing systems by young drivers. *Transport policy*, 29, 64-73.

Ekman, F. (2023). *User Trust Here and Now but Not Necessarily There and Then-A Design Perspective on Appropriate Trust in Automated Vehicles (AVs)*. Chalmers Tekniska Hogskola (Sweden).

Emery, F. E., & Trist, E. L. (1960). Socio-Technical Systems. In C. W. Churchman, & M. Verhulst (Eds.), *Management Sciences: Models and Techniques*, 2, 83-97.

Emory, K., Douma, F., & Cao, J. (2022). Autonomous vehicle policies with equity implications: Patterns and gaps. *Transportation Research Interdisciplinary Perspectives*, 13, 100521.

Etminani-Ghasrodashti, R., Patel, R. K., Kermanshachi, S., Rosenberger, J. M., Weinreich, D., & Foss, A. (2021). Integration of shared autonomous vehicles (SAVs) into existing transportation services: A focus group study. *Transportation Research Interdisciplinary Perspectives*, 12, 100481.

Fagnant, D. J., & Kockelman, K. (2015). Preparing a nation for autonomous vehicles: opportunities, barriers and policy recommendations. *Transportation Research Part A: Policy and Practice*, 77, 167-181.

Fagnant, D. J., & Kockelman, K. M. (2014). The travel and environmental implications of shared autonomous vehicles, using agent-based model scenarios. *Transportation Research Part C: Emerging Technologies*, 40, 1-13.

Fowler Jr, F. J. (2013). Survey Research Methods (Applied Social Research Methods) Survey research methods. Sage publications.

Fraedrich, E., Beiker, S., & Lenz, B. (2015). Transition pathways to fully automated driving and its implications for the sociotechnical system of automobility. *European Journal of Futures Research*, 3, 1-11.

Fraedrich, Fraedrich, E., & Lenz, B. (2016). Societal and individual acceptance of autonomous driving. *Autonomous Driving: Technical, legal and social aspects*, 621-640.

Freemark, Y., Hudson, A., & Zhao, J. (2019). Are cities prepared for autonomous vehicles? Planning for technological change by US local governments. *Journal of the American Planning Association*, 85(2), 133-151.

Fuenfschilling, L., & Truffer, B. (2014). The structuration of socio-technical regimes—Conceptual foundations from institutional theory. *Research policy*, 43(4), 772-791.).

Fulton, L., Mason, J., & Meroux, D. (2017). *Three revolutions in urban transportation: How to achieve the full potential of vehicle electrification, automation, and shared mobility in urban transportation systems around the world by 2050* (No. STEPS-2050).

Fyhri, A., & Backer-Grøndahl, A. (2012). Personality and risk perception in transport. *Accident Analysis & Prevention, 49*, 470–475. https://doi.org/10.1016/j.aap.2012.03.017

Gerte, R., Konduri, K. C., & Eluru, N. (2018). Is there a limit to adoption of dynamic ridesharing systems? Evidence from analysis of Uber demand data from New York City. *Transportation Research Record*, 2672(42), 127-136.

Giesecke, R., Surakka, T., & Hakonen, M. (2016, April). Conceptualising mobility as a service. In *2016 eleventh international conference on Ecological Vehicles and Renewable Energies (EVER)* (pp. 1-11). IEEE.

Gkritza, K., Gkartzonikas, C., Losada-Rojas, L. L., & Candanedo, R. E. (2022). Public Acceptance and Socio-Economic Analysis of Shared Autonomous Vehicles: Implications for Policy and Planning. Center for Connected and Automated Transportation: Report No. 32. Purdue University.

Golbabaei, F., Yigitcanlar, T., Paz, A., & Bunker, J. (2023). Perceived Opportunities and Challenges of Autonomous Demand-Responsive Transit Use: What Are the Socio-Demographic Predictors?. *Sustainability*, 15(15), 11839.

Gray, D., Farrington, J. H., & Kagermeier, A. (2008). Geographies of rural transport. Retrieved from: https://api.semanticscholar.org/CorpusID:127593376h.

Greifenstein, M., Güthner, H., Kuhnert, F., & Herrmann, A. (2024). From test sites to public roads: A look at the global status of shared autonomous vehicles. *ATZ Worldwide, 02-03*, 60–64.

Guerra, E. (2016). Planning for cars that drive themselves: Metropolitan planning organizations, regional transportation plans, and autonomous vehicles. *Journal of Planning Education and Research,* 36(2), 210-224. https://doi.org/10.1177/0739456X15613591.

Guidon, S., Becker, H., Dediu, H., & Axhausen, K. W. (2019). Electric bicycle-sharing: A new competitor in the urban transportation market? An empirical analysis of transaction data. *Transportation Research Record*, *2673*(4), 15-26.

Gunasekaran, V., & Harmantzis, F. C. (2007). Emerging wireless technologies for developing countries. *Technology in society*, *29*(1), 23-42.

Gurumurthy, K. M., Kockelman, K. M., & Simoni, M. D. (2019). Benefits and costs of ride-sharing in shared automated vehicles across Austin, Texas: Opportunities for congestion pricing. *Transportation Research Record*, 2673(6), 548-556.

Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E. (2010). *Multivariate Data Analysis*, 7th ed., Prentice Hall, Upper Saddle River, NJ.

Harb, M., Xiao, Y., Circella, G., Mokhtarian, P. L., & Walker, J. L. (2018). Projecting travelers into a world of self-driving vehicles: estimating travel behavior implications via a naturalistic experiment. *Transportation*, 45, 1671-1685.

Hilgarter, K., & Granig, P. (2020). Public perception of autonomous vehicles: A qualitative study based on interviews after riding an autonomous shuttle. *Transportation Research Part F: Traffic Psychology and Behaviour*, 72, 226-243.

Hofstede, G. (2007). A European in Asia. *Asian Journal of Social Psychology*, 10(1), 16-21.

Homem de Gouveia, P., Boccioli, F., Wrzesińska, D., Kabbaj, L., & Manso García, J. (2023, December 6). *New report on shared micromobility regulation*. EU Urban Mobility Observatory. Retried from: https://www.polisnetwork.eu/wp-content/uploads/2023/11/SHARED-MICROMOBILITY-REPORT.pdf

Hosmer, D. W. & Lemeshow, S. (2000). *Applied Logistic Regression*. New York: Wiley.

Hou, Y., Garikapati, V., Weigl, D., Henao, A., Moniot, M., & Sperling, J. (2020). *Factors Influencing Willingness to Share in Ride-Hailing Trips* (No. NREL/PR-5400-75682). National Renewable Energy Lab. (NREL), Golden, CO (United States).

Hwang, K., & Giuliano, G. (1990). The determinants of ridesharing: Literature review. The University of California Transportation Center. *Working Paper UCTC No. 38*. Retrieved from: https://escholarship.org/uc/item/0gd0d2fj.

Imhof, S., Frölicher, J., & von Arx, W. (2020). Shared Autonomous Vehicles in rural public transportation systems. *Research in Transportation Economics,* 83, 100925. https://doi.org/10.1016/j.retrec.2020.100925

International Road Transport Union. (n.d.). *Bus driver shortage: How do we bridge the gap?* Retrieved November 12, 2024, from https://www.iru.org/news-resources/newsroom/bus-driver-shortage-how-do-we-bridge-gap

Isaac, E., & Davis, U. C. (2014). *Disruptive innovation: Risk-shifting and precarity in the age of Uber* (p. 7). Berkeley Roundtable on the International Economy [University of California, Berkeley].

Jiang, L., Chen, H., & Chen, Z. (2022). City readiness for connected and autonomous vehicles: A multi-stakeholder and multi-criteria analysis through analytic hierarchy process. *Transport Policy*, 128, 13-24.

Jiang, Z., Wang, S., Mondschein, A. S., & Noland, R. *B. (2020).* Spatial distributions of attitudes and preferences towards autonomous vehicles. *Findings.* https://findingspress.org/article/12653-spatial-distributions-of-attitudes-and-preferences-towards-autonomous-vehicles

Johansson, M. V., Heldt, T., & Johansson, P. (2006). The effects of attitudes and personality traits on mode choice. *Transportation Research Part A: Policy and Practice*, 40(6), 507-525.

Kammerlander, M., Schanes, K., Hartwig, F., Jäger, J., Omann, I., & O'Keeffe, M. (2015). A resource-efficient and sufficient future mobility system for improved well-being in Europe. *European Journal of Futures Research*, 3, 1-11.

Karlsson, I. C. M., Mukhtar-Landgren, D., Smith, G., Koglin, T., Kronsell, A., Lund, E., Sarasini, S., & Sochor, J. (2020). Development and implementation of Mobility-as-a-Service – A qualitative study of barriers and enabling factors. *Transportation Research Part A: Policy and Practice*, 131, 283-295. https://doi.org/10.1016/j.tra.2019.09.028

Kass, G. V. (1980). An exploratory technique for investigating large quantities of categorical data. *Journal of the Royal Statistical Society: Series C (Applied Statistics)*, 29(2), 119-127.

Kaulio, M. A., & Karlsson, I. M. (1998). Triangulation strategies in user requirements investigations: a case study on the development of an IT-mediated service. *Behaviour & information technology*, 17(2), 103-112.

Khan, M. A., Etminani-Ghasrodashti, R., Shahmoradi, A., Kermanshachi, S., Rosenberger, J. M., & Foss, A. (2022). Integrating shared autonomous vehicles into existing transportation services: evidence from a paratransit service in Arlington, Texas. *International Journal of Civil Engineering*, 20(6), 601-618.

Khan, S. K., Shiwakoti, N., Stasinopoulos, P., & Warren, M. (2023). A multinational empirical study of perceived cyber barriers to automated vehicles deployment. *Scientific Report*s, 13(1), 1842.

König, A., Wirth, C., & Grippenkoven, J. (2021). Generation Y's information needs concerning sharing rides in autonomous mobility on demand systems. *Sustainability*, 13(14), 8095.

Kouroutakis, A. E. (2020). Autonomous vehicles: regulatory challenges and the response from Germany and UK. *Mitchell Hamline Law Review*, 46(5), 3.

KPMG International. (2019). Autonomous Vehicles Readiness Index, Assessing countries' preparedness for autonomous vehicles. Retrieved from: https://assets.kpmg.com/content/dam/kpmg/xx/pdf/2019/02/2019-autonomous-vehicles-readiness-index.pdf.

Krueger, R. A. & Casey, M. A. (2009): Focus Groups: A practical guide for applied research, London: Sage.

Lavieri, P. S. (2018). *Is the Future of Urban Mobility Shared?: Modeling Ride-Hailing Adoption and Preferences for Ownership and Sharing of Autonomous Vehicles*. The University of Texas at Austin.

Lavieri, P. S., & Bhat, C. R. (2019). Investigating objective and subjective factors influencing the adoption, frequency, and characteristics of ride-hailing trips. *Transportation Research Part C: Emerging Technologies*, 105, 100-125.

Lavieri, P. S., & Bhat, C. R. (2019). Modeling individuals' willingness to share trips with strangers in an autonomous vehicle future. *Transportation Research Part A: Policy and Practice, 124, 242-261.* https://doi.org/10.1016/j.tra.2019.03.009

Lenz, B., & Fraedrich, E. (2016). New mobility concepts and autonomous driving: the potential for change. *Autonomous Driving: Technical, Legal and Social Aspects*, 173-191.

Lepore, J. (2014). The disruption machine. *The New Yorker*, 23, 30-36.

Levin, M. W. *(2017). Modeling and optimizing network infrastructure for autonomous vehicles* (Doctoral dissertation). *University of Texas.* https://repositories.lib.utexas.edu/handle/2152/47278

Liew, Y. W., Vafaei-Zadeh, A., Teoh, A. P., & Ramayah, T. (2023). Predicting public willingness to use autonomous shuttles: Evidence from an emerging economy. *Transportation Research Record, 2678*(5), 736–757. https://doi.org/10.1177/03611981231192099

Lim, W., Lee, S., Sung, B., & Cronin, S. (2023). Is Australia ready for autonomous vehicles? Examining the factors influencing AV adoption through expert interviews. *Australasian Marketing Journal*, 14413582231175152.

Lindkvist, H., and Govick, L. (2024). Micro-meso-macro assessment of drivers and barriers to implementing geofencing for sustainable transport. *Transportation Research Part D: Transport and Environment*, 130, 104163.

Litman, T. (2015, January 11-15). Autonomous vehicle implementation predictions: Implications for transport planning [Conference paper]. Transportation Research Board 94th Annual Meeting, Washington, DC, United States.* *Transportation Research Board.* https://trid.trb.org/view/1334138

*Litman, T. (2017). Autonomous vehicle implementation predictions. *Victoria Transport Policy Institute Victoria, Canada.* Retrieved from: https://www.vtpi.org/avip.pdf

Litman, T. (2020, January 9). Autonomous vehicle implementation predictions: Implications for transport planning.* *Victoria Transport Policy Institute.* https://www.vtpi.org/avip.pdf.

*this report is updated periodically, so different versions of it have been cited.

Liu, Y., & Yang, Y. (2018). Empirical examination of users' adoption of the sharing economy in China using an expanded technology acceptance model. *Sustainability*, 10(4), 1262.

Lunden, I. (2020, May 7). *Waymo says it will resume driving operations starting in Phoenix next week*. TechCrunch. Retrieved from https://techcrunch.com/2020/05/07/waymo-says-it-will-resume-driving-operations-starting-in-phoenix-next-week/

Mack, E. A., Miller, S. R., Chang, C. H., Van Fossen, J. A., Cotten, S. R., Savolainen, P. T., & Mann, J. (2021). The politics of new driving technologies: Political ideology and autonomous vehicle adoption. *Telematics and Informatics*, 61, 101604.

March, J. G. & Olsen, J. P. (1989). *Rediscovering institutions*. New York: The Free Press.

Margolin, J. B., Misch, M. *R., & Stahr, M. (1978).* Incentives and Disincentives of Ride Sharing. *Transportation Research Record, 673, pp 7--15.* http://onlinepubs.trb.org/Onlinepubs/trr/1978/673/673-002.pdf

Marletto, G. (2019). Who will drive the transition to self-driving? A socio-technical analysis of the future impact of automated vehicles. *Technological Forecasting and Social Change,* 139 (October 2018), 221–234. https://doi.org/10.1016/j.techfore.2018.10.023

Martinho, A., Herber, N., Kroesen, M., & Chorus, C. (2021). Ethical issues in focus by the autonomous vehicles industry. *Transport Reviews, 41*(5), 556–577. https://doi.org/10.1080/01441647.2020.1862355

McAslan, D., Gabriele, M., & Miller, T. R. (2021). Planning and policy directions for autonomous vehicles in metropolitan planning organizations (MPOs) in the United States. *Journal of Urban Technology*, 28(3-4), 175-201.

Melander, L., Nyquist-Magnusson, C., & Wallström, H. (2022). Drivers for and barriers to electric freight vehicle adoption in Stockholm. *Transportation Research Part D: Transport and Environment*, 108, 103317.

Menard, S. (2002). *Applied logistic regression analysis* (2nd ed.). SAGE Publications.

Menon, N., Barbour, N., Zhang, Y., Pinjari, A. R., & Mannering, F. (2019). Shared autonomous vehicles and their potential impacts on household vehicle ownership: An exploratory empirical assessment. *International Journal of Sustainable Transportation*, 13(2), 111-122.

Merat, N., Madigan, R., & Nordhoff, S. (2017). Human factors, user requirements, and user acceptance of ride-sharing in automated vehicles. *International Transport Forum. Cooperative Mobility Systems and Automative Driving: Discussion Paper 2017-10*. Retrieved from: https://www.oecd-ilibrary.org/deliver/0d3ed522-en.pdf.

Merfeld, K., Wilhelms, M. P., Henkel, S., & Kreutzer, K. (2019). Carsharing with shared autonomous vehicles: Uncovering drivers, barriers and future developments–A four-stage Delphi study. *Technological Forecasting and Social Change*, 144, 66-81.

Metz, D. (2018). Developing Policy for Urban Autonomous Vehicles: Impact on Congestion. *Urban Sci*. 2018, 2, 33.

Meyer, G., & Shaheen, S. (2017). *Disrupting Mobility. Lecture Notes in Mobility*. Cham: Springer International Publishing.

Meyer, J. W., & Rowan, B. (1977). Institutionalized organizations: Formal structure as myth and ceremony. *American Journal of Sociology*, 83(2), 340-363.

Middleton, S., & Zhao, J. (2020). Discriminatory attitudes between ridesharing passengers. *Transportation*, *47*(5), 2391-2414.

Milakis, D., & Müller, S. (2021). The societal dimension of the automated vehicles transition: Towards a research agenda. *Cities*, 113, 103144.

Milakis, D., Van Arem, B., & Van Wee, B. (2017). Policy and society related implications of automated driving: A review of literature and directions for future research. *Journal of Intelligent Transportation Systems*, 21(4), 324-348.

Miljødirektoratet. (2024, May 21). *Forslag om forbud mot fossile brensler* [Proposal to ban fossil fuels]. Retrieved from https://www.miljodirektoratet.no/

Minja, M. (2021). The Car-free Livability Programme, Oslo. In N. Douay & M. Minja (Eds.), *Urban Planning for Transitions* (Chapter 6). Wiley. https://doi.org/10.1002/9781119821670.ch6

Moody, J., Middleton, S., & Zhao, J. (2019). Rider-to-rider discriminatory attitudes and ridesharing behavior. *Transportation Research Part F: Traffic Psychology and Behaviour*, 62, 258-273.

Moradi, A., & Vagnoni, E. (2018). A multi-level perspective analysis of urban mobility system dynamics: what are the future transition pathways?. *Technological Forecasting and Social Change*, 126, 231-243.

Moreno, A. T., Michalski, A., Llorca, C., & Moeckel, R. (2018). Shared Autonomous Vehicles Effect on Vehicle-Km Traveled and Average Trip Duration. *Journal of Advanced Transportation*, 2018(1), 8969353.

Mounce, R., & Nelson, J. D. (2019). On the potential for one-way electric vehicle car-sharing in future mobility systems. *Transportation Research Part A: Policy and Practice*, *120*, 17-30.

Mukhtar-Landgren, D., & Paulsson, A. (2021). Governing smart mobility: Policy instrumentation, technological utopianism, and the administrative quest for knowledge. Administrative *Theory & Praxis,* 43(2), 135-153. https://doi.org/10.1080/10841806.2020.1870153

Mukhtar-Landgren, D., Karlsson, M., Koglin, T., Kronsell, A., Lund, E., Sarasini, S., Sochor, J., & Wendle, B. (2016). Institutional conditions for integrated mobility services (IMS). *Towards a Framework for Analysis*, 16, 5-24.

Mulley, C., & Nelson, J. D. *(2019).* Public transportation systems. *The Wiley Blackwell Encyclopedia of Urban and Regional Studies*, 1-6. John Wiley & Sons, Ltd.. https://doi.org/10.1002/9781118568446.eurs0246

Nair, G. S., & Bhat, C. R. (2021). Sharing the road with autonomous vehicles: Perceived safety and regulatory preferences. *Transportation Research Part C: Emerging Technologies*, 122, 102885.

Naiseh, M., Clark, J., Akarsu, T., Hanoch, Y., Brito, M., Wald, M., Webster, T., & Shukla, P. (2024). Trust, risk perception, and intention to use autonomous vehicles: An interdisciplinary bibliometric review. *AI & Society*. https://doi.org/10.1007/s00146-024-01895-2

Nastjuk, I., Herrenkind, B., Marrone, M., Brendel, A. B., & Kolbe, L. M. (2020). What drives the acceptance of autonomous driving? An investigation of acceptance factors from an end-user's perspective. *Technological Forecasting and Social Change*, *161*, 120319.

Nazari, F., Noruzoliaee, M., & Mohammadian, A. (2018). Shared versus private mobility: Modeling public interest in autonomous vehicles accounting for latent attitudes. *Transportation Research Part C: Emerging Technologies*, 97, 456–477. https://doi.org/10.1016/j.trc.2018.11.005

Nazari, F., Soto, Y., & Noruzoliaee, M. (2023). Privately-Owned versus Shared Automated Vehicle: The Roles of Utilitarian and Hedonic Beliefs. arXiv preprint arXiv:2309.03283.

Nemoto, E. H. (2022). *Towards a New Sustainable Mobility Paradigm: The Role and Impacts of Automated Minibuses in the Mobility Transition* (Doctoral dissertation, Université Paris-Saclay, CentraleSupélec). Available at HAL Archives.

Neoh, J. G., Chipulu, M., & Marshall, A. (2017). What encourages people to carpool? An evaluation of factors with meta-analysis. *Transportation*, 44(2), 423-448.

Nielsen, J. R., Hovmøller, H., Blyth, P. L., & Sovacool, B. K. (2015). Of "white crows" and "cash savers:" A qualitative study of travel behavior and perceptions of ridesharing in Denmark. *Transportation Research Part A: Policy and Practice*, 78, 113-123.

Nieuwenhuijsen, J., de Almeida Correia, G. H., Milakis, D., Van Arem, B., & van Daalen, E. (2018). Towards a quantitative method to analyze the long-term innovation diffusion of automated vehicles technology using system dynamics. *Transportation Research Part C: Emerging Technologies*, 86, 300-327.

Nieuwenhuijsen, M. J., & Khreis, H. (2016). Car free cities: Pathway to healthy urban living. *Environment international*, *94*, 251-262.

Nikitas, A., Vitel, A. E., & Cotet, C. (2021). Autonomous vehicles and employment: An urban futures revolution or catastrophe?. *Cities*, 114, 103203.

Nordhoff, S., de Winter, J., Madigan, R., Merat, N., van Arem, B., & Happee, R. (2018). User acceptance of automated shuttles in Berlin-Schöneberg: A questionnaire study. *Transportation Research Part F: Traffic Psychology and Behaviour*, 58, 843-854.

Nordic Labour Journal. (2023, September 21). *Nordic emergency readiness*. Retrieved from: http://www.nordiclabourjournal.org/i-fokus/in-focus-2023/theme-nordic-emergency-readyness/article.2023-09-21.0682871057

Nunes, A., & Hernandez, K. D. (2020). Autonomous taxis & public health: High cost or high opportunity cost?. *Transportation Research Part A: Policy and Practice*, 138, 28-36.

Olin, J. J., & Mladenović, M. N. (2022). Imaginaries of road transport automation in Finnish governance culture—A critical discourse analysis. *Sustainability, 14(3), 1437..* https://doi.org/10.3390/su14031437

Opdenakker, R. J. G. (2006). Advantages and disadvantages of four interview techniques in qualitative research. In *Forum Qualitative Sozialforschung= Forum: Qualitative Social Research* (Vol. 7, No. 4, pp. art-11). Institut fur Klinische Sychologie and Gemeindesychologie.

Oppegaard, S. M., Saari, T., & Saloniemi, A. (2020). Uber's trajectories in the Nordic countries. Platform work in the Nordic models: Issues, cases and responses, *TemaNord report*, 513.

Othman, K. (2023). Investigating how the public acceptance of autonomous vehicles evolve with the changes in the level of knowledge: A demographic analysis. *Cogent Engineering*, 10(1), 2220502.

Paddeu, D., Parkhurst, G., & Shergold, I. (2020). Passenger comfort and trust on first-time use of a shared autonomous shuttle vehicle. *Transportation Research Part C: Emerging Technologies*, 115, 102604.

Pakusch, C., Stevens, G., & Bossauer, P. (2018, May). Shared Autonomous Vehicles: Potentials for a Sustainable Mobility and Risks of Unintended Effects. In *ICT4S* (pp. 258-269).

Park, S., Park, J., Cho, S., & Won, J. (2017, May). Approaches to Successful Entry of the Ride-sharing Service for Startups. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems* (pp. 1161-1169).

Park, Y., Chen, N., & Akar, G. (2018). Who is interested in carpooling and why: the importance of individual characteristics, role preferences and carpool markets. *Transportation research record*, 2672(8), 708-718.

Patel, R. K., Etminani-Ghasrodashti, R., Kermanshachi, S., Rosenberger, J. M., & Foss, A. (2023). Exploring willingness to use shared autonomous vehicles. *International Journal of Transportation Science and Technology*, 12(3), 765-778.

Patton, MQ. (1999). "Enhancing the quality and credibility of qualitative analysis." *HSR: Health Services Research*. 34 (5) Part II. pp. 1189-1208.

Phun, V. K., & Yai, T. (2016). State of the art of paratransit literatures in Asian developing countries. *Asian Transport Studies*, *4*(1), 57-77.

Powell, W. W., & DiMaggio, P. J. (Eds.). (1991). *The new institutionalism in organizational analysis*. University of Chicago Press.

Prioleau, D., Dames, P., Alikhademi, K., & Gilbert, J. E. (2020, November). Barriers to the adoption of autonomous vehicles in rural communities. In *2020 IEEE International Symposium on Technology and Society (ISTAS)* (pp. 91-98). IEEE.

Pyper, J. (2014). Self-driving cars could cut greenhouse gas pollution. *Scientific American*, 15.

Rajper, S. Z., & Albrecht, J. (2020). Prospects of electric vehicles in the developing countries: A literature review. *Sustainability*, 12(5), 1906.

Remy, V. F. M., & Guseva Canu, I. (2023). Healthy bus drivers, sustainable public transport: A three-time repeated cross-sectional study in Switzerland. *International Journal of Public Health, 68,* Article 1605925. https://doi.org/10.3389/ijph.2023.1605925

Riggs, W., & Cornet, H. (2024). Multidisciplinary dialogues on assessing the automation-readiness of cities. In *Road Vehicle Automation 11 (ARTSymposium 2023)* (pp. 60–68).

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.

Ruhrort, L. (2020). Reassessing the role of shared mobility services in a transport transition: Can they contribute the rise of an alternative socio-technical regime of mobility?. *Sustainability*, 12(19), 8253.

Rydningen, U., Høynes, R. C., & Kolltveit, L. W. (2017). Oslo 2019: A car-free city centre. *WIT Transactions on Ecology and the Environment*, *226*, 3-16.

SAE International. (2021). *SAE J3016™ Levels of Driving Automation*. Retrieved from https://www.sae.org/standards/content/j3016_202104/

Sanguinetti, A., Kurani, K., Ferguson, B., Sanguinetti, A., Kurani, K., & Ferguson, B. (2019). Is it OK to Get in a Car with a Stranger? Risks and Benefits of Ride-pooling in Shared Automated Vehicles. https://doi.org/10.7922/G27M064Z.

Sarriera, J. M., Álvarez, G. E., Blynn, K., Alesbury, A., Scully, T., & Zhao, J. (2017). To share or not to share: Investigating the social aspects of dynamic ridesharing. *Transportation Research Record*, 2605(1), 109-117.

Scott, W. R. (2014). W. Richard SCOTT (1995), Institutions and Organizations. Ideas, Interests and Identities. Paperback: 360 pages Publisher: Sage (1995) Language: English ISBN: 978-142242224. *Management*, (1), 136-140.

Shaheen, S. A., Chan, N. D., & Gaynor, T. (2016). Casual carpooling in the San Francisco Bay Area: Understanding user characteristics, behaviors, and motivations. *Transport Policy*, 51, 165-173.

Shaheen, S., & Cohen, A. (2019). Shared ride services in North America: definitions, impacts, and the future of pooling. *Transport reviews*, 39(4), 427-442.

Skulmoski, G. J., Hartman, F. *T., & Krahn, J. (2007).* The Delphi method for graduate research. *Journal of Information Technology Education: Research, 6(1), 1-21..* https://doi.org/10.28945/199

Smith, G., Sochor, J., & Sarasini, S. (2018). Mobility as a service: Comparing developments in Sweden and Finland. *Research in Transportation Business & Management*, 27, 36-45.

Soh, E., & Martens, K. (2024). Public values in the socio-technical construction of autonomous vehicle futures. *Public Management Review*, 26(5), 1322-1340.

Sörensen, L., Bossert, A., Jokinen, J. P., & Schlüter, J. (2021). How much flexibility does rural public transport need?–Implications from a fully flexible DRT system. *Transport Policy*, 100, 5-20.

Soteropoulos, A., Berger, M., & Ciari, F. (2019). Impacts of automated vehicles on travel behaviour and land use: an international review of modelling studies. *Transport reviews*, 39(1), 29-49.

Spickermann, A., Grienitz, V., & Von der Gracht, H. A. (2014). Heading towards a multimodal city of the future?: Multi-stakeholder scenarios for urban mobility. *Technological Forecasting and Social Change*, 89, 201-221.

Spijkerboer, R. C., Turhan, E., Roos, A., Billi, M., Vargas-Payera, S., Opazo, J., & Armiero, M. (2022). Out of steam? A social science and humanities research agenda for geothermal energy. *Energy Research & Social Science*, 92, 102801.

Sprenkeling, M., Geerdink, T., Slob, A., & Geurts, A. (2022). Bridging social and technical sciences: Introduction of the Societal Embeddedness Level. *Energies*, 15(17), 6252.

Strauss, A., & Corbin, J. (1990). *Basics of qualitative research* (Vol. 15). Newbury Park, CA: Sage.

Strömberg, H., Ramos, É. M. S., Karlsson, M., Johansson, M., Ekman, F., Bligård, L. O., & Bergstad, C. J. (2021). A future without drivers? Comparing users', urban planners' and developers' assumptions, hopes, and concerns about autonomous vehicles. *European transport research review*, *13*, 1-12.

Suck, E., Morshed, G., & Koll, O. (2023). Stakeholder expectations and contributions to creating a market for automated, connected, electric and shared vehicles. *Research in Transportation Business & Management*, 50, 101036

Taeihagh, A., & Lim, H. S. M. (2019). Governing autonomous vehicles: emerging responses for safety, liability, privacy, cybersecurity, and industry risks. *Transport reviews*, 39(1), 103-128.

Tolbert, Pamela S. and Zucker, Lynne (1983) 'Institutional sources of change in the formal structure of organizations: the diffusion of civil service reform, 1880-1935', *Administrative Science Quarterly*, 28: 22-39.

Toth, B., Toth, J., Lakatos, A., & Turoń, K. (2022, October). Innovative complex-system-based cooperation between demand responsive transport services, shared mobility and autonomous bus services. In *2022 IEEE 1st International Conference on Cognitive Mobility (CogMob)* (pp. 000127-000134). IEEE.

Transportstyrelsen. (n.d.). Supplementary information for trial operation permits with automated vehicles (Version 1.0t). *Swedish Transport Agency*. Retrieved from https://www.transportstyrelsen.se/globalassets/global/vag/fordon/automatiserade-fordon/supplementary-information-for-trial-operation-permits-with-automated-vehicles-1.0t.pdf

Tremoulet, P. D., Seacrist, T., Ward McIntosh, C., Loeb, H., DiPietro, A., & Tushak, S. (2020). Transporting children in autonomous vehicles: An exploratory study. *Human factors*, 62(2), 278-287.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. MIS quarterly, 425-478.

Vens, C., Struyf, J., Schietgat, L., Džeroski, S., & Blockeel, H. (2008). Decision trees for hierarchical multi-label classification. *Machine learning*, 73, 185-214.

Walters, J. G., Marsh, S., & Rodrigues, L. (2022). A Rural Transport Implementation Index for Connected, Autonomous and Electric Vehicles. *Future Transportation*, 2(3), 753-773.

Wang, A., Stogios, C., Gai, Y., Vaughan, J., Ozonder, G., Lee, S., ... & Hatzopoulou, M. (2018). Automated, electric, or both? Investigating the effects of transportation and technology scenarios on metropolitan greenhouse gas emissions. *Sustainable cities and society*, 40, 524-533.

Wolf, Martin. (2021). Smart Policy for Smart Vehicles: Regulatory revisions to incentivize efficient autonomous automobiles. *Journal of Science Policy & Governance*. 18. 10.38126/JSPG180116.

Wright, S., Nelson, J. D., & Cottrill, C. D. (2020). MaaS for the suburban market: Incorporating carpooling in the mix. *Transportation Research Part A: Policy and Practice*, *131*, 206-218.

Xu, Z., Zhang, K., Min, H., Wang, Z., Zhao, X., & Liu, P. (2018). What drives people to accept automated vehicles? Findings from a field experiment. *Transportation Research Part C: Emerging Technologies*, 95, 320-334.

Yuen, K. F., Choo, L. Q., Li, X., Wong, Y. D., Ma, F., & Wang, X. (2023). A theoretical investigation of user acceptance of autonomous public transport. *Transportation, 50*(2), 545–569. https://doi.org/10.1007/s11116-021-10253-w

Yun, S., & Lee, J. (2015). Advancing societal readiness toward renewable energy system adoption with a socio-technical perspective. *Technological Forecasting and Social Change*, 95, 170-181.

Zhang, Q., Yang, X. J., & Robert Jr, L. P. (2022). Individual differences and expectations of automated vehicles. *International Journal of Human–Computer Interaction*, 38(9), 825-836.

Zhu, G., Chen, Y., & Zheng, J. (2020). Modelling the acceptance of fully autonomous vehicles: A media-based perception and adoption model. *Transportation Research Part F: Traffic Psychology and Behaviour*, 73, 80-91.