University of St.Gallen
Institute for Mobility

Societal Impact Dimensions of Autonomous Ride-pooling

A holistic multi-stakeholder societal perspective

Tamara Wisser (tamara.wisser@unisg.ch)
Working Paper, 23. September 2025

Image Source: Midjourney

Abstract

Autonomous ride-pooling implementations have commenced globally, and initiative managers seek accurate assessments of how and to what extent this novel on-demand transit service reaps benefits or downfalls for society. However, the societal impact of autonomous ride-pooling remains ambiguous, and without holistically involving society, there is a risk of inaccurate or incomplete societal impact assessments. This study aims to close this gap by redefining literature-based societal impact dimensions with Quadruple Helix stakeholders of an autonomous ride-pooling initiative in Zug, Switzerland. The resulting conceptual framework involves six societal impact dimensions – *Social Equity, Quality of Life, Safety & Security, Economy, Mobility & Transport, Sustainability, Space & Infrastructure* – and three influencing factors – *Social Perception & Acceptance, Business Model, Policy & Regulation*. It provides a comprehensive structure for holistic societal impact assessments in dimensions that go beyond established ones and reflect societal priorities. Future research should operationalize these societal impact dimensions with robust indicators, especially the most relevantly perceived *Social Equity* dimension, and find more meaningful ways for laypersons to participate in mobility innovation development.

1 Introduction

As autonomous driving becomes part of transport systems globally, the focus of analysis increasingly shifts from technology ("Does it work?") to society ("How do people benefit from it?"). A special case is autonomous ride-pooling, a shared autonomous vehicle (SAV) service, which combines impacts from autonomous driving, impacts from shared mobility, and usually also impacts from electric and connected vehicles. The novel service promises societal benefits, such as increased traffic safety, sustainability, and inclusion. However, there is also a risk of enhancing existing challenges, including increased vehicle kilometers traveled, congestion, or accident fatalities, if travel demand is induced or the average vehicle occupancy (or sharing rate) remains low. At this early implementation stage, the societal impact of autonomous ride-pooling remains ambiguous and uncertain.

Given cost estimates of $50,000 up to over $200,000 per autonomous vehicle (AV) in sophisticated AV operations (Riggs & Richardson, 2024), public and private stakeholders initiating autonomous ride-pooling services seek assessments of their (potential) societal impact. Determining if and to what extent the societal benefits of autonomous ride-pooling outweigh the costs demonstrates its true value and provides an important tool in the governance of SAVs (Zheng et al., 2025).

Despite its relevance, there is no established societal impact assessment of autonomous ride-pooling. Moreover, the literature lacks a multi-stakeholder account of relevant societal dimensions to determine the most important impacts, which bears the risk of incomplete or inaccurate societal impact assessments. This contribution aims to bridge the gap by validating and expanding societal impact dimensions of autonomous ride-pooling from a holistic, multi-stakeholder perspective. By considering the perspectives of societal stakeholders, the following question is investigated:
Which dimensions could be considered in the societal impact assessment of autonomous ride-pooling?

In a first step, societal impact dimensions found in contemporary literature are summarized. These dimensions are then discussed with societal stakeholders in the context of an autonomous ride-pooling initiative in Switzerland, thereby validating and extending the societal impact dimensions, if and where necessary. Finally, a reconceptualized societal impact of autonomous ride-pooling framework is proposed, providing a structure for societal impact assessments in key dimensions.

2 Key Concepts

2.1 The Impact of Autonomous Ride-Pooling

Autonomous ride-pooling is an on-demand transit service using shared autonomous vehicles (SAVs). A routing algorithm groups multiple trips headed in a similar direction and optimizes the route for short wait and travel times while allowing passengers to enter and leave the vehicle as close as possible to their origin and destination (MOIA, 2025a). Non-autonomous ride-pooling services have launched globally during the past decade, including UberX Share (formerly Uber Pool, 2014-2020, reintroduced in 2022)[1], GrabShare (since 2016)[2], and MOIA (since 2019)[3]. All three companies have since started to develop autonomous ride-pooling and/or ride-hailing services, optimizing flexibility, operational costs, and, as a solution to driver shortages (Zwick et al., 2022). MOIA is testing autonomous ride-pooling services in Hamburg and introduced an autonomous mobility "Turnkey Solution" in June 2025 (Bundesministerium für Verkehr, 2023; MOIA, 2025b). Uber and Grab have announced partnerships with autonomous technology companies to introduce autonomous ride-pooling, ride-hailing, and/or delivery services (Grab, 2025; Uber, 2025).

The widespread uptake of autonomous ride-pooling could impact society in multiple ways and levels through ripple effects and synergies between effects from autonomous, shared, electric, and connected mobility (Milakis et al., 2017). Potential benefits include lower travel costs and travel time, reduced private vehicle ownership and usage, increased average vehicle occupancy, increased traffic safety, and decreased greenhouse gas emissions. Potential downfalls involve induced travel demand (with lower travel costs), public transport substitution, or increased vehicle kilometers/miles traveled. These and further impacts are discussed with strongly diverging outcomes depending on the methodology and context (e.g., Westphal and Blaschke, 2025). In their systematic literature review, Sheldon and Dua (2024) find that theoretical studies of ride-hailing (in interaction with electrification, pooling, and automation) tend to report positive environmental and energy impacts, while empirical studies report more negative outcomes. Similarly, Silva et al. (2022) compare emissions variations from AVs depending on the case, type of study/context, and assumptions, with changes in emissions for shared and on-demand AVs ranging between -87% and +25%. Another review finds variations in energy use from AVs

[1] Uber: https://www.uber.com/newsroom/uberx-share/ / https://www.uber.com/en-BD/newsroom/history/

[2] Grab: https://www.grab.com/sg/press/tech-product/grabshare-launches-new-enhanced-option-for-better-matched-rides/

[3] MOIA: https://www.moia.io/de-DE/warum-moia

between -80% (due to ridesharing, platooning, or more efficient traffic flows) up to +300% (if VMT/VKT increase and larger luxury vehicles with higher speeds are employed) (Greenblatt & Shaheen, 2015). Most publications focus on environmental, transport-related, and economic externalities (Peer et al., 2024; Schröder & Kaspi, 2024). A smaller body on public health and safety, social and spatial equity, and livability impacts emerges, but these dimensions are under-studied (Dianin et al., 2021; Harrison et al., 2022; Milakis & Müller, 2021).

The research landscape on autonomous ride-pooling / SAV impacts still possesses a couple of gaps: First, societal impacts of SAVs are typically discussed in isolation instead of examining their interrelations or considering different stakeholder perspectives (La Delfa & Han, 2025). Second, the reported societal impacts from SAVs and autonomous ride-pooling vary strongly, emphasizing their contingent nature and the need for empirical data from implementations, which enable more realistic assumptions (Greenblatt & Shaheen, 2015; Narayanan et al., 2020). Most importantly, data on the uptake and modal shift after introducing SAVs/autonomous ride-pooling are lacking, even though many societal impacts are predicated on changes mobility behaviors (La Delfa & Han, 2025). Finally, exploring the long-term effects and social implications of SAVs/autonomous ride-pooling remains a priority (Milakis et al., 2017).

2.2 Societal Impact Assessment

Societal impact (also known as 'social impact') is concerned with the contribution of specific research projects, measures, or policies to different dimensions of society (e.g., social, environmental, and/or economic). The importance of societal impact stems from the growing need to demonstrate the difference publicly funded research and development makes for society, and the utilitarian notion that society can only benefit from initiatives if they are "converted into marketable and consumable products […] or services" (Bornmann, 2013, p. 217). Another motive, as stated by the European Union, is to provide a "coherent analysis of the reasoning […] behind, and the foreseeable effects of, any proposed measures or policy initiatives", thereby "improving the quality of legislation" (Collovà, 2015, p. 1).

While societal impact assessments are considered essential tools for decision-making, accountability, and legitimacy, their quantification proves difficult: Neither the causality, nor the geography, nor the time frame of societal impacts is clear (Bornmann, 2013). The relatively established Social Return on Investment (SROI) approach monetizes social, environmental, and economic impacts, which enables standardization and comparability, but is controversial for assigning monetary values to non-monetary impacts (Maier et al., 2015). More individualistic assessment methods provide nuanced pictures, but they can rarely be compared or summed up. Assessment methods include, but are not limited to, interviews, surveys, focus groups, workshops, and expert assessments (Smit & Hessels, 2021), and the most commonly assessed impacts are economic (Bornmann, 2013).

According to Costa and Pesci (2016), societal impact is constructed from multi-stakeholder perspectives, which is also why a 'golden standard' of assessments is considered unfeasible. Instead, their proposed multiple-constituencies approach calls for the active engagement of different stakeholders in constructing and assessing the societal impact of a specific initiative, while accommodating their specific needs (Costa & Pesci, 2016). The importance of active stakeholder involvement in societal impact assessments is supported by other scholars (Bührer et al., 2022; Feor et al., 2023).

2.3 Societal Involvement and Public Participation

For realistic assumptions regarding autonomous ride-pooling services, involving the public in the innovation development is critical. The potential users of autonomous ride-pooling ultimately determine its uptake and thus help anticipate the likelihood of different societal impacts (Axsen & Sovacool, 2019).

The Quadruple Helix model emphasizes the role of civil society in innovation development. More specifically, it proposes that the knowledge of four major actors ('helices') should be integrated for innovations to succeed: academia, industry, state/government, and civil society (Carayannis & Campbell, 2009). By adding the "media-based and culture-based public" to the former Triple Helix, the model recognizes that values, culture, and the media influence the public perception of innovations (Carayannis & Campbell, 2009; Leydesdorff & Etzkowitz, 1998). The model highlights the democratic participation and co-creation of knowledge and innovations – the "democracy of knowledge" (Carayannis & Campbell, 2009, pp. 208, 222, 226). The meaningful involvement of civil society (along with academia, industry, and the government) could lead to more publicly desirable solutions, help overcome implementation challenges, and legitimize publicly funded initiatives (Schütz et al., 2019).

The question is *how* civil society can and should be involved in innovation development. Public participation is already established within the government and industry helices: Publicly funded initiatives or legislative processes increasingly require public participation (Bekius et al., 2025). In research and development, however, public participation is challenging. A recent review of public participation in sustainable mobility initiatives revealed more than 40 participatory forms, yet the public still "has a low to moderate voice in influencing sustainable mobility policy" (Bekius et al., 2025, p. 688). This may be due to inadequate formats that, for instance, require in-depth knowledge and expertise or are too time-consuming for citizens (Schütz et al., 2019). There is a call for creative and democratic governance formats that balance effective public involvement with efficient development processes and operations.

2.4 Research Gap

The societal impact of autonomous ride-pooling remains ambiguous, but there is a growing imperative to accurately assess it. The substantial financial investments required per SAV demand a clear justification with societal benefits to secure the support of the public. Holistically engaging societal stakeholders could support this need in three ways:

1. Involving all four helices (civil society, academia, industry, and the government) provides valuable contextual knowledge, which could lead to more publicly desirable autonomous ride-pooling implementations. This increases their chance of success and the chance to obtain empirical data for more realistic assumptions.
2. Public participation in the societal impact assessment of autonomous ride-pooling could establish an effective democratic governance, while maintaining an efficient implementation process. This addresses the need for more democratic participation in sustainable mobility initiatives.
3. Integrating the perspectives of societal stakeholders (potentially) affected leads to a more accurate societal impact assessment of autonomous ride-pooling, which increases the assessment's credibility.

Despite the clear importance of societal involvement, this remains a critical gap in the literature. Current research lacks diverse stakeholder engagement in defining meaningful societal impact dimensions of autonomous ride-pooling initiatives, particularly in the context of real-world applications.

This study addresses this gap by (1) systematically involving Quadruple Helix societal stakeholders from an ongoing autonomous ride-pooling initiative in Zug, Switzerland, and (2) collaboratively defining societal impact dimensions with these stakeholders, using dimensions found in the literature as a starting point.

3 Materials and Methods

To derive societal impact dimensions of autonomous ride-pooling from a holistic societal perspective, a two-step methodological approach is followed: First, an integrative literature review is conducted to identify existing dimensions in the literature. This approach is inspired by Nemoto et al. (2021) and Milakis et al. (2017), two highly cited contributions that use integrative literature reviews to conceptualize the impacts and societal implications of shared autonomous electric vehicles and autonomous driving, respectively. This results in a conceptual framework reflecting the societal impact dimensions discussed in contemporary autonomous ride-pooling literature. In a second step, societal stakeholders (as framed in the Quadruple Helix model) of an autonomous ride-pooling initiative in Zug, Switzerland, are interviewed, and the Framework method is applied to validate, extend, and/or reconceptualize the literature-based conceptualization.

3.1 Integrative Literature Review

An integrative literature review is conducted to conceptualize societal impact dimensions in academic literature and industry reports. It is considered suitable for grasping novel and rapidly emerging topics with diverging views and fuzzy terminology (Snyder, 2019; Torraco, 2016), which is the case for the societal impact of autonomous ride-pooling. This provides a suitable starting point to (re-)conceptualize the societal impact dimensions from a holistic societal perspective (step 2).

3.1.1 Literature Selection

Literature on societal impact and autonomous ride-pooling was integrated from three databases (Web of Science, ScienceDirect, Scopus). Three keyword groups were combined: keywords related to SAVs and autonomous ride-pooling, societal impact keywords, and methodological keywords containing common methods applied to assess the societal impact. The combination varied per database depending on the search rules. Results were limited to contributions published between January 2020 and February 2025, which reflects the approximate time frame for autonomous ride-pooling implementations globally and thus contemporary, more realistic contributions (see Section 2.1). As ScienceDirect and Scopus limit the number of search terms, leading to over 800 results per database, the results were further confined to suitable subject areas and English records.

Connected Papers to Nemoto et al. (2021) supplemented the results and contributions shared by interviewees. Duplicates and publications with no access were excluded. All contributions' titles and abstracts were screened for their thematic fit to societal outcomes (instead of determinants) of SAVs/autonomous ride-pooling, which was repeated in the text screening. This resulted in 44 contributions considered for the review (see Table 1 and 2). Notably, only 7 records reviewed involved civil society stakeholders, only 3 of which involved all four helices. This further highlights the need for holistic studies with societal stakeholder involvement to study the societal impact of autonomous ride-pooling.

Table 1: Integrative Literature Review Process

Source	No. of results
Web of Science	63
ScienceDirect	708
Scopus	902
Connected Papers (Nemoto et al. (2021)	40
Shared by Interviewees	8
Total Records Identified	1721
Records removed after filtering (2020-2025, research disciplines, English or German, access)	-673
Records removed after title and abstract screening (societal outcomes of autonomous ride-pooling)	-948
Duplicates removed	-12
Records removed after full-text screening (societal outcomes of autonomous ride-pooling)	-44
Total Records Reviewed	44

Table 2: Literature Overview

	Quadruple Helix Involvement (e.g., research consortium, data collection/analysis, funding…)			
Source	Academia	Government	Industry	Civil Society
Faisal et al. (2019)	X			
Williams et al. (2020)	X			
May et al. (2020)	X	X		
Faber and van Lierop (2020)	X			X
Pfaffenbichler et al. (2020)	X			
Golbabaei et al. (2020)	X			
Pernestål et al. (2020)	X			
Roukouni and Homem de Almeida Correia (2020)	X	X		
Narayanan et al. (2020)	X	X		
Nahmias-Biran et al. (2021)	X			
Nemoto et al. (2021)	X	X	X	
Pan et al. (2021)	X			
Eppenberger and Richter (2021)	X			
Hörl et al. (2021)	X	X		X
Milakis and Müller (2021)	X			
Kontar et al. (2021)	X			X
Dianin et al. (2021)	X			
Kumakoshi et al. (2021)	X		X	
Fakhrmoosavi et al. (2022)	X			
Dlugosch et al. (2022)	X			
Alonso Raposo et al. (2022)	X	X	X	
Harrison et al. (2022)	X	X		

Whitmore et al. (2022)	X	X		
Akimoto et al. (2022)	X			
Silva et al. (2022)	X	X		
Almlöf et al. (2022)	X	X		
Iacobucci et al. (2023)	X			
McKane and Hess (2023)	X	X		
Nemoto et al. (2023)	X	X	X	X
Debbaghi et al. (2023)	X	X	X	X
Rahman and Thill (2023)	X			
Cleij et al. (2023)	X	X	X	
Zhong et al. (2023)	X	X		
Arnold et al. (2023)	X	X	X	X
Schröder and Kaspi (2024)	X			
Martinez et al. (2024)	X			
Peer et al. (2024)	X			
Dianin, Gidam, Ravazzoli and Hauger (2024)	X	X	X	
Letmathe and Paegert (2024)	X	X		
Dianin, Gidam, Ravazzoli, Stawinoga, et al. (2024)	X	X		X
Zeng et al. (2024)	X	X		
Sheldon and Dua (2024)	X			
Gabriel (2024)	X	X	X	
Ferran et al. (2025)	X	X	X	

3.1.2 Review and Conceptualization

The societal impact dimensions from the publications reviewed were coded using ATLAS.ti. Again, special attention was paid to whether they represent an autonomous ride-pooling outcome (e.g., increased spatial accessibility) or a determinant (e.g., legal permits for SAVs or optimum fleet sizing). The former were collected and described in neutral terms (since it is unclear whether outcomes will be positive or negative), while the latter were excluded from further analysis for being out of scope. In addition to the societal dimensions, their sub-dimensions and indicators were collected and grouped based on their theme to specify possible impacts to be assessed within each societal dimension. A comparative model was created using Notebook LM, an AI tool that was provided with the same 44 records, which were used to refine the societal impact dimensions, sub-dimensions, and aspects in the conceptualization.

The resulting conceptual framework organizes the societal impact of autonomous ride-pooling in six dimensions (Figure 1). The first dimension, *Accessibility, Mobility and Equity*, deals with social issues of minorities: (1) the usability of mobility services and the resulting access to mobility options, daily activities, education, and work, (2) impacts on the travel autonomy and mobility of non-motorists (e.g., people with disabilities, elderly, children, people without access to a private vehicle), and (3) social, transport, safety equity, and the service availability, which is relevant, e.g., for rural dwellers. The second dimension, *Public Health and Safety*, holistically encompasses public well-being by covering impacts on privacy, crime rates, accident rates, and public health. The third dimension, *Mobility Behavior and User Perception,* examines behavioral patterns and the modal shift with autonomous ride-pooling, a pivotal determinant of many other impacts. It also deals with user perception and acceptance, including the willingness to share rides, to pay for autonomous ride-pooling, and to spend time travelling. The fourth dimension, *Economy and Transport System,* includes impacts on macro- and microeconomic impacts, such as on employment, productivity, or the total vehicle fleet size. On the other hand, it deals with the transport system performance, which involves traffic conditions, travel comfort, or transport revenues. The *Environmental Sustainability* dimension summarizes impacts on the environment in three sub-dimensions: natural resource and energy consumption, air quality and emissions, and transport electrification. The final dimension, *Space Development and Land Use,* addresses changes in urban form and infrastructure (e.g., urban sprawl or infrastructure demand), attractiveness of public spaces, and land use impacts (e.g., relocation or space efficiency).

This multi-dimensional framework showcases far-reaching and long-term implications that autonomous ride-pooling could have for society. Apart from established dimensions, such as economic or environmental impacts, it specifically includes social impacts in three of six dimensions, emphasizing that the novel on-demand service is a socio-technical and socio-economic intervention, not just a technological innovation.

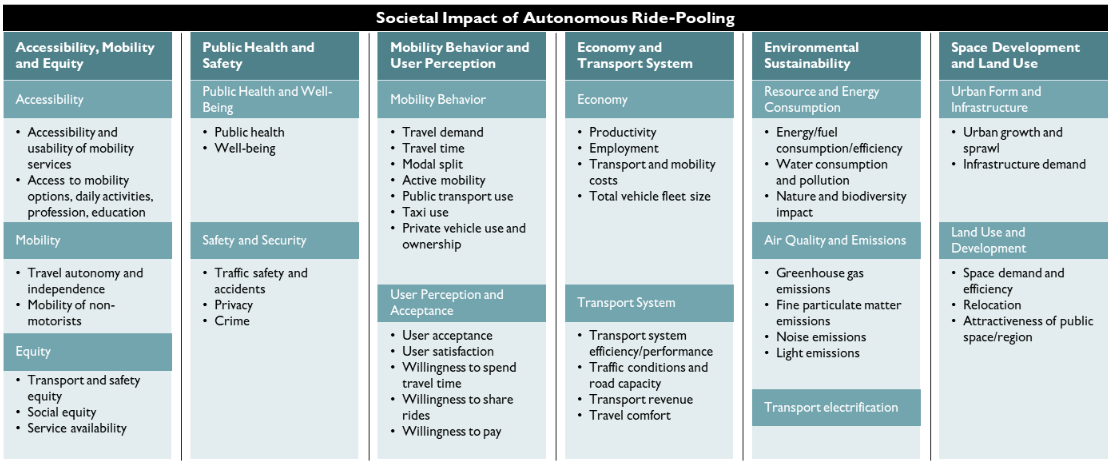

Figure 1: Conceptual Societal Impact of Autonomous Ride-Pooling Framework
Reference: own illustration based on an integrative literature review

3.2 Societal Stakeholder Interviews

To derive a multi-stakeholder perspective of societal impact dimensions, societal stakeholders from an autonomous ride-pooling initiative in Zug, Switzerland, were interviewed. The initiative by the ZUG ALLIANCE, a consortium of local public and private stakeholders, conducted a feasibility study on autonomous ride-pooling in Zug and works towards setting up a pilot project in the region. All project partners see potential in the technology and consider autonomous ride-pooling a valuable addition to the existing mobility system. However, only a pilot implementation could demonstrate in which societal impact dimensions, and under which conditions, the service creates the greatest benefit.

3.2.1 Stakeholder Sampling

A purposive sampling strategy was applied to identify and invite societal stakeholders of the autonomous ride-pooling initiative in Zug. Suitable stakeholders were identified through personal network, desk research, and snowball sampling, and had to meet at least one of three criteria:

1. Local stake: The person has a stake in the Zug initiative, because they are located in the Canton of Zug (e.g., residences or workforce).
2. Thematic stake: The person has a stake in the Zug initiative because they are concerned with autonomous ride-pooling in Zug (or in Switzerland) as part of their function (e.g., service providers and suppliers, mobility experts, potential competitors).
3. Extreme user stake: The person has a stake in the Zug initiative because they represent a special interest or target group of autonomous ride-pooling services (e.g., people with reduced mobility and minorities).

In addition to the criteria, all societal stakeholders had to be primary representatives of one of the four helices in the Quadruple Helix (see Section 2.3). This ensured that all four relevant stakeholder groups of innovations are involved in the Zug initiative. Based on these conditions, more than 300 societal stakeholders were invited to interviews.

In the end, 56 stakeholder interviews with 59 people were conducted, three of which served as pre-tests and one of which could not be recorded due to technical difficulties. The 52 remaining interviews with an average duration of 57 minutes were conducted online via Microsoft Teams, Zoom, or in person. Figure 2 provides an overview of how the Quadruple Helix was represented by the societal stakeholders.

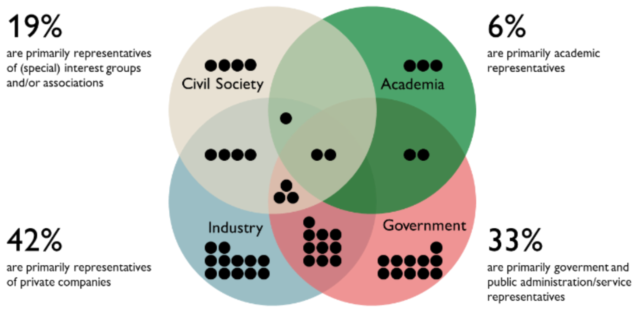

Figure 2: Stakeholder distribution across the Quadruple Helix
Reference: own illustration based on Carayannis & Campbell (2009)

3.2.2 Data Collection

A semi-structured interview guideline was designed to interactively explore and discuss the six proposed societal impact dimensions. First, interviewees were introduced to an autonomous ride-pooling definition. This was important for stakeholders unfamiliar with the novel service and to establish a mutual understanding. Then, the conceptual framework of the societal impact dimensions of autonomous ride-pooling was presented and discussed, focusing on dimensions missing from the framework. The interactive step 3 involved revisiting the societal dimensions, sub-dimensions, and aspects in more detail. Interviewees were asked to position each sub-dimension and indicator of the conceptual framework within a two-dimensional 7-point matrix visualized on Miro, where the y-axis represented the perceived importance for the societal impact of autonomous ride-pooling (1 = "very unimportant", 4 = "neutral", 7= "very important") and the x-axis represented the expected societal outcome from autonomous ride-pooling (-3 = "very negative outcomes expected", 0= "no significant outcomes expected", +3 = "very positive outcomes expected"). The positioning within the matrix visualized how important individual societal impact aspects were perceived, and why, and provided insight into assumptions, hopes, fears, questions, priorities, and missing dimensions from the interviewees' point of view. The matrices were not statistically analyzed due to strong subjectivity, limited between-subject comparability, and a limited sample size. Nevertheless, they were treated as contextual notes in the qualitative analysis. In the final stage of the interview, the potential implementation of autonomous ride-pooling in Zug was discussed, as well as the interviewee's attitude, hopes, fears, and expectations. The interviews were recorded with Microsoft Teams/Zoom, transcribed using Sally AI, and reviewed by the author.

3.2.3 Data Analysis

To validate, extend, and reconceptualize the societal impact dimensions of autonomous ride-pooling, the Framework method (Ritchie & Spencer, 2002) is applied. This approach originated in the United Kingdom for applied qualitative policy research purposes and is a widely used thematic analysis method that comprehensively organizes different perspectives on an issue in thematic matrices (Kiernan & Hill, 2018; Ritchie & Spencer, 2002). It can be used for inductive, deductive, or a combined qualitative analysis. The Framework Method was chosen for this paper because it:

1. enables the systematic and deductive validation of the previously conceptualized societal impact dimensions.
2. allows for the inductive extension and/or reconceptualization of the societal impact dimensions.
3. comprehensively visualizes and compares different societal stakeholders' perspectives on the societal impact of autonomous ride-pooling, typically in a matrix.

The Framework method follows five key stages (Ritchie & Spencer, 2002): Familiarization with the data, where the transcripts, field notes, and matrices per interviewee were reviewed. Then a thematic framework is identified. In this case, the conceptualized societal impact dimensions of autonomous ride-pooling served as the thematic framework. Its dimensions were used in the third step to systematically index and sort the interview transcripts in ATLAS.ti: This included deductively applying the societal dimensions, sub-dimensions, and indicators from the conceptual framework to the interview transcripts, but also the inductive coding of emerging dimensions. Moreover, the societal stakeholders' perspectives (i.e., assumptions, hopes, fears, questions, and priorities) were collected to contextualize the dimensions. In step four, charting, the codes were rearranged and sorted to gain a full picture of how relevant the original societal impact dimensions were perceived by which stakeholders, and which new societal impact dimensions were proposed. The final step, mapping and interpretation, involved the construction of matrices to map the stakeholder groups' aggregated perspectives on societal impact dimensions.

4 Findings

This chapter presents the findings from the societal stakeholder interviews and the reconceptualized framework of the societal impact of autonomous ride-pooling. In Chapter 4.1, the stakeholders' perceptions of the six literature-based societal impact dimensions are summarized, including contextual information regarding a potential implementation in Zug, Switzerland. Based on these perceptions, Chapter 4.2 presents the reconceptualized framework and describes all changes made to it and why.

4.1 Perception of Societal Impact Dimensions

Across all four stakeholder groups, the dimension perceived as the most relevant is the first one, called *Accessibility, Mobility and Equity*. The expected societal impact can explain the high relevance: Many of the interviewees believed that autonomous ride-pooling could provide non-motorists in more rural areas of Zug with a novel, affordable service, when no public transport option is available (e.g., adolescents at night). The impact on people with disabilities, on the other hand, was rated moderate, especially by public transport providers, because Swiss public transport is already designed to be accessible and widely available. It was also pointed out that the positive societal impact within this dimension strongly depended on the service design: In the case of minors, whether they could book a service themselves and at what age was questioned. In the case of people with disabilities, interviewees were skeptical, whether the service would be accessible, especially the booking via a smartphone app or accessing the autonomous vehicle without assistance. Furthermore, it was pointed out that the sub-dimensions and indicators discussed had a couple of redundancies, which could be summarized and grouped differently in line with established definitions of accessibility (e.g., Disability Discrimination Act[4]).

Another societal impact dimension that was perceived as relevant is *Environmental Sustainability*. Some interviewees pointed out that a positive impact on the environment was imperative for any novel mobility service. However, in the case of autonomous ride-pooling in the canton of Zug, one of the smaller Swiss cantons, it was felt that the impacts on the environment – whether positive or negative – could not be substantial, which led to a lower perceived relevance. Regarding the sub-dimensions and indicators, one public transport provider representative suggested that further resources should be included in the *Resource and Energy Consumption* sub-dimension (e.g., materials used in the production of vehicles). However, since this study focuses on dimensions and sub-dimensions, this indicator was not included in the final framework.

[4] Federal Office of Transport: https://www.bav.admin.ch/bav/en/home/general-topics/accessible-public-transport.html

Economy and Transport System was perceived as the third most relevant societal impact dimension, but different suggestions were made to reconceptualize it. Regarding the economic sub-dimension, it was pointed out that the included indicators mixed macroeconomic impacts (employment and productivity) with microeconomic impacts (total vehicle fleet size, transport and mobility costs), which could be separated. Interviewees also stated that the transport system sub-dimension deserved its own dimension instead of being grouped with the economic impacts, especially in the context of a new transport service as autonomous ride-pooling. This was acknowledged in the reconceptualization.

The *Public Health and Safety* dimension received a mixed relevance rating from the interviewees: While the *Safety and Security* sub-dimension was rated highly relevant and was often considered a precondition to the implementation of autonomous ride-pooling (although with both positive and negative societal impacts expected), *Public Health and Well-Being* was rated moderately relevant to irrelevant. This can be explained by the expected societal impacts from autonomous ride-pooling often viewed as insignificant. No changes were proposed within this dimension.

Similarly, *Mobility Behavior and User Perception* rendered mixed findings. In the *Mobility Behavior* sub-dimension, impacts on travel demand and use of different modes were rated relevant, with varying positive or negative societal impacts depending on the mode and the service availability. One important question was whether the autonomous ride-pooling service would end at the cantonal border or whether it was possible to board the vehicle in neighboring cantons. This is particularly relevant for the Canton of Zug, which records the highest number of commuters from other Swiss cantons (40’200 commuters on average), more than half of whom choose to commute by motorized individual transport (Statistik Kanton Zug, n.d.). *User Perception and Acceptance,* on the other hand, seemed too abstract for most interviewees. The indicators within this sub-dimension were mostly perceived as determinants of autonomous ride-pooling rather than outcomes, but it was also noted that autonomous ride-pooling could change public perception and acceptance over time. As the framework intends to make autonomous ride-pooling outcomes tangible, not their determinants, this dimension was fully reconceptualized.

Finally, the dimension *Space Development and Land Use* was assigned the lowest relevance on average. While efficient space use is a high priority in the Canton of Zug, the impacts from a small autonomous ride-pooling fleet were perceived as insignificant. Moreover, it was noted by cantonal administrators and transport planners that potential negative impacts from urban spraw were virtually impossible thanks to cantonal regulations that control for these impacts, which makes these societal impacts less relevant.

4.2 Reconceptualized Societal Impact of Autonomous Ride-Pooling

Based on the stakeholder interviews, the societal impact dimensions were restructured and renamed. While there were differences in the perceived relevance of the individual societal impact dimensions, none were perceived as completely irrelevant. Thus, all previous dimensions can also be found in the reconceptualized framework (Figure 3). Moreover, as the focus lies on the societal impact dimensions, not indicators, the reconceptualized framework only shows societal impact dimensions and sub-dimensions. These provide a frame and leave sufficient room to define suitable indicators for an autonomous ride-pooling initiative per dimension and sub-dimension. In the following, the reconceptualized dimensions as well as the newly added influencing factors are described.

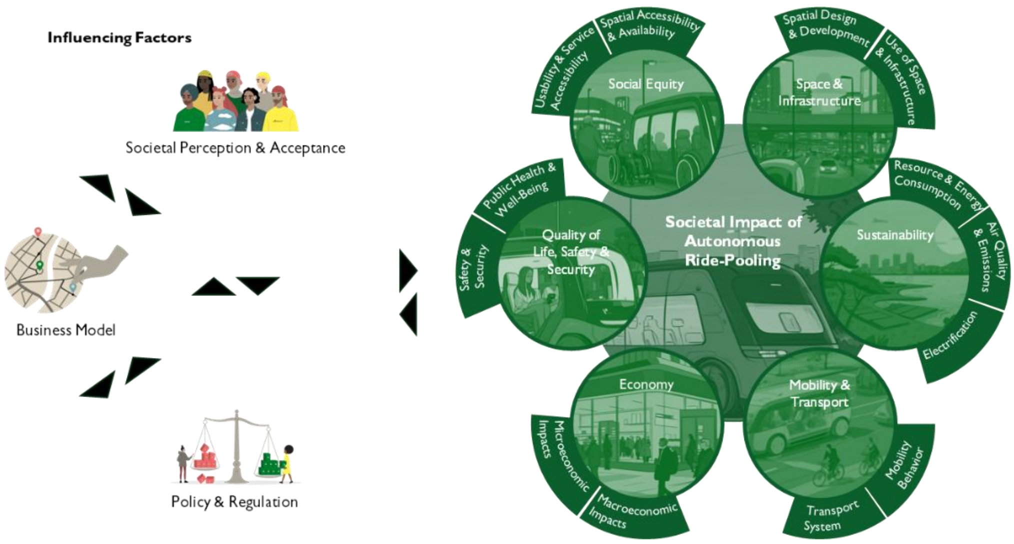

Figure 3: Reconceptualized Societal Impact of Autonomous Ride-Pooling Framework
Reference: own illustration based on societal stakeholder interviews / Images: University of St.Gallen; Midjourney

4.2.1 Societal Impact Dimensions

The *Accessibility, Mobility and Equity* dimension was renamed to *Social Equity*, which better captures what this dimension focuses on. In line with the feedback from the interviews, the sub-dimensions were merged into two more comprehensive groups: *Usability & Service Accessibility,* focusing on the accessible design of autonomous ride-pooling services, and *Spatial Accessibility and Availability,* focusing on how autonomous ride-pooling could improve accessibility to user groups, such as people in rural areas or non-motorists.

Similarly, *Space Development and Land Use* is now called *Space & Infrastructure*, and its sub-dimensions were reconceptualized to avoid redundancies: The new sub-dimension *Spatial Design & Development* focuses on more aggregated and long-term regional impacts, such as public space attractiveness, urban growth, or people's (re-)location choices for their home and workplace. In contrast, the second new sub-dimension, *Use of Space & Infrastructure,* captures more direct impacts of autonomous ride-pooling on space and infrastructure, such as (parking) space or infrastructure demand (e.g., drop-off areas at train stations for autonomous ride-pooling services).

The *Quality of Life, Safety & Security* dimension was renamed for an improved summary and description of its sub-dimensions. Similarly, the *Environmental Sustainability* dimension and its sub-dimension *Transport Electrification* were renamed to *Sustainability* and *Electrification,* respectively, following the stakeholders' feedback that they could be more concise.

Two dimensions were completely revised after the interviews: The first one, *Economy and Transport System,* was divided into two dimensions: *Economy,* summarizing *Microeconomic* and *Macroeconomic Impacts,* and *Mobility & Transport,* containing impacts on *Mobility Behaviors* (e.g. aggregated changes in travel demand, modal split, and modal shift) and the *Transport System* (e.g., road capacity, traffic, travel comfort). Societal stakeholders pointed out how essential changes in mobility behaviors and in the transport system due to autonomous ride-pooling are for many other societal impacts. Therefore, they were reconceptualized as a dimension that is equally important as the other dimensions. As a consequence, *Economy* also became a separate dimension, which led to new sub-dimensions, dividing macroeconomic impacts (e.g., labor and productivity) from microeconomic impacts (e.g., total vehicle fleet size). The other revised dimension is *Mobility Behavior and User Perception:* Societal stakeholders found it challenging to assess the relevance and outcomes within the sub-dimension *User Perception and Acceptance*, as it was felt that this contained determinants of autonomous ride-pooling rather than outcomes. Therefore, *Mobility Behavior* was newly categorized in the *Mobility & Transport* dimension, while *User Perception and Acceptance* was lifted from the societal impact dimensions and became an influencing factor.

4.2.2 Influencing Factors

Almost all interviewees noted that the outcomes in different dimensions depended on three major factors. Thus, it was decided that they should be added to the societal impact of autonomous ride-pooling framework. These factors strongly determine the positive or negative societal impact in all six dimensions, but can also be influenced by the societal impact and each other.

The first influencing factor is *Societal Perception & Acceptance.* The magnitude of the societal impact of autonomous ride-pooling essentially depends on how many people adopt and perceive the novel service, and the extent to which they change their mobility habits consequently. This influencing factor represents the former sub-dimension *User Perception and Acceptance*.

Second, stakeholders mentioned the role of *Business Model* design in the societal impact: If the autonomous ride-pooling service has too long wait times, is not affordable, or is not designed to be accessible, its societal impact will remain limited. Moreover, if the fleet is too small or managed inefficiently, the societal impacts in the environmental, spatial and mobility, and transport dimensions will be insignificant, potentially negative.

Finally, autonomous ride-pooling services require permits, including public street permits for the SAVs or authorization to stop at virtual stops. Therefore, the third influencing factor is *Policy & Regulation.* As stated by the interviewees, policymakers can actively shape the societal impact by, for instance, giving autonomous ride-pooling fleets priority in traffic or by publicly stating their support for the novel service, thereby influencing the public perception and societal impact.

5 Discussion

The involvement of societal stakeholders revealed significant overlaps with societal impact dimensions found in contemporary literature, including economic, social, environmental, spatial, transport- and safety-related impacts, and provides a frame to measure the societal impact of autonomous ride-pooling in dimensions that are perceived as relevant. This indicates that the literature successfully reflects the primary societal concerns regarding autonomous ride-pooling. Nevertheless, the stakeholder interviews provided a nuanced reframing of the dimensions and valuable contextual information for the implementation. For instance, social equity impacts were perceived as the most relevant and framed for specific user groups (e.g., adolescents in rural areas), while they remain underrepresented in academic literature (see Section 2.1). This contradiction suggests that the social equity dimension needs to be prioritized, most importantly, with suitable methods and indicators. Moreover, the interviews revealed important questions regarding the service design (e.g., affordability, availability, vehicle and service design), which should be regarded in the implementation of autonomous ride-pooling to achieve better public desirability (see Section 2.3).

While the holistic societal approach provided valuable context, methodological challenges arose: First, the perceived relevance of dimensions, sub-dimensions, and indicators has limited between-subject comparability, as each stakeholder framed the rating from a different point of view. A considerable share of interviewees framed the relevance of dimensions as requirements, e.g., sustainability *must* be a very relevant dimension, because that is the primary reason to implement novel mobility services. Other interviewees framed the relevance based on the expected outcomes, e.g., public health is less relevant, as the impact of autonomous ride-pooling will be minimal. The third group of interviewees rated the dimensions' relevance based on their preferences and perceptions.

This constituted a second challenge, primarily with civil society stakeholders: The unfamiliarity with autonomous ride-pooling likely led to a share of only 20% laypersons in the sample, and rather unrealistic assumptions during the interviews. As the exact fleet size, price, and service area of autonomous ride-pooling in Zug were still unknown at the stage of interviews, stakeholders were forced to make their own assumptions. This led to strong differences, e.g., one interviewee assumed the fleet could not exceed 10 SAVs, while another assumed the fleet could comprise up to 1,000 SAVs, which inevitably influenced their perception of relevance and expected outcomes. This challenge was partly addressed by introducing all interviewees to autonomous ride-pooling and by answering their questions during the interviews. Nevertheless, it highlights a critical gap in the democratic governance of mobility innovations: How can societies collectively make decisions about innovations that are too abstract for a substantial share of the population? One possible solution could be to provide more precise information regarding the mobility innovation. Another solution, if the innovation is already available, is to let citizens gather experiences with the mobility innovation, then engage them in citizen dialogues to collect their feedback. However, this entails further challenges, such as limited time availability of citizens, further emphasizing the need for novel public participation formats (see Section 2.3).

6 Conclusion

Autonomous ride-pooling will impact society in several ways, and there is a growing need to accurately assess whether its positive impacts outweigh the costs and negative impacts. This paper contributes to more holistic societal impact assessments by integrating dimensions from contemporary literature with societal stakeholder perspectives in the context of an autonomous ride-pooling initiative in Zug, Switzerland. It provides an empirical foundation for dimensions and a more nuanced picture of real-world priorities, questions, and concerns regarding autonomous ride-pooling. These could provide a starting point for the implementation and support more realistic assumptions for ex ante impact assessments. Second, it answers the call for democratic governance in mobility innovation development, involving Quadruple Helix stakeholders of the Swiss initiative. Finally, it identifies critical gaps in the democratic governance of mobility innovations, specifically for laypersons, underlining the importance of finding meaningful participation formats for unfamiliar stakeholders in mobility innovation development.

The resulting societal impact of autonomous ride-pooling framework includes six dimensions – *Social Equity, Quality of Life, Safety & Security, Economy, Mobility & Transport, Sustainability, Space & Infrastructure* – and three influencing factors, which were (re-)conceptualized to reflect priorities within society. It provides initiative managers with a tool to structure impacts in the most relevant societal impact dimensions beyond conventional ones, such as economy, environment, and transport. Although the holistic approach did not reveal any novel dimensions, it reframed existing ones. This provides researchers and policymakers with valuable contextual information and a solid, empirically valid framework, e.g., which societal impacts the public perceives as the most relevant, and why.

While the methodology did reveal rich insights, its limitations need to be acknowledged, including the inherent subjectivity of the conceptual framework and the challenging engagement of laypersons. The subjectivity was partially addressed in the conceptualization by comparing it to an AI-generated model and by systematically reconceptualizing the framework based on 52 Quadruple Helix stakeholder interviews. However, the framework analysis relies on single-coder interpretations, which may have influenced the final dimensions. Moreover, the strongly diverging levels of familiarity with autonomous ride-pooling among the societal stakeholders limited the between-subject comparability. Ensuring a minimum level of familiarity with the concept of autonomous ride-pooling may have enhanced the findings. It underlines a greater question of how laypersons can effectively participate in mobility innovation initiatives.

This work points to several promising future research directions. First, the social equity dimension could be prioritized by developing assessment methods and indicators that facilitate its analysis. Second, the qualitative methodology could be reproduced in a mature autonomous ride-pooling implementation, where laypersons can experience autonomous ride-pooling in a real-life setting. This could lead to more in-depth insights. Finally, the framework can be operationalized with qualitative and quantitative indicators per dimension to comprehensively capture the societal impact of autonomous ride-pooling initiatives.

References

Akimoto, K., Sano, F., & Oda, J. (2022). Impacts of ride and car-sharing associated with fully autonomous cars on global energy consumptions and carbon dioxide emissions *Technological Forecasting and Social Change*, *174*, 121311. https://doi.org/10.1016/j.techfore.2021.121311

Almlöf, E., Zhao, X., Pernestål, A., Jenelius, E., & Nybacka, M. (2022). Frameworks for assessing societal impacts of automated driving technology. *Transportation Planning and Technology*, *45*(7), 545-572. https://doi.org/10.1080/03081060.2022.2134866

Alonso Raposo, M., Grosso, M., Mourtzouchou, A., Krause, J., Duboz, A., & Ciuffo, B. (2022). Economic implications of a connected and automated mobility in Europe. *Research in Transportation Economics*, *92*, 101072. https://doi.org/10.1016/j.retrec.2021.101072

Arnold, T., Haefeli, U., Prinzing, O., Artho, J., Götz, M., & Marconi, D. (2023). *Gesellschaftliche Akzeptanz zur Nutzung von Ride-Pooling*. (1752). Retrieved from https://www.mobilityplatform.ch/de/1752.html

Axsen, J., & Sovacool, B. K. (2019). The roles of users in electric, shared and automated mobility transitions. *Transportation Research Part D: Transport and Environment*, *71*, 1-21. https://doi.org/10.1016/j.trd.2019.02.012

Bekius, F., van der Waerden, J., de Vries, G., van der Heijden, R., & Janssen, J. (2025). A review of case study-based academic literature on public participation in sustainable mobility. *Transport Policy*, *171*, 682-694. https://doi.org/10.1016/j.tranpol.2025.07.009

Bornmann, L. (2013). What is societal impact of research and how can it be assessed? A literature survey. *Journal of the American Society for Information Science and Technology*, *64*(2), 217-233. https://doi.org/10.1002/asi.22803

Bührer, S., Feidenheimer, A., Walz, R., Lindner, R., Beckert, B., & Wallwaey, E. (2022). Concepts and methods to measure societal impacts – an overview [Working Paper]. *Discussion Papers Innovation Systems and Policy Analysis*, *74*. Retrieved 8 September 2025, from

Bundesministerium für Verkehr. (2023, 10 November 2023). *Integration von autonomen Fahrzeugen in Mobilitätsanwendungen – ALIKE*. Retrieved 19 September from https://www.bmv.de/SharedDocs/DE/Artikel/DG/AVF-projekte/alike.html

Carayannis, E. G., & Campbell, D. F. J. (2009). 'Mode 3' and 'Quadruple Helix': toward a 21st century fractal innovation ecosystem. *International Journal of Technology Management*, *46*, 201-234. https://doi.org/10.1504/IJTM.2009.023374

Cleij, D., Weijermars, W., & Elvik, R. (2023). First steps towards a holistic impact assessment methodology for connected and automated vehicles. *Open Research Europe*, *1*(104). https://doi.org/10.12688/openreseurope.13870.3

Collovà, C. (2015). *How does ex-ante Impact Assessment work in the EU*. (PE 528.809). European Parliamentary Research Service EPRS Retrieved from https://www.europarl.europa.eu/RegData/etudes/BRIE/2015/528809/EPRS_BRI(2015)528809_EN.pdf

Costa, E., & Pesci, C. (2016). Social impact measurement: why do stakeholders matter? *Sustainability, Accounting, Management and Policy Journal*, *7*(1), 99-124. https://doi.org/10.1108/SAMPJ-12-2014-0092

Debbaghi, F.-Z., Vanhaverbeke, L., & Rombaut, E. (2023). Assessing the impacts of shared autonomous mobility with M3ICA: A multi-impact, multi-actor, multi-criteria approach. *Transportation Research Procedia*, *72*, 2317-2322. https://doi.org/10.1016/j.trpro.2023.11.722

Dianin, A., Gidam, M., Ravazzoli, E., & Hauger, G. (2024). Collective accessibility impacts of public transport automation on rural areas: The case study of Mühlwald, South Tyrol. *International Journal of Transportation Science and Technology*. https://doi.org/10.1016/j.ijtst.2024.11.004

Dianin, A., Gidam, M., Ravazzoli, E., Stawinoga, A. E., & Hauger, G. (2024). Individual accessibility impacts of public transport automation on (groups of) rural dwellers. *Journal of Public Transportation*, *26*, 100098. https://doi.org/10.1016/j.jpubtr.2024.100098

Dianin, A., Ravazzoli, E., & Hauger, G. (2021). Implications of Autonomous Vehicles for Accessibility and Transport Equity: A Framework Based on Literature. *Sustainability*, *13*, 4448. https://doi.org/10.3390/su13084448

Dlugosch, O., Brandt, T., & Neumann, D. (2022). Combining analytics and simulation methods to assess the impact of shared, autonomous electric vehicles on sustainable urban mobility *Information & Management*, *59*(5), 103285. https://doi.org/10.1016/j.im.2020.103285

Eppenberger, N., & Richter, M. A. (2021). The opportunity of shared autonomous vehicles to improve spatial equity in accessibility and socio-economic developments in European urban areas. *European Transport Research Review*, *13*. https://doi.org/10.1186/s12544-021-00484-4

Faber, K., & van Lierop, D. (2020). How will older adults use automated vehicles? Assessing the role of AVs in overcoming perceived mobility barriers. *Transportation Research Part A: Policy and Practice*, *133*, 353-363. https://doi.org/10.1016/j.tra.2020.01.022

Faisal, A. I. M., Yigitcanlar, T., Kamruzzaman, L., & Currie, G. (2019). Understanding autonomous vehicles: A systematic literature review on capability, impact, planning and policy *Journal of Transport and Land Use*, *12*, 45-72. https://doi.org/10.5198/jtlu.2019.1405

Fakhrmoosavi, F., Kamjoo, E., Kavianipour, M., Zockaie, A., Talebpour, A., & Mittal, A. (2022). A stochastic framework using Bayesian optimization algorithm to assess the network-level societal impacts of connected and autonomous vehicles. *Transportation Research Part C: Emerging Technologies*, *139*, 103663. https://doi.org/10.1016/j.trc.2022.103663

Feor, L., Clarke, A., & Dougherty, I. (2023). Social Impact Measurement: A Systematic Literature Review and Future Research Directions. *World*, *4*, 816-837. https://doi.org/10.3390/world4040051

Ferran, V., Magallón, I., & Rodríguez, P. (2025). Societal Impacts of Automated Mobility for Public Transport: Insights from a Modified Delphi Study and Expert Interviews. In H. Cornet & M. Gkemou (Eds.), *Shared Mobility Revolution. Pioneering Autonomous Horizons*. Springer. https://doi.org/10.1007/978-3-031-71793-2_9

Gabriel, N. (2024). *Handlungsempfehlungen für Kantone und Gemeinden im Umgang mit dem automatisierten Fahren* [Master Thesis, ETH Zurich].

Golbabaei, F., Yigitcanlar, T., & Bunker, J. (2020). The role of shared autonomous vehicle systems in delivering smart urban mobility: A systematic review of the literature *International Journal of Sustainable Transportation*, *15*(10), 731-748. https://doi.org/10.1080/15568318.2020.1798571

Grab. (2025, 10 March). *Grab Partners with Autonomous Technology Companies to Assess Impact of Autonomous Vehicles in Southeast Asia* https://www.grab.com/sg/press/others/grab-partners-with-autonomous-technology-companies-to-assess-impact-of-autonomous-vehicles-in-southeast-asia/

Greenblatt, J. B., & Shaheen, S. (2015). Automated Vehicles, On-Demand Mobility, and Environmental Impacts. *Current Sustainable/Renewable Energy Reports*, *2*, 74-81. https://doi.org/10.1007/s40518-015-0038-5

Harrison, G., Stanford, J., Rakoff, H., Smith, S., Shepherd, S., Barnard, Y., & Innamaa, S. (2022). Assessing the influence of connected and automated mobility on the liveability of cities. *Journal of Urban Mobility*, *2*, 100034. https://doi.org/10.1016/j.urbmob.2022.100034

Hörl, S., Becker, F., & Axhausen, K. W. (2021). Simulation of price, customer behaviour and system impact for a cost-covering automated taxi system in Zurich. *Transportation Research Part C: Emerging Technologies*, *123*, 102974. https://doi.org/10.1016/j.trc.2021.102974

Iacobucci, R., Donhauser, J., Schmöcker, J.-D., & Pruckner, M. (2023). The demand potential of shared autonomous vehicles: a large-scale simulation using mobility survey data *Journal of Intelligent Transportation Systems*, *28*(5), 719-740. https://doi.org/10.1080/15472450.2023.2205021

Kiernan, M. D., & Hill, M. (2018). Framework analysis: a whole paradigm approach. *Qualitative Research Journal*, *18*(3), 248-261. https://doi.org/10.1108/QRJ-D-17-00008

Kontar, W., Ahn, S., & Hicks, A. (2021). Autonomous vehicle adoption: use phase environmental implications. *Environmental Research Letters*, *16*, 064010. https://doi.org/10.1088/1748-9326/abf6f4

Kumakoshi, Y., Hanabusa, H., & Oguchi, T. (2021). Impacts of shared autonomous vehicles: Tradeoff between parking demand reduction and congestion increase. *Transportation Research Interdisciplinary Perspectives*, *12*, 100482. https://doi.org/10.1016/j.trip.2021.100482

La Delfa, A., & Han, Z. (2025). Sustainable Mobility and Shared Autonomous Vehicles: A Systematic Literature Review of Travel Behavior Impacts. *Sustainability*, *17*, 3092. https://doi.org/10.3390/su17073092

Letmathe, P., & Paegert, M. (2024). External effects of urban automated vehicles on sustainability. *Journal of Cleaner Production*, *434*, 140257. https://doi.org/10.1016/j.jclepro.2023.140257

Leydesdorff, L., & Etzkowitz, H. (1998). The Triple Helix as a model for innovation studies. *Science and Public Policy*, *25*(3), 195-203. https://doi.org/10.1093/spp/25.3.195

Maier, F., Schober, C., Simsa, R., & Millner, R. (2015). SROI as a Method for Evaluation Research: Understanding Merits and Limitations. *Voluntas*, *26*, 1805-1830. https://doi.org/10.1007/s11266-014-9490-x

Martinez, L. M., Pritchard, J. P., & Crist, P. (2024). Shared Mobility's Role in Sustainable Mobility: Past, Present, and Future *Annual Review of Environment and Resources*, *49*, 191-222. https://doi.org/10.1146/annurev-environ-121522-041916

May, A. D., Shepherd, S., Pfaffenbichler, P., & Emberger, G. (2020). The potential impacts of automated cars on urban transport: An exploratory analysis. *Transport Policy*, *98*, 127-138. https://doi.org/10.1016/j.tranpol.2020.05.007

McKane, R. G., & Hess, D. (2023). The impact of ridesourcing on equity and sustainability in North American cities: A systematic review of the literature. *Cities*, *133*, 104122. https://doi.org/10.1016/j.cities.2022.104122

Milakis, D., & Müller, S. (2021). The societal dimension of the automated vehicles transition: Towards a research agenda. *Cities*, *113*, 103144. https://doi.org/10.1016/j.cities.2021.103144

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. https://doi.org/10.1080/15472450.2017.1291351

MOIA. (2025a). *Autonomous Ridepooling: What is it?* Retrieved 19 September 2025 from https://www.moia.io/en/blog/autonomous-ridepooling

MOIA. (2025b, 17 June). *MOIA unveils series production version ID. Buzz AD and turnkey solution for fully autonomous mobility services* https://www.moia.io/en/news/moia-unveils-series-production-version-id-buzz-ad-and-turnkey-solution-for-fully-autonomous-mobility-services

Nahmias-Biran, B.-h., Oke, J. B., Kumar, N., Azevedo, C. L., & Ben-Akiva, M. (2021). Evaluating the impacts of shared automated mobility on-demand services: an activity-based accessibility approach. *Transportation*, *48*, 1613-1638. https://doi.org/10.1007/s11116-020-10106-y

Narayanan, S., Chaniotakis, E., & Antoniou, C. (2020). Shared autonomous vehicle services: A comprehensive review. *Transportation Research Part C: Emerging Technologies*, *111*, 255-293. https://doi.org/10.1016/j.trc.2019.12.008

Nemoto, E. H., Issaoui, R., Korbee, D., Jaroudi, I., & Fournier, G. (2021). How to measure the impacts of shared automated electric vehicles on urban mobility. *Transportation Research Part D: Transport and Environment*, *93*, 102766. https://doi.org/10.1016/j.trd.2021.102766

Nemoto, E. H., Korbee, D., Jaroudi, I., Viere, T., Naderer, G., & Fournier, G. (2023). Sustainability assessment of the deployment of automated minibuses in urban mobility of European cities. *Transportation Research Procedia*, *72*, 1364-1371. https://doi.org/10.1016/j.trpro.2023.11.599

Pan, S., Fulton, L. M., Roy, A., Jung, J., Choi, Y., & Gao, H. O. (2021). Shared use of electric autonomous vehicles: Air quality and health impacts of future mobility in the United States *Renewable and Sustainable Energy Reviews*, *149*, 111380. https://doi.org/10.1016/j.rser.2021.111380

Peer, S., Müller, J., Naqvi, A., & Straub, M. (2024). Introducing shared, electric, autonomous vehicles (SAEVs) in sub-urban zones: Simulating the case of Vienna. *Transport Policy*, *147*, 232-243. https://doi.org/10.1016/j.tranpol.2023.12.002

Pernestål, A., Engholm, A., Kristoffersson, I., & Hammes, J. J. (2020). The Impacts of Automated Vehicles on the Transport System and How to Create Policies that Target Sustainable Development Goals. In A. Paulsson & C. H. Sørensen (Eds.), *Shaping Smart Mobility Futures: Governance and Policy Instruments in times of Sustainability Transitions* (pp. 37-53). Emerald Publishing Limited. https://doi.org/10.1108/978-1-83982-650-420201003

Pfaffenbichler, P., Gühnemann, A., Klementschitz, R., Emberger, G., & Shepherd, S. (2020). A Systemic Analysis of Impacts of Individual and Shared Automated Mobility in Austria *Transportation Research Procedia*, *49*, 6-16. https://doi.org/10.1016/j.trpro.2020.09.002

Rahman, M. M., & Thill, J.-C. (2023). Impacts of connected and autonomous vehicles on urban transportation and environment: A comprehensive review *Sustainable Cities and Society*, *96*, 104649. https://doi.org/10.1016/j.scs.2023.104649

Riggs, W., & Richardson, E. (2024). Estimating the Cost of Autonomous Vehicles. 1-10. Retrieved 2 September, from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4998828&download=yes

Ritchie, J., & Spencer, L. (2002). Qualitative data analysis for applied policy research. In A. Bryman & R. G. Burgess (Eds.), *Analyzing Qualitative Data* (1 ed., pp. 173-194). Routledge. https://doi.org/10.4324/9780203413081

Roukouni, A., & Homem de Almeida Correia, G. (2020). Evaluation Methods for the Impacts of Shared Mobility: Classification and Critical Review *Sustainability*, *12*(24), 10504. https://doi.org/10.3390/su122410504

Schröder, D., & Kaspi, M. (2024). Quantifying the external costs of autonomous on-demand ride-pooling services. *Case Studies on Transport Policy*, *18*, 101302. https://doi.org/10.1016/j.cstp.2024.101302

Schütz, F., Heidingsfelder, M. L., & Schraudner, M. (2019). Co-Shaping the Future in Quadruple Helix Innovation Systems: Uncovering Public Preferences toward Participatory Research and Innovation. *She Ji: The Journal of Design, Economics, and Innovation*, *5*(2). https://doi.org/10.1016/j.sheji.2019.04.002

Sheldon, T. L., & Dua, R. (2024). Impacts of ride-hailing on energy and the environment: a systematic review. *Environmental Research Letters*, *19*, 1-21. https://doi.org/10.1088/1748-9326/ad3285

Silva, Ó., Cordera, R., González-González, E., & Nogués, S. (2022). Environmental impacts of autonomous vehicles: A review of the scientific literature. *Science of the Total Environment*, *830*, 1-11. https://doi.org/10.1016/j.scitotenv.2022.154615

Smit, J. P., & Hessels, L. K. (2021). The production of scientific and societal value in research evaluation: a review of societal impact assessment methods. *Research Evaluation*, *30*(3), 323-335. https://doi.org/10.1093/reseval/rvab002

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, *104*, 333-339. https://doi.org/10.1016/j.jbusres.2019.07.039

Statistik Kanton Zug. (n.d.). *Pendlerinnen und Pendler*. Retrieved 19 September from https://www.zg.ch/behoerden/gesundheitsdirektion/statistikfachstelle/themen/11-mobilitaet-und-verkehr/pendlerstatistik

Torraco, R. J. (2016). Writing Integrative Literature Review: Using the Past and Present to Explore the Future. *Human Resource Development Review*, *15*(4), 404-428. https://doi.org/10.1177/1534484316671606

Uber. (2025). *Driving autonomous forward*. Retrieved 19 September 2025 from https://www.uber.com/us/en/autonomous/

Westphal, S. C., & Blaschke, M. J. (2025). Autonomous, electric, shared – what makes a difference for future sustainable mobility? , 1-28. Retrieved 4 September, from

Whitmore, A., Samaras, C., Hendrickson, C. T., Matthews, H. S., & Wong-Parodi, G. (2022). Integrating public transportation and shared autonomous mobility for equitable transit coverage: A cost-efficiency analysis. *Transportation Research Interdisciplinary Perspectives*, *14*, 100571. https://doi.org/10.1016/j.trip.2022.100571

Williams, E., Das, V., & Fisher, A. (2020). Assessing the Sustainability Implications of Autonomous Vehicles: Recommendations for Research Community Practice *Sustainability*, *12*, 1902. https://doi.org/10.3390/su12051902

Zeng, T., Zhang, H., Moura, S. J., & Shen, Z.-J. M. (2024). Economic and environmental benefits of automated electric vehicle ride-hailing services in New York City. *Scientific Reports*, *14*, 1-15. https://doi.org/10.1038/s41598-024-54495-x

Zheng, N., Kamruzzaman, L., Vu, H., & Currie, G. (2025). Environmental impacts of autonomous vehicles. *Transportation Research Part D: Transport and Environment*, *143*, 104747. https://doi.org/10.1016/j.trd.2025.104747

Zhong, S., Liu, A., Jiang, Y., Hu, S., Xiao, F., Huang, H.-J., & Song, Y. (2023). Energy and environmental impacts of shared autonomous vehicles under different pricing strategies *npj Urban Sustainability*, *3*, 1-10. https://doi.org/10.1038/s42949-023-00092-2

Zwick, F., Kuehnel, N., & Hörl, S. (2022). Shifts in perspective: Operational aspects in (non-)autonomous ride-pooling simulations. *Transportation Research Part A: Policy and Practice*, *165*, 300-320. https://doi.org/10.1016/j.tra.2022.09.001

List of Aids

Aid / Tool	Purpose
Connected Papers	Support with literature search
Endnote	Organization of references, citation support
Notebook LM	Societal impact framework generation to compare with the own conceptualization based on the integrative literature review
Miro	Visual aid in interviews, digital whiteboard for interview notes
Microsoft Teams	Interviews, interview recording
Zoom	Interviews, interview recording
Sally AI	Interview transcription
ATLAS.ti	Qualitative content analysis, framework conceptualization
Grammarly	Reformulations throughout paper
Claude	Reformulations throughout paper, content structuring/arrangement support throughout paper
Midjourney	Image Generation (Title Page and Reconceptualized Societal Impact of Autonomous Ride-Pooling Framework)

Anhänge und weiterführende Informationen auf Anfrage erhältlich.
Kontaktieren Sie Tamara Wisser (tamara.wisser@unisg.ch)

Appendices and further information available on request.
Please contact Tamara Wisser (tamara.wisser@unisg.ch)