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# Innovative Mobility Concepts for the Future of Transport: Organizational Strategy and Consumer Behavior

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# List of Abbreviations

| | |
|---|---|
| CD | Compact Disc |
| DOI | Diffusion of Innovation |
| Dr. | Doktor |
| DVD | Digital Versatile Disc |
| ed. | edition |
| e.g. | exempli gratia |
| et al. | et alii / et aliae |
| i.e. | id est |
| MLP | Multi-Level Perspective |
| p. | page |
| Prof. | Professor |
| TAM | Technology Acceptance Model |
| TPB | Theory of Planned Behavior |
| TRA | Theory of Reasoned Action |
| TT | Technological Transition |
| TUM | Technical University Munich |
| UK | United Kingdom |
| Univ. | Universität |
| UTAUT | Unified Theory of Acceptance and Use of Technology |

# Abstract

This dissertation presents three essays on the future of transport analyzing organizational strategy and customer behavior. The qualitative approach provides a critical organizational viewpoint and an understanding of how to cope with challenges arising from transformational change. The quantitative approach is an in-depth analysis of customers' technology acceptance, examining how shifting preferences affect purchase and usage intentions regarding self-driving cars. Overall, this thesis contributes by analyzing multiple actors involved in a socio-technical transition, as well as their influence on the emergence and acceptance of innovative technologies.

Die vorliegende Dissertation umfasst drei Aufsätze, die die Zukunft der Mobilität von einer unternehmerischen als auch einer Kundenperspektive analysieren. Der qualitative Forschungsansatz umfasst einen kritischen unternehmerischen Blick auf die sich wandelnde Mobilität und liefert ein Verständnis für die Bewältigung der sich daraus ergebenden Herausforderungen. Die quantitative Erhebung und Analyse der Technologieakzeptanz in Bezug auf die Kauf- und Nutzungsintention selbstfahrender Fahrzeuge liefert neue Erkenntnisse bezüglich sich wandelnder Kundenpräferenzen. Die Dissertation leistet somit einen wichtigen Beitrag in der Analyse unterschiedlichster Akteure der sozio-technischen Transformation sowie deren Einfluss auf die Entwicklung und Akzeptanz innovativer Technologien.

# 1 Introduction

## 1.1 Motivation and Research Questions

The automotive sector is undergoing a (r)evolutionary transformation on multiple levels. As a result, the dominance of the classical vehicle concept is in question, while the transition from combustion engine to battery-operated electric vehicles is merely one facet of a larger transformation. Further, developments in the autonomous driving field are moving forward at a rapid pace and shared usage approaches are gaining considerably more attention. However, the increasing problems of urban transport, such as increased emissions, traffic volume, or lack of space, set boundaries to vehicle ownership. Although the private car has been the embodiment of individual mobility for over 100 years, the necessity for alternative mobility solutions has never been greater. As stated by Spickermann, Grienitz, and Heiko (2014), "[…] in the future, it is not about reducing mobility as such since individual mobility is the prerequisite for social participation, progress, growth, and self-realization" (p. 216). Ideally, the development of innovative mobility concepts would improve transportation while also meeting the multi-dimensional expectations of all involved actors. In this context, shared autonomous vehicles are enabling more flexible usage approaches while simultaneously increasing the safety, capacity, and efficiency of transport (Fagnant, Kockelman, & Bansal, 2015). Additionally, modern societies aim for high levels of autonomy, where the hazard-free fulfillment of individual mobility manifests without the responsibilities associated with ownership. The entertainment industry, in which individuals are increasingly aiming for pay-per-use or subscription models (e.g., Spotify or Netflix) over material goods (e.g., CDs or DVDs), is another example of this development. The growing popularity of carsharing (e.g., ShareNow), or ride hailing services, (e.g., myTaxi), is the first indication of future mobility trends.

Hence, the current developments in the automotive industry are considerably more complex than the emergence of single technological innovations or new business models. Since sustainable urban transport constitutes one of the grand societal challenges of the 21st century (George, Howard-Grenville, Joshi, & Tihanyi, 2016), far-reaching changes in the mobility sector are, thus, grounded within deeper societal and political structures. While regulators provide direction and counteract the difficulties in urban and environmental

development, long-standing industry participants struggle with new regulations. Additionally, companies such as Tesla and Uber have created radically new products and services on the market, claiming to have the right answers to novel customer demand types, thereby challenging incumbent firms in the traditional automotive industry. These new competitors benefit from large investments from various funders and can act more rapidly without the inherited burden of existing business and production structures (Farla, Markard, Raven, & Coenen, 2012). By contrast, long-standing participants on the market operate more slowly and make large investments at the risk of profitability goals. Securing short-term results while, at the same time, making a business future-proof requires a fine balance between success and failure. By investigating how organizations engage in the continuous changes imposed by the increasingly competitive settings, Brown and Eisenhardt (1997) show that radical experimentation through multiple product innovations while linking the present and future is a critical success factor. However, established organizations may struggle when faced with technological change or shifting markets and ultimately fail to remain competitive, although they have invested heavily in emerging technologies (Brown & Eisenhardt, 1995; Christensen & Bower, 1996; O'Reilly & Tushman, 2004). According to Ederer and Manso (2013), one reason is represented by classical pay-for-performance measures that miss promoting creativity and motivating innovative activities in shifting organizations. Ultimately, a higher tolerance for failure and rewards for long-term success are indispensable in times of revolutionary change (Manso, 2011).

In this context, investigating the developments in the automotive industry from a critical organizational viewpoint should provide a better understanding of these challenges and give managerial implications on how to meet changing mobility demand as well as remain successful in an increasingly competitive market environment. Hence, a clear answer to the question of how to cope with the challenges arising from transformational change is provided by this study:

***Research Question 1:***
***What are the key challenges for established firms due to the transformational changes towards a new era of transport?***

Answering this question pertains to two articles on critically examining the perspective of a traditional car manufacturer under the research framework of technological foresight and

societal transitions. While the first article, titled *"Do Future Mobility Concepts Fit Customer Demand?,"* analyzes the transition in more general terms, the second article, titled *"An organizational view on transport transitions involving new mobility concepts and changing customer demand,"* elaborates on the changing framework conditions, various expectations, and organizational strategies. It does so by applying a multi-level perspective to obtain deeper insights into what opportunities to seize and what challenges to counteract as a traditional car manufacturer so as to, ultimately, be able to actively shape the future of transport.

The customer perspective is further analyzed by examining how shifting preferences and changing mobility behaviors affect the acceptance of innovative concepts for the future of transport. This prediction of behavioral intentions should help identify key determinants of technology acceptance for privately owned versus shared driverless vehicles. The main objective is to provide directions on how the predominant understanding of automobiles might change and if the emotional attachment caused by the "joy" of driving a classical car can be overruled by the enjoyment of being driven in a self-driving car. The following research question is thus posited:

***Research Question 2:***

***Will individuals still be willing to buy a car when they will no longer drive it themselves?***

The empirical investigation to answer the proposed research question is based on the widely recognized technology acceptance model and is presented in a working paper titled *"Self-driving cars: Intention to buy or intention to use? How enjoyment and the shift in preferences affect technology acceptance."* Hence, the research approach is an in-depth analysis of technology acceptance based on the differences between purchase and usage intentions. By including context-specific determinants, such as perceived enjoyment and technological risk, the understanding of technology acceptance is expanded and important implications for the development and implementation of self-driving cars are provided.

Overall, this thesis contributes to the literature by identifying the multiple actors involved in the current transition as well as their influence on the emergence and diffusion of innovative technologies. The research objectives, theoretical bases, and methodological approaches of the two studies respectively pertaining to each research question, are presented in the following section.

## 1.2 Research Objectives and Methodological Approach

Two empirical studies are conducted to answer the previously presented research questions. By combining transition and acceptance research for investigating organizational strategies and customer preferences, this thesis aims to provide managerial implications for how to successfully design and implement new mobility concepts for the future of transport. A multi-method approach represents the research design framework. To provide broader assumptions on the future of transport, more than one method of data collection and analysis are necessary for understanding both the subjective viewpoints of the objective reality, as well as being able to concretely structure and test the drawn assumptions based on causal relationships (Morgan & Smircich, 1980). Hence, while the context of the investigation—the future of transport—remains the same, the methodology and unit of analysis vary across studies, from the organizational to the customer level (Langley, 1999).

### 1.2.1 Organizational Perspective (Research Question 1)

**Research objective:** As a first step, the future of transport is investigated from an organizational perspective using a qualitative approach to identify the strategies and expectations of a traditional car manufacturer by presenting exclusive insights into organizational strategy. Examining the dynamic interplay between changing customer expectations and a strategically shaped vision identifies organizational challenges and provides managerial implications on how to meet changing customer demand for the future of transport. By broadening the problem frame and analytical perspective, this work strives to provide a more comprehensive understanding of current developments in the mobility sector.

**Theoretical basis:** Socio-technical transition research simultaneously investigates the changing conditions that involve multiple actors at different levels (e.g., Bijker, 1997; Geels & Schot, 2007). The multi-level perspective on socio-technical transitions introduced by Geels (2002) - an internationally renowned expert in the field of transition research - constitutes a simple way to analyze complex and large-scale transitions. Specifically, it provides a conceptual framework to explain the purpose, emergence, and success of innovative activities, in alignment with the dynamic interactions of organizational, social, and political developments. More recently, Geels (2018) analyzed the dynamics of a low-carbon transition by applying the multi-level perspective to

passenger mobility in the UK (1990-2016). By "zooming out," the study addresses multiple-regime developments (e.g., auto-mobility, train, and bus) including different niche-innovations, to illustrate a more comprehensive reconfiguration process. According to Smith, Voß, and Grin (2010), exploring "the bigger picture" is the unique allure of the multi-level perspective on socio-technical transitions (p. 435). The main objective of this thesis is to draw this "bigger picture" by analyzing the organizational level and to provide guidelines on how to counteract the challenges arising from transformational change (research question 1). Hence, this framework is chosen as the theoretical basis for the underlying investigation, as described and discussed in detail in Section 2.1.

**Methodological approach**: To answer the proposed research question, semi-structured interviews with experts from a traditional car manufacturer (single case study) are chosen to gain insights into different views, expectations, and interpretations (Gläser & Laudel, 2010). The grounded theory approach of Glaser and Strauss (1967) is used as the procedure to develop a theoretical perspective from the close interaction with empirical data and to propose transferable concepts for future research. This inductive research method is a fruitful tool to investigate from within, obtain information about different topics, and ultimately propose the underlying theory (Charmaz, 2006). Since iterative induction and deduction cycles guarantee the necessary flexibility during data collection and analysis (Miles, Huberman, & Saldana, 2014), the theorizing approach based on a single case study is further strengthened by evidence triangulation (Eisenhardt, 1989). While the inductive part of the examination generates an initial set of explanations, the deductive examination builds on the multi-level perspective and the socio-technical transition framework allowing one to further relate the data and theory (Langley, 1999). Hence, this initial analysis represents the explorative approach to reflect the current transition in the automotive industry and explores which of the future mobility concepts are expected to prevail and how they fit customer demand. The follow-up analyses use collected interview data to examine system developments on multiple levels and to investigate whether incumbent firms are strategically well-prepared for the future of transport.

### 1.2.2 Customer Perspective (Research Question 2)

**Research objective:** The initial qualitative analysis of this thesis, as described above, reveals that autonomous driving and shared mobility are perceived to be "the game changers" for the future of transport. Self-driving cars are seen as a promising solution to urban transport problems by enabling smart concepts for shared usage approaches at significantly reduced costs. Since they operate with lower error probabilities compared to human abilities and can manage traffic more intelligently, traffic accidents will likely be reduced and roadway capacity increased (Fagnant & Kockelman, 2015). Furthermore, customer experience would be enhanced by making better use of time and providing more convenient alternatives for individual mobility. However, concerns about practicality, a suitable legal framework, and liability issues might be obstacles to the dissemination of self-driving cars (Fagnant & Kockelman, 2015). Hence, a second empirical study focuses on the customer perspective by conducting an in-depth analysis of technology acceptance and elaborating on important determinants, such as perceived enjoyment and technological risk. By including these context-specific variables and differentiating between purchase and usage intentions, the understanding of technology acceptance is expanded, thereby providing important implications for the design and application of self-driving cars.

**Theoretical basis:** The research design is based on the widely recognized technology acceptance model (TAM) of Davis (1986), which is a useful tool to investigate customers' willingness to adopt new products and services based on valid and reliable psychological variables (Legris, Ingham, & Collerette, 2003). The underlying assumption is that consumers have a higher intention to buy or use a product if it is perceived as useful and easy to use (Moore & Benbasat, 1991). A detailed description of the TAM can be found in Section 2.2, which presents the developments, refinements, and a critical review of the model, followed by previous research findings on the role of perceived enjoyment and perceived risk.

**Methodological approach:** To assess the various preferences regarding privately owned and shared driverless vehicles, the TAM is expanded into two separate models, in which purchase and usage intentions represent the dependent variables. To the best of the authors' knowledge, an approach comparing the influence of the same set of independent variables on different outcome variables is novel in acceptance research. In addition to the classic constructs (i.e., perceived ease of use and usefulness), the influences of perceived

enjoyment and risk are investigated. To account for the influence of intrinsic motivation on behavioral intentions, the research model is extended by considering the tendency to seek enjoyment and the expectation that the joy of driving decreases with higher autonomy. By contrast, being able to perform other tasks while being driven, might positively influence behavioral intentions. Considering the public discussions on autonomous driving and current challenges, i.e., lacking legal framework, safety-related risk factors, reliability or liability issues, and privacy concerns, perceived technological risk represents another extension of the research model.

To investigate the consumer acceptance of self-driving vehicles as a technological innovation, empirical data are collected using a survey-based approach. After verifying the collected data, regression analyses test the respective hypotheses. Linear regression is the most commonly used method of examination in TAM research (Davis, 1989; Legris et al., 2003; Venkatesh & Davis, 2000). Moreover, due to its robustness, it seems to be the most reliable approach for investigating technology acceptance (Gefen, Straub, & Boudreau, 2000).

## 1.3 Structure and Outlook

The research questions above are answered in two separate empirical studies resulting in three papers. The overall thesis is structured as follows:

Chapter 2 introduces and discusses the theoretical framework for the multi-method approach and provides a literature overview and discussion in the context of the research aims of this thesis. Section 2.1 presents the multi-level perspective on socio-technical transitions, as it forms the theoretical foundation of the qualitative examination. An exemplary case-study of a transport transition is described as it will later be transferred to the underlying research approach. The TAM, which is the basis for the quantitative empirical inquiry, is described in Section 2.2. Model developments, refinements, and a critical reflection are presented, followed by a review of previous studies on the role of perceived enjoyment and perceived technological risk.

Chapters 3 and 4 answer the first research question, being respectively comprised of two articles, titled *"Do Future Mobility Concepts Fit Customer Demand"* and *"An Organizational View on Transport Transitions Involving New Mobility Concepts and Changing Customer Demand."* The ultimate purpose of these essays is to define the context and build the hypotheses for the subsequent quantitative investigation.

The underlying research proposal to answer the second research question investigating the acceptance of self-driving cars and the respective results is presented in the form of a working paper in Chapter 5, *"Self-Driving Cars: Intention to Buy or Intention to Use? How Enjoyment and The Shift in Preferences Affect Technology Acceptance."*

Finally, Chapter 6 provides a conclusion of all studies by summarizing the key results, presenting an overview of possible future scenarios based on insights gained from expert interviews and the customer acceptance study, as well as providing recommendations for future research and practical implications.

Overall, this thesis identifies the differing views on the future of transport from a critical organizational perspective and highlights the challenges for traditional car manufacturers. The presented studies uncover significant difficulties resulting from a misleading steering system. Although traditional management practices enhance productivity, they might also inhibit creativity. According to the insights gained from the interviewed experts, classical accounting measures and a sole focus on traditional incentive systems are contradictory to innovative proposals: *"An engineer or project leader usually has responsibility for costs and is measured on the basis of an outdated system. That corset prevents creative*

*proposals and the integration of new customer features"* (interviewed expert, Case D). Exploring new approaches instead of repeating what has been done in the past is indispensable in a shifting market and for satisfying more individual customer demand. Hence, there is a strong need to broaden the steering system by adding creativity enhancing measures to facilitate a higher tolerance for failure and innovative approaches. Brand-new products and services need to be developed beyond already existing vehicle concepts in order to ensure the long-term competitiveness of established firms in the future of transport.

In addition, the interviewed experts are convinced and the customer acceptance study confirms that shared, driverless vehicles can better satisfy the individual preferences of future generations while simultaneously counteracting the increasing problems of urban transport and its environmental impact. Hence, the expectations are high on both the demand as well as the supply side since these integrated concepts not only represent a profitable solution to counteract the grand societal challenge of sustainable transport, but also fulfill more sophisticated customer demand. The fundamental question arises whether shared driverless vehicles will be able to replace the paradigm of private property and traditional vehicle concepts. Answering this question by comparing purchase and usage intentions of self-driving vehicles indicates that the usage approach is slightly preferable while the intention to buy still exists. Therefore, it is assumed that private vehicle ownership will remain dominant, at least for the foreseeable future, as long as shared vehicles do not deliver the same level of flexibility and comfort: *"One's own, individual car will continue to exist. That is the customers' claim. However, attitudes toward mobility are changing towards use-case-specific requirements"* (interviewed expert, Case O).

Furthermore, the results indicate that perceived usefulness remains a strong indicator of behavioral intentions. However, and unexpectedly, perceived enjoyment while driving autonomously is the most influential determinant positively affecting the acceptance of self-driving cars. Although driving is still anticipated to be enjoyable in certain situations, it is likely that, in the future, the pleasure of driving will be replaced by the pleasure of being driven. Hence, individuals are observed to be aware of the potential relief from cumbersome driving situations. Since a negative effect of perceived enjoyment of driving conventionally cannot be confirmed, it is assumed that the substitution by an automated system does not lead to rejection. The ability to engage in other activities should, therefore, receive the highest attention in developing and implementing self-driving cars. Individuals are shown to be open to autonomous vehicles although the technology is still in its infancy.

Nonetheless, and despite public debates, the political environment and extant research indicate the opposite by emphasizing fear or at least non-acceptance of this new technology. However, our results show a different picture, supporting that perceived risk regarding self-driving cars is of lesser relevance for customer acceptance than expected. Hence, the perception of the gains and positive consequences attributed to self-driving cars seems to already overrule the various concerns presumed to hinder adoption.

Overall, this thesis provides a comprehensive overview of the current challenges for the automotive industry from an organizational perspective and contributes to the literature by analyzing multiple actors (i.e., organizations, customers, and legislation) involved in the socio-technical transition as well as their influence on the emergence and acceptance of innovative technologies for the future of transport. By addressing the shift in values and new types of mobility demand from the customer perspective, this thesis suggests that it has become more important for established organizations to further promote the courage to explore new paths. The implementation of shared, driverless vehicles and thereby being able to meet more sophisticated customer requirements might constitute one solution to ensure long-term success in an increasingly competitive market environment. Respective results indicate that innovative modes of transport may guarantee for the satisfaction of future mobility desires without the direct need for private car ownership, at least in the long run.

Despite enhancing the understanding of a socio-technical transition on different levels and elements, a certain disadvantage with regard to external validity and the level of generality is acknowledged since the qualitative data base is limited to a single organization (traditional car manufacturer) and the survey data only represents the German population. However, the assessment of various influencing factors on the future of transport, related organizational strategies, and changing customer behaviors using a multi-method approach leads to preliminary insights and has important implications for future research. Furthermore, the approach to compare the influence of the same set of independent variables on two different outcome variables (i.e., purchase and usage intentions) is novel in research and expands the understanding of technology acceptance in general.

# 2 Theoretical Framework

## 2.1 The Multi-Level Perspective (MLP)

In 1930 General Motors speculated about the first automated cars soon to be on the market and gained great popularity in support of their claim. However, almost 100 years later and although it seems that we are on the right track, cars do still not drive autonomously. Geels and Smit (2000) investigate failed technological promises and why future expectations are too optimistic or turn out to be wrong in the retrospective. By analyzing their impact on societal transformations and technological developments, the authors point out several difficulties and neglected aspects in future expectations. According to them, these expectations have a performative role but are biased by cultural concerns and reflective hopes. New technologies are anticipated to substitute old technologies neglecting any generating effect. This functional thinking (efficiency aspect) disregards personal preferences and individual needs assuming that social practices remain stable. Furthermore, speed of development is often overestimated ignoring the necessary alignment between user preferences, technology characteristics, and organizational practices. Hence, promising gains and advantages are overestimated while underestimating practical difficulties. To improve future scenarios, the authors suggest to carefully consider the interactions between technology and society in order to better capture the broad variety of possible impacts (Geels & Smit, 2000).

### 2.1.1 Socio-Technical Transitions

Frank Geels (2002) elaborates on the previously described aspects introducing a comprehensive multi-level perspective on technological transitions describing it as an evolutionary rather than a revolutionary process (e.g., the transition from sailing ships to steamships, 1780-1900). Geels (2002) aims to integrate different findings on the basis of the sociology of technology concept and encourages research to bridge the gap between economics and technology studies. Accordingly, he claims that technology on itself has no power and defines **technological transitions** (TT) as major transformations in the way societal functions are fulfilled: “TT do not only involve changes in technology, but also changes in user practices, regulation, industrial networks, infrastructure, and symbolic meaning or culture” (p. 1257). According to Geels (2002) technology only functions in

association with social structures, organizations and human actors introducing a framework to analyze and understand technical transitions: the multi-level perspective.

"The important point of the multi-level perspective is that the further success of a new technology is not only governed by processes within the niche, but also by developments at the level of the existing regime and the sociotechnical landscape" (p. 1261). Ultimately, technical transitions only occur when developments on all levels link up and reinforce each other. In that context, s**ocio-technical regimes** are a wider community of different social groups including engineers, policy makers, users, and scientists searching in the same direction. Technological trajectories are a result of incremental improvements. In contrast, radical innovations are generated in **niches**, which act as incumbent rooms and are protected from normal market selections to provide space for learning and interaction. Novelties are the seed for change and emerge due to a specific problem or on the basis of knowledge and capabilities (Geels, 2002, p. 1260). The **socio-technical landscape** forms the external structure containing a set of heterogeneous factors for the interaction of actors (Geels, 2002, p. 1260). "The nested character of these levels, means that regimes are embedded within landscapes and niches within regimes" (p.1261). Not every niche innovation is successful and triggers regime changes. If it does, the step from niche to regime level does not occur at a certain point in time. It develops gradually by subsequent usage or applications involving experimentation, adjustments and learning processes until, ultimately, a reconfiguration process occurs. Figure 2.1 illustrates the successful development from the niche to the landscape level.

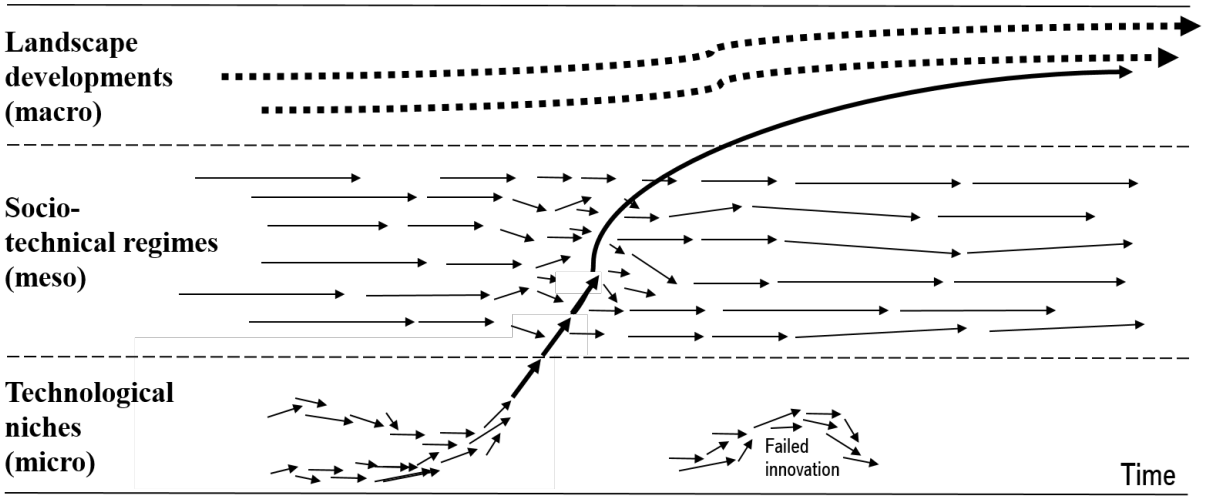


**Figure 2.1: The Multi-Level Perspective (Geels, 2002)**

In 2004, Frank Geels widens the unit of analyses from sectoral systems of innovations to socio-technical systems by including not only the supply side but also the demand side. He

sheds light on the institutional aspect which guides actors' perceptions and activities and explicitly incorporates the user perspective. By integrating the diffusion of a technology from a user perspective, he focuses on the fulfilment of societal functions such as transportation or communication rather than on economic performance aspects. It is furthermore claimed that a socio-technical system functions through activities of human actors which are embedded in social groups and share the same perceptions, norms and preferences. Social groups, i.e., users, public authorities, firms or universities, are interdependent and their relationships change over time. Thus, Geels (2004) conceptualizes the dynamic interplay between these actors in order to provide a comprehensive approach to analyze the long-term evolution of a system with regard to technology and society.

As a result, transition theory has been widely applied to describe developments in the mobility sector. Spickermann et al. (2014) for example propose a socio-technical system of multimodal mobility to counteract urban mobility challenges. By applying the multi-level perspective, the authors analyze the efforts to advance future transport systems of the actors in different fields. Mazur, Contestabile, Offer, and Brandon (2015) conduct a micro-level analysis of German car manufacturers and identify how they react to a variety of policies on emission reductions and sustainable car technologies, concluding that for existing firms to engage in niche innovations instead of incremental change, additional external pressure in the form of customer demand and success of new competitors is thus necessary (Mazur et al., 2015). The growing body of literature (see Farla et al., 2012) drawing attention to complex organizational, social and political interactions illustrates the importance of bridging the gap between transition research and innovation studies to better understand shared expectations and competing interests.

### 2.1.2 A Historical Case Study

The analytical framework of the multi-level perspective is initially developed from historic transitions. In order to give an example of how the multi-level perspective evolved, Geels' (2005) investigation of the transition from one social-technical system (horse-drawn carriages) to another (automobiles) at the level of a societal function (transport) is presented. Additionally, the case shares many similarities with the current transition in the automotive industry, which can later be transferred to our research approach.

The study goes beyond the simple substitution in which horses are replaced by cars. By focusing on the alignment of elements such as knowledge, regulations and infrastructure, the author is able to show that "technological substitution" is too simple to explain a

transition that is shaped by a wider socio-technical context (Geels, 2005). It is claimed that other aspects such as policies, user practices or cultural meaning are overlooked. Furthermore, path dependence or particular niches that played a crucial role in the competition between gasoline, electric and steam automobiles have so far been neglected. Ultimately, Geels (2005) is able to conceptualize a particular transition pathway for the societal function of urban passenger transport from 1860-1930:

In *phase 1* from 1860 to 1885 increasing urbanization on the landscape level puts pressure on the existing transport regime. The expansion of horse-based transportation leads to horse-drawn trams being the first urban mass transport mode while other niches innovations for fun and entertainment (i.e., bicycles, electric vehicles, steam vehicles) exist without putting pressure on the regime.

*Phase 2* (1855-1903) is characterized by continued urbanization in combination with industrialization and immigration. Associated costs, congestion, pollution and safety issues put pressure on the regime for urban transport in technical, economic and cultural dimensions. The health, hygiene and parkway movement leads to bicycles being seen as a new "hygiene" mobility practice providing a high level of flexible and individual usage. Furthermore, electric vehicles are considered as clean, quiet, reliable and easy to handle. Societal and cultural enthusiasm for electricity developed the electric tram into a new transport regime. Ultimately, by adding petrol, steam and electric engines to existing coaches automobiles emerge as radically new transport options triggering much enthusiasm. In addition, four important niches occur: touring, racing, taxi and luxury promenading.

From 1903 to 1914 the expansion of electric trams and the stabilization of a car regime took place. In this *third phase*, the relative importance of different transport options changed. Horses disappeared, bicycles lost their importance and became children's toys whereas the electric tram stabilizes as the dominant urban transport mode. At the same time gasoline automobiles captured more market niches such as the taxi-niche while electric vehicles remain to be seen as luxury cars.

*Phase 4* describes the development towards a car-based personal transportation regime from 1914 to the 1930s. The demand for gasoline cars now also captured rural areas and lead to a competition between the electric tram regime and the automobile regime. Smoothness of ride, comfort and convenience became important performance criteria. While the car developed into a "rolling living room" the emergence of a "car culture" is

facilitated. Ultimately, performance improvements and positive linkages with landscape developments result in the gasoline automobile regime gaining an increased momentum. Figure 2.2 illustrates the developments on multiple levels as a de- and re-alignment of the socio-technical system:

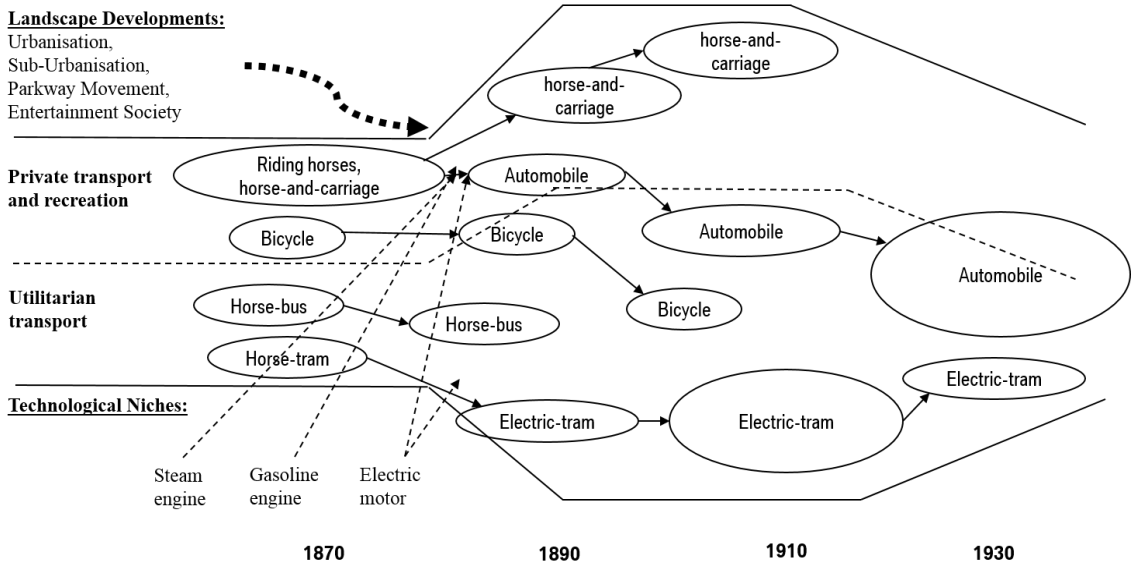


**Figure 2.2: De-alignment and Re-alignment (Geels, 2005)**

While transition studies mainly analyze the past (e.g., historical case studies), our research approach is under the framework of technological foresight, considering the entire spectrum of the future of mobility. However, since the historical case study bears a certain resemblance to the current transition in the automotive industry, it provides a good basis for how similarities can later be transferred to our research approach and might help to understand the evolutionary process from classical car ownership to shared, autonomous vehicles (illustration see Chapter 6.2, Figure 6.1). Additional arguments why to choose the multi-level perspective as the theoretical framework for the qualitative study are presented in the following.

### 2.1.3 Criticism and Derived Base for Research

Further conceptual refinements of the multi-level perspective are made in response to criticisms on the different ways to operationalize the empirical and analytical levels. Geels and Schot (2007) position socio-technical regime shifts as more encompassing changes than solely technological discontinuities clarifying the relations between the three structural levels and agency. The claim of a niche-driven bias as a bottom up approach is therefore countered by paying explicit attention to multiple developments on the regime and landscape level as well as on their influence on the innovation itself.

Furthermore, the authors disagree that the perspective is functionalistic and dominated by rational action, stating that social groups are implicated and playing an important role in the multi-level perspective. The actions of social groups, power struggles and change of perceptions are furthermore made visible in case studies. In accordance, Geels and Schot (2007) develop a typology of four transition pathways differing in timing and nature of interactions illustrated with historical examples from previous studies:

1) Transformation as social movements characterized by outside pressure and institutional power struggles. Example see Geels (2006b): hygienic transition from cesspools to sewer system;

2) Technological substitution as competition between existing regime technologies and novelties. Example see Geels (2002): sailing ships to steamships;

3) Reconfiguration as cumulative component changes because of economic and functional reasons. Example see Geels (2006a): traditional factories to mass production;

4) De-alignment and re-alignment as a restabilization of a regime created by strong pressure from multiple new entrants competing for resources. Example see Geels (2005): horse drawn carriages to automobiles.

The enumerated examples of different historical transitions share a number of similarities with the current developments in the automotive industry and are therefore used as a basis for further interpretations later in this thesis (see Section 6.2).

In addition, Geels (2011) focuses on sustainability transitions which differ from historical transitions in the way that they are goal-oriented addressing environmental problems but usually do not offer user or performance benefits. They require a change in frame conditions to be able to compete with existing systems and often imply a strategic reorientation of incumbent firms (Geels, 2011). By clarifying the choices related to his perspective and translating the criticisms into suggestions for future research, Geels (2011) attempts to further develop the multi-level perspective. Respective suggestions which are particularly relevant for our own investigations are therefore briefly introduced and built upon later in this thesis:

Firstly, Geels (2011) suggest to address the continuous importance of regime actors by including insights from the business perspective with regard to strategic management and reorientation offering relevant insights of the interplay of existing and new technologies. As a response to this suggestion we investigate the business perspective on the current transformation in the automotive industry by conducting qualitative interviews with representatives from a German car manufacturer.

Secondly, the interdependence and multi-regime interactions (e.g., linkage of transport and electricity regime through battery electric vehicles) are so far understudied suggesting to investigate positive and negative influences. In order to address this gap in research, we are investigating not only a single technological development such as electrification but also innovations such as autonomous driving or the influence of shared usage approaches. The inclusion of broader economic developments as suggested by Geels (2011) helps us to draw a more comprehensive picture of the large-scale transition in the transport sector.

Thirdly, the multi-level perspective provides an overall approach for narrative explanations of transitions for longer time periods using historical or secondary data. To provide a more systematic research also investigating expectations of future developments instead of examining what has happened in the past, our research uses primary data from qualitative interviews. The collected data is based on the multi-level perspective and analyzed according to the respective dimensions, still containing elements of creative interpretation, as suggested by Geels (2011).

Ultimately, long-term transitions are complex, multi-faceted and rare. It is therefore difficult to analyze respective relationships and processes statistically. Geels (2011) concludes that there is not one single way to examine the special characteristics of socio-technical transitions and states that criticism is a constructive tool to guide future research exploring new approaches. By combining a qualitative approach (first study) with a quantitative analyses (second study), we are able to investigate various actors on different levels of the socio-technical systems being able to both openly explore and interpret current developments on the one side and statistically analyze relevant relationships with regard to established constructs on the other.

## 2.2 The Technology Acceptance Model (TAM)

Since the TAM and its further extensions are only briefly touched upon in the article (Chapter 5), the foundations of acceptance research and the role of the additionally relevant determinants, perceived enjoyment and perceived technological risk, are discussed in more detail in the following.

The most widespread concept for innovation adoption is the diffusion of innovation (DOI) framework by Rogers (2010). According to the theory, a product needs to be perceived as better than its predecessor or the idea it supersedes (relative advantage), suitable for the intended use, and consistent with existing expectations (compatibility). Furthermore, the innovation needs to be easy to use (complexity), suitable for being tested prior to the adoption (triability) and it should be visible to others (observability). Tornatzky and Klein (1982) support the importance of Roger's DOI framework by reviewing existing empirical findings concerned with innovation characteristics. This meta-analysis shows that relative advantage, complexity, and compatibility are the most consistent characteristics being significantly related to innovation adoption (Tornatzky & Klein, 1982). In accordance, Davis (1986) develops a model where the two main constructs determining acceptance, perceived usefulness and perceived ease of use, show a close resemblance to relative advantage, compatibility and complexity.

The Technology Acceptance Model (TAM) of Davis (1986) is the most widely applied theoretical model to predict the acceptance of an emerging technology, representing a practical approach to measure the motivation to use an information system ("user acceptance testing") (Lee, Kozar, & Larsen, 2003). The model assesses the relative likelihood of user acceptance prior to implementation by investigating causal relationships between system characteristics and usage intentions. The author therefore introduces and validates two key variables (perceived usefulness and perceived ease of use) which are proposed to influence usage behavior. According to Davis (1989) perceived usefulness refers to "the degree to which a person believes that using a particular system would enhance his or her job performance" indicating a positive use-performance relationship (p.320). Perceived ease of use is defined as "the degree to which a person believes that using a particular system would be free of effort" claiming that a system, that is perceived to be easier to use than another, is more likely to be accepted (Davis, 1989, p. 320). The constructs are confirmed to determine user acceptance and are highly correlated with self-reported usage as well as self-predicted future usage. The respective relationships are

illustrated in Figure 2.3. It is furthermore postulated and confirmed in various studies that the usefulness-usage relationship is stronger compared to the ease of use-usage relationship (see Lee et al., 2003).

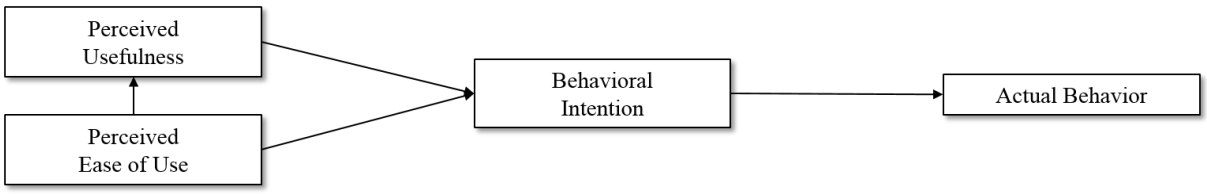


**Figure 2.3: Technology Acceptance Model (Davis, 1989)**

The Technology Acceptance Model is originally based on the Theory of Reasoned Action (TRA) by Fishbein and Ajzen (1975), which is one of the most influential models predicting attitude-behaviour relationships in consumer research (Ajzen & Fishbein, 1977; Madden, Ellen, & Ajzen, 1992; Sheppard, Hartwick, & Warshaw, 1988). The theory postulates that motivational influences and salient beliefs (e.g., attitudes and subjective norms) affect intentions ultimately leading to performing a certain behavior (Fishbein & Ajzen, 1975) as illustrated in Figure 2.4.

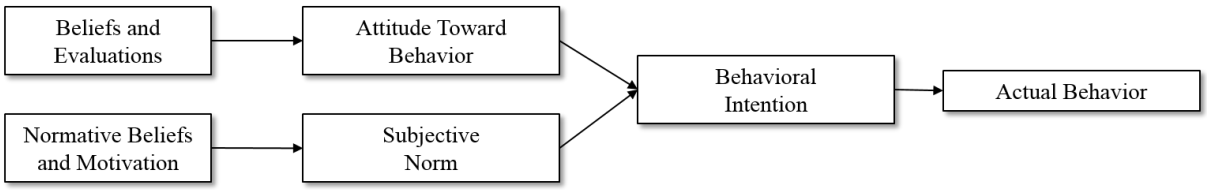


**Figure 2.4: Theory of Reasoned Action (Fishbein & Ajzen, 1975)**

The Theory of Planned Behavior (TPB) by Ajzen (1985) is an extension of the Theory of Reasoned Action (Fishbein & Ajzen, 1975) and includes the exogenous variable perceived behavioral control, which is defined as the confidence in the ability to perform a certain behavior (Ajzen, 1991, p.184). The determinant accounts for significant variance in numerous studies (see Armitage & Conner, 2001), confirming that behavioral control affects actual behavior directly and indirectly through behavioral intentions.

By elaborating on and comparing the previously introduced models with the TAM, Davis, Bagozzi, and Warshaw (1989) address the ability to predict behavioral intentions in terms of additional related variables: attitude and subjective norm (Fishbein & Ajzen, 1975). The authors are once again able to confirm the strong effect of perceived usefulness, explaining more than half of the variance in intentions and a small but significant effect of perceived ease of use, while attitudes are observed to only partially mediating intentions and subjective norms had no effect on intentions at all. Thereby, the comparison supports their rather simple but powerful approach for explaining user acceptance and guiding

managerial implications: a model only including perceived usefulness and perceived ease of use.

Further studies comparing the TPB with the TAM, confirm the high predictable power of both models and their equivalent ability to explain behavior (Mathieson, 1991; Taylor & Todd, 1995). While the TPB provides more specific information that can better guide development of a system, the TAM represents more a general assessment of user perceptions (e.g., usefulness and ease of use). Even though TPB might provide a fuller understanding for design and implementation strategies, the TAM is the preferable model when predicting usage behavior is of primary importance (Taylor & Todd, 1995). It is therefore concluded that the TAM has a slight empirical advantage due to its simplicity and standard instruments (Mathieson, 1991).

### 2.2.1 Model Developments and Extensions

The TAM has been further developed and extended by a large number of researchers as well as been applied to a great variety of different contexts over the last 30 years.

By investigating the influence of motivational factors on usage behavior, Davis, Bagozzi, and Warshaw (1992) differentiate between extrinsic motivation (perceived usefulness) and intrinsic motivation (perceived enjoyment). In contrast to perceived usefulness, postulating a use-performance relationship, perceived enjoyment is defined as the extent to which an activity is perceived to be enjoyable in its own right, apart from any performance consequences (Davis et al., 1992, p.1113). While perceived usefulness remains to be the major determinant in this study, perceived enjoyment is confirmed to also have a significant positive effect, explaining 15 % of the variance in usage intentions. By addressing the relative effects of enjoyment versus usefulness, the authors are able to show that a system, which is perceived as both useful and enjoyable, is more likely to be accepted among potential users (Davis et al., 1992). Definitions of intrinsic and extrinsic motivation (Ryan & Deci, 2000), which form the base for the perceived enjoyment construct, further extensions and corresponding applications are presented later in this chapter (see Section 2.2.3).

Gefen and Straub (1997) provide a conceptual extension to acceptance research by adding gender as a fundamental aspect of culture. The findings indicate that women and men differ in their perceptions but not in the actual use of a system, suggesting that acceptance may not only depend on contextual factors but also on the gender of a potential user (Gefen & Straub, 1997). Malhotra and Galletta (1999) present an alternative theoretical base for

the inclusion of social influences, which is in contrast to the subjective norm construct (Fishbein & Ajzen, 1975) operationalized in the context of compliance, identification and internalization (Kelman, 1958, 1961). The authors claim to thereby offer a richer understanding of users' self-determination and behavior (Malhotra & Galletta, 1999). Later on, Venkatesh and Morris (2000) provide a basis for integrating both gender influences and subjective norm in the context of individual adoption and acceptance (see Figure 2.5).

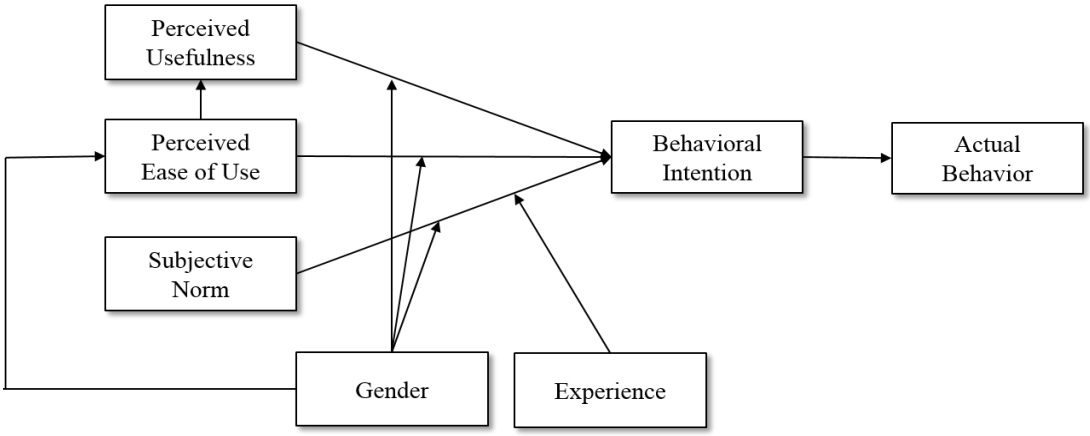


**Figure 2.5: Model Adaption by Venkatesh & Morris (2000)**

Findings indicate that men's acceptance behavior is more strongly influenced by the perception of usefulness whereas women's intentions and usage behaviors are more strongly affected by perceived ease of use and subjective norm. The authors claim that gender is overlooked in past TAM research and that productivity-oriented factors are overestimated while social influences are underestimated (Venkatesh & Morris, 2000).

The **TAM 2** by Venkatesh and Davis (2000) hence forms a theoretical extension of the original TAM and is developed and tested to explain perceived usefulness and usage intentions in terms of social influences and cognitive instrumental processes (see Figure 2.6).

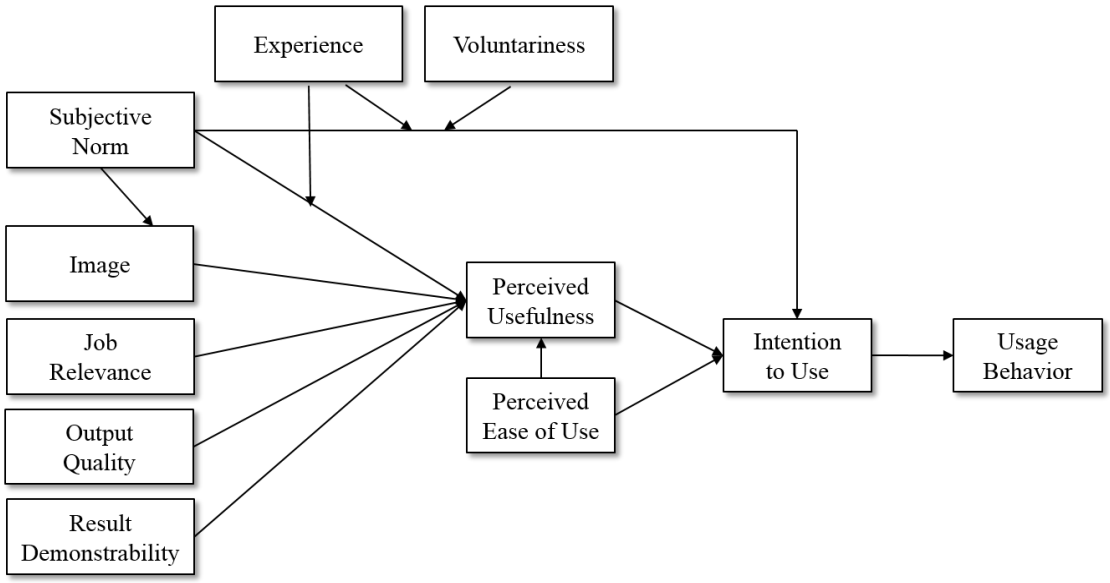


**Figure 2.6: Technology Acceptance Model 2 (Venkatesh & Davis, 2000)**

Respective constructs of the model: subjective norm, voluntariness, image, job relevance, output quality, result demonstrability, and perceived ease of use are measured at three points at time and in four different organizations. All in all the variables account for 46% to 60% of the variance in usefulness perceptions and 34% to 52% in usage intentions. Thereby the authors are able to prove that the added determinants in the advanced model significantly influence user acceptance.

After reviewing, comparing and discussing existing models in user acceptance literature, Venkatesh, Morris, Davis, and Davis (2003) formulate and empirically validate a unified model, called the Unified Theory of Acceptance and Use of Technology (**UTAUT**). The model includes four core determinants (performance expectancy, effort expectancy, social influence, and facilitating conditions) and four moderators (gender, age, voluntariness, and experience). The authors are able to outperform previous models with regard to explanatory power, reaching an $R^2$ of .70 (i.e., variance explained). The UTAUT illustrated in Figure 2.7 is thereby proven to be a useful tool to assess the likelihood of success for new technologies and to understand drivers of acceptance (Venkatesh et al., 2003).

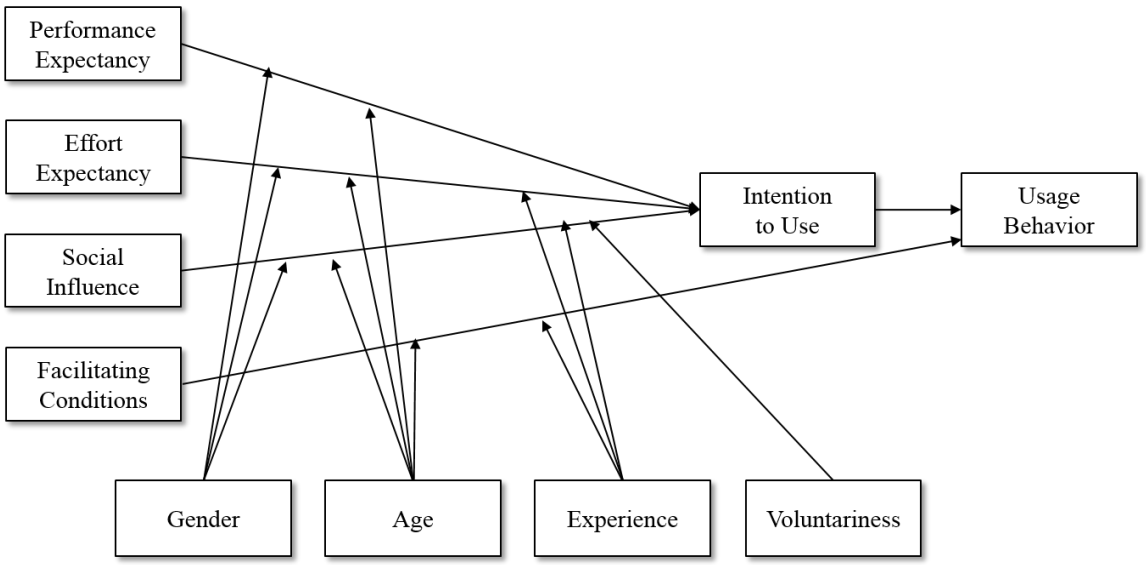


**Figure 2.7: Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003)**

The **TAM 3** is another extension of the original TAM dealing with the role of interventions that can lead to greater acceptance and utilization. By developing and testing a comprehensive integrated model, Venkatesh and Bala (2008) are presenting a research approach to guide pre- and post-implementation interventions to enhance the adoption and the use of technologies.

### 2.2.2 Critical Review

The TAM has had a remarkable effect on technology acceptance research. However, it has also been reviewed and critically examined by various scholars. Moore and Benbasat (1991) for example claim that there is a lack of theoretical foundation and address unsatisfactory levels of validity and reliability of existing scales. Based on previous research on innovation characteristics (Rogers, 2010; Tornatzky & Klein, 1982) and technology acceptance (Davis, 1986), the authors develop a parsimonious instrument to study the initial adoption of IT innovations introducing an 38-item instrument comprising seven scales: relative advantage, compatibility, ease of use, result demonstrability, image, visibility, trialability, and voluntariness. The creation of an overall instrument combining factors that have successfully predicted the adoption and acceptance of innovations in the past, helps to better understand how perceptions affect actual usage (Moore & Benbasat, 1991).

The study by Adams, Nelson, and Todd (1992) presents an evaluation of the ease of use and usefulness scales, comparing the relationship between these variables and system usage for different technologies. Study 1 assesses convergent and discriminant validity in

the context of messaging applications, whereas their second study complements the approach by examining three popular software applications. The results show reliable and validate scales for all of the measurements. Consistent with previous findings, the authors are able to confirm that usefulness is the key determinant of usage intentions. Conditions of usage are furthermore explored in order to explain differences in findings, coming to the conclusion that constructs vary with factors such as user and task characteristics, or experience with any given application (Adams et al., 1992).

Szajna (1996) provides another confirmatory test of the revised TAM in the form of a longitudinal study on a pre- and post-implementation stage. The author claims that the original TAM may be the more suitable tool to predict intentions and technology acceptance. It is furthermore suggested to measure actual usage rather than self-reported usage and proposed that a determinant capturing the experience with a given technology may be a significant enhancement to the model (Szajna, 1996).

Lee et al. (2003) illustrate the chronological progress of TAM research examining accomplishments and limitations of the model (Figure 2.8).

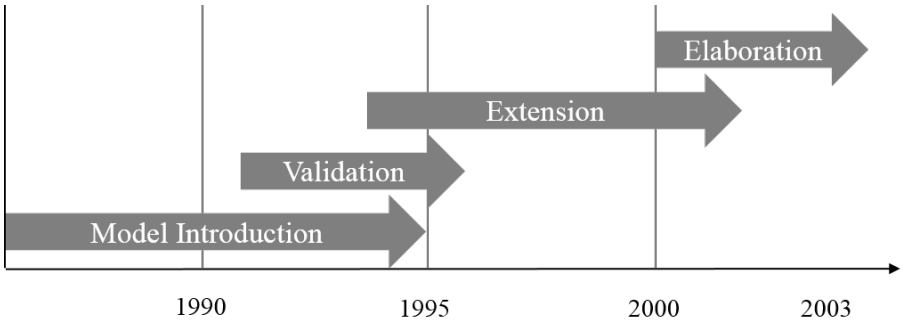


**Figure 2.8: Progress of TAM Research (Lee et al. 2003)**

Various external variables have been introduced extending the model which has been applied to a great amount of different contexts and settings. By investigating past and present findings of more than 100 published articles, Lee et al. (2003) make an attempt not only in critically examining the model but also in predicting the model's future trajectory. The authors conclude that in spite of its shortcomings and contradictory views on TAM research, stating that it has been overdone, the model remains to be a valuable basis for making future discoveries (Lee et al., 2003).

Legris et al. (2003) presents another critical analysis of TAM research, honoring the quality and statistical reliability of results while simultaneously addressing the convergence and divergence of results. By examining the relations between external variables and indicators for system success, the authors discover significant factors not

included in previous models and suggest to put more emphasis on measurement improvements. It is concluded that to better explain system use, the model needs to be integrated into a broader context, covering human and social change in the innovation adoption process (Legris et al., 2003).

By systematically analyzing explanatory and situational factors, Sun and Zhang (2006b) address two main limitations in technology acceptance research: low explanatory power and inconsistent relationships across studies. The role of ten moderating factors are identified and categorized according to organizational, technological and individual factors. Thereby, the authors introduce an integrative model to enhance explanatory power and to provide an understanding of so far less investigated factors (Sun & Zhang, 2006b).

The meta-analysis by King and He (2006) uses 88 published studies confirming that TAM is a valid and robust model to investigate usage intentions suggesting an even wider applicability. By investigating correlations and effect sizes, the authors are able to confirm the influence of perceived usefulness on behavioral intentions, whereas the direct effect of ease of use on behavioral intentions can only be confirmed for internet applications and should not be generalized to other contexts. The authors are furthermore able to show a significant difference in results between professional and general users (King & He, 2006).

Bagozzi (2007) provides another approach to counteract the number of shortcomings of the technology acceptance model. Since the author claims that the model is too simple and leaves out important psychological factors, he proposes a paradigm shift towards an understanding of the mechanism of self-regulation and the decision making process. Building on causal variables within the TAM and its extension, Bagozzi (2007) aims to deepen the theory of technology use by integrating and being open to other research streams grounded in emotional, cultural and goal-directed behavior.

In the context of autonomous driving, the TAM has recently been applied to assess and confirm its utility for advanced driver assistance systems (Rahman, Lesch, Horrey, & Strawderman, 2017). Kohl, Knigge, Baader, Böhm, and Krcmar (2018) use the TAM as a basis to anticipate the acceptance of self-driving cars, presenting an alternative approach using twitter. Recognizing the role of the TAM in acceptance research, Hengstler, Enkel, and Duelli (2016) analyze the relationship between humans and automation emphasizing on the critical role of perceived risk and trust in a technology and the innovative firm. Furthermore, Zmud and Sener (2016) apply the car technology acceptance model (an adaption of the UTAUT) to understand the adoption and use of self-driving cars in Austin by adding a qualitative investigation to further elaborate on travel behavior decisions.

Overall and despite of its shortcomings (e.g., intention-behavior linkage, self-reported usage), the TAM has been empirically proven to yield statistically reliable results and to consistently predict and explain about 40 percent of system usage (Bagozzi, 2007; Legris et al., 2003). The appeal of the model, which was originally developed to evaluate the market potential of emerging computer based systems, is that it is both simple and precise (Mathieson, 1991; Taylor & Todd, 1995). It is furthermore characterized by its high flexibility and generalizability that allows it to be adapted to a variety of different contexts (King & He, 2006; Lee et al., 2003). The large number of studies over past decades confirm that the TAM is not only able to explain user acceptance of newly emerging information systems but also predict usage behavior with regard to a great variety of innovative technologies and additional external variables (e.g., Featherman & Pavlou, 2003; Gefen & Straub, 1997; Moon & Kim, 2001; Pavlou, 2003; van der Heijden, 2004). Hence, it forms the base for the underlying research approach in Chapter 5 and is substantially extended to investigate two context-specific determinants of behavioral intentions towards self-driving cars which are introduced below.

### 2.2.3 The Role of Perceived Enjoyment in Acceptance Research

As briefly introduced in Section 2.2.1, Davis et al. (1992) added and thereby extended the TAM to account for the motivational aspect perceived enjoyment originated from the classical concept of intrinsic and extrinsic motivation. Ryan and Deci (2000) discuss the distinction between these two types of motivation in terms of basic psychological needs and present classic definitions: the intrinsic motivation to engage in exploratory, playful, and curiosity-driven behaviors is defined as the "[…] the doing of an activity for its inherent satisfaction rather than for some separable consequence" (Ryan & Deci, 2000, p.56). Hence, intrinsically motivated behaviors are a free choice and performed to satisfy psychological needs for autonomy and self-determination. In contrast, extrinsically motivated behaviors differ in the degree to which they are autonomous and accompanied by the experience of external control or pressure. Hence, extrinsic motivation leads to an activity, which is done in order to attain some separable outcome or to gain instrumental value (Ryan & Deci, 2000, p. 60).

Elaborating on the previously introduced definitions of intrinsic and extrinsic motivation and the key constructs of the TAM, Malhotra, Galletta, and Kirsch (2008) study the locus of user motivations, providing an understanding beyond the dichotomy of mandatory

versus volitional behaviors. The authors develop a theoretical basis for how a certain behavior results from perceived external influences, personal volition or a combination of both. Thereby they are able to show how external influences are transformed into self-guided behavior and how social norms and values are internalized as endogenous motivations, thereby, paving the way for understanding the positive psychology of productivity (Malhotra et al., 2008, p.293).

Igbaria, Schiffman, and Wieckowski (1994) examine the effects of perceived usefulness and perceived fun on microcomputer technology acceptance on the basis of previous research from Davis et al. (1989, 1992). Results indicate that perceived usefulness is the most important determinant in predicting system usage. In addition, a negative impact of anxiety directly and indirectly (via perceived fun) is confirmed. Perceived fun and satisfaction are also proven to have an effect on technology acceptance but are less influential. The authors suggest to rethink the concept of work and joy and to further investigate the influence of system usage on individual and organizational performance (Igbaria et al., 1994).

Igbaria, Parasuraman, and Baroudi (1996) synthesize prior research findings and test a motivational model, supporting the proposition that perceived usefulness is the principal motivator for microcomputer usage. In addition, findings demonstrate that skills do play a critical role by directly promoting usage and indirectly through perceived usefulness, enjoyment and social pressure. It is furthermore shown that complexity has a negative effect on perceived enjoyment, indicating that it is important to further emphasize on features that make technologies enjoyable to use (Igbaria et al., 1996).

Teo, Lim, and Lai (1999) investigate usage intentions of the Internet with regard to intrinsic (i.e., enjoyment) and extrinsic (i.e., usefulness) motivation. Results demonstrate that perceived usefulness is the main determinant affecting all of the measured usage dimensions (i.e., frequency of use, daily use, and diversity of use). Perceived enjoyment and ease of use only affect specific dimensions. Whereas enjoyment is confirmed to influence frequency and daily usage, ease of use influences frequency and diversity of use. The authors conclude that perceived usefulness is generally more important than perceived ease of use and perceived enjoyment, indicating that systems that are enjoyable and easy to use are not accepted if they do not provide necessary functionalities (Teo et al., 1999).

Based on the described motivational influences, Moon and Kim (2001) include the construct playfulness as users' intrinsic beliefs in an – at that time - newly emerging technology: the world-wide-web. By extending the TAM (Davis, 1986, 1989), the authors

aim to enhance the explanatory power of the model beyond the two fundamental determinants perceived usefulness and ease of use. Besides verifying the importance of the two initial variables, the authors are able to confirm a significant effect of perceived playfulness on attitudes toward using and behavioral intentions to use the world-wide-web (Moon & Kim, 2001).

Van der Heijden (2004) investigates hedonic information systems (pleasure-oriented) which in contrast to utilitarian systems (productive use) provide a self-fulfilling value focusing on the fun-aspect. The author is able to support the hypotheses that, in the context of hedonic systems, perceived enjoyment and perceived ease of use are stronger determinants of usage intentions than perceived usefulness. It is thereby postulated that perceived usefulness loses its dominant role in favor of enjoyment and ease of use. Hence, even if a utilitarian system is rejected by its users, the findings indicate that acceptance may be reached by adding hedonic features (van der Heijden, 2004).

Sun and Zhang (2006a) investigate the causal relationships between perceived enjoyment and perceived ease of use as it is theorized and empirically tested in prior literature. In order to examine whether perceived enjoyment is an antecedent or a consequence of ease of use, the authors employ an alternative statistical method: Cohen's path analysis. By investigating two different technologies and user samples, it is shown that the influence of perceived enjoyment on perceived ease of use is the dominant causal direction for utilitarian systems (Sun & Zhang, 2006a). The authors furthermore claim that the investigation of causal relationships and their dominant direction should receive more attention in future research.

In order to understand e-shopping behavior, Ha and Stoel (2009) integrate quality, enjoyment, and trust into a technology acceptance model. While perceived usefulness remains to be the most powerful predictor, the influence of perceived ease of use on attitudes toward e-shopping cannot be confirmed. Findings furthermore reveal a high predictive value of trust and enjoyment, which ultimately play a significant role in consumer acceptance. The authors thereby highlight the importance of consumers' safety and experiential needs (Ha & Stoel, 2009).

### 2.2.4 The Role of Perceived Risk in Acceptance Research

"Trust plays a central role in helping consumers overcome perceptions of risk and insecurity" (McKnight, Choudhury, & Kacmar, 2002, p. 334). In accordance, existing research is able to confirm that trust is a precondition of social behavior, supporting the

hypothesis that the perceptions of risk are influencing behavioral intentions (Gefen, 2000; Jarvenpaa, Tractinsky, & Vitale, 2000; Lee & See, 2004; McKnight, Carter, Thatcher, & Clay, 2011). According to Bauer (1960), consumers perceived risk can be interpreted as a subjective impression of the real world that motivates a certain behavior to avoid mistakes. Due to consumers' limited information and semi-reliable memory an accurate assessment of objective risk is not possible. However, evaluating risk perceptions is a powerful tool to explain consumer behavior (Mitchell, 1999).

Cunningham (1967) suggests a two-component model and defines two determinants of perceived risk as "the amount that would be lost (i.e., that which is at stake) if the consequences of an act were not favourable, and the individual's subjective feeling of certainty that the consequences will be unfavourable" (p.39). Mitchell (1999) reviews and summarizes the literature on consumer-perceived risk, setting it in context with related constructs from marketing research. By investigating different models and operationalizations to measure perceived risk, the author proposes criteria to choose between different models. After comparing models according to these aspects (i.e., understanding, prediction, suitability for reliability and validity assessment, practicability and usability), the two-component model (Cunningham, 1967) is suggested to be the most generally useful model for researchers and practitioners (Mitchell, 1999).

Pavlou (2003) integrates perceived risk and trust with the two key constructs of the TAM (perceived usefulness and ease of use) to predict consumer acceptance of e-commerce. The additional variables capturing behavioral and environmental uncertainty are tested in two empirical studies (exploratory and confirmatory) and thereby proven to be direct antecedents of behavioral intentions. The author suggests that uncertainty reduction should therefore receive more attention in consumer research. By reaching high explanatory power, the author is able to propose a basic model enhancing the understanding of consumer behavior in e-commerce (Pavlou, 2003). In another study by Featherman and Pavlou (2003), measures of negative utility (i.e., potential losses) are operationalized as specific risk facets and empirically tested within the TAM. By further investigating the construct of perceived risk, the authors propose a more granular level of analysis. The introduced research model suggests to include a performance-based perceived risk variable and can confirm its effect on the adoption of e-services (Featherman & Pavlou, 2003).

Im, Kim, and Han (2008) investigate the effects of four potential moderating variables including technology type and perceived risk in order to refine the UTAUT. The authors are thereby able to confirm a moderating effect of perceived risk on perceived usefulness,

ease of use and ultimately users' technology adoption. The study highlights the importance to emphasize on ease of use and to differentiate between utilitarian and hedonic systems with regard to the value for potential users (Im et al., 2008).

By investigating the acceptance of mobile banking services as an emerging technology, Luo, Li, Zhang, and Shim (2010) are extending acceptance research incorporating integral roles of multi-dimensional trust and multi-faceted risk. Findings indicate that six facets of risk perceptions (i.e., financial, performance, privacy, time, psychological, and overall risks) are salient antecedents to innovative technology acceptance. The authors furthermore support the fact that performance expectancy is the core determinant and propose a useful lens for examining comprehensive risk perceptions in acceptance research (Luo et al., 2010).

Lee and Song (2013) analyze the impact of trust and perceived risk on the core constructs of the UTAUT applying it to the context of certified e-Document Authority. The authors are thereby able to confirm a significant effect of trust and perceived risk and can support the positive influence of performance expectancy and social influence on behavioral intentions.

Kervick, Hogan, O'Hora, and Sarma (2015) are investigating Smartphone Driver Support Systems building on technology acceptance research and incorporate perceived risk and social influence as potential influencing factors on behavioral intentions. The study suggest to enhance perceptions of gains and to promote positive perceptions of peer usage (Kervick et al., 2015).

After having reviewed the TAM and its further extensions, it becomes clear that it is the model of choice, when investigating technology acceptance. The influence of perceived enjoyment and perceived technological risk on the acceptance of self-driving cars is investigated and discussed in-depth within the working paper in Chapter 5.

# 3 Publication: Do Future Mobility Concepts Fit Customer Demand?

Abstract:

Electric vehicles, features for autonomous driving, and car-sharing services in combination with mega trends - such as urbanization and digitalization - have the potential to revolutionize the entire mobility sector. Our study addresses the ongoing shift in values and the kind of individual consumer demand that has to be met by providing innovative and flexible concepts for future transport. In particular, we call into question what challenges need to be faced, when various new technologies and business models are integrated. Our qualitative approach is based on the use of semi-structured interviews with representatives from a traditional car manufacturer. By investigating the expectations and actions of different stakeholders from an organizational perspective, we find important predictions concerning the inevitable changes in consumer behavior and consequently in organizational strategy. It becomes clear that one of the key challenges is an appropriate steering system to motivate innovation activities and enhance creativity in order to ensure long-term success in an increasingly competitive market environment.

[1] This chapter is based on a paper (single-authored) that has been published 2018 in *Conference Proceedings of International Conference on Advances in Economics, Social Science and Human Behaviour Study,* p. 23-29 (DOI :10.15224/978-1-63248-156-6-22 / ISBN : 978-1-63248-156-6).

# 4 Publication: An Organizational View on Transport Transitions Involving New Mobility Concepts and Changing Customer Demand

Abstract:

The integration of electric, shared and autonomous vehicles is shaping new forms of mobility and ultimately the future of the entire automotive industry. Our study addresses the ongoing shift in values and individual customer demand that has to be met by providing innovative concepts for future transport. We call into question what challenges arise when new technological developments and complex societal changes need to be aligned in a socio-technical system. Our qualitative approach is based on the use of semi-structured interviews with representatives from a traditional car manufacturer. By investigating the expectations and actions from an organizational perspective we find important predictions concerning the inevitable changes in customer behaviour and organizational strategy. It becomes clear that one of the key challenges is an appropriate steering system to motivate innovation activities and enhance creativity within the organization in order to ensure long-term success in an increasingly competitive market environment.

[2] This chapter is based on a paper co-authored by Alwine Mohnen (2019) that has been accepted for publication in *Environmental Innovation and Societal Transitions,* 31, 54-63 (DOI: 10.1016/j.eist.2019.01.005).

# 5 Working Paper: Self-Driving Cars: Intention to Buy or Intention to Use? How Perceived Enjoyment Affects Acceptance.

Abstract:

The purpose of this study is to compare purchase and usage intentions with regard to self-driving cars, expecting a shift from private car ownership to shared usage approaches. In order to analyze key determinants in customer acceptance, potential influencing factors such as perceived enjoyment and risk are investigated. Based on the widely recognized Technology Acceptance Model, our quantitative research approach uses survey data from 341 participants. Findings indicate that 71% are willing to use a self-driving car and 55% are interested in buying one. Explanatory power is high for both models, predicting either purchase or usage intentions, thereby indicating that self-driving cars are more likely to be accepted if potential customers perceive them to be enjoyable and useful. Hence, pleasure and time spend in a car, now being able to realize other activities (e.g., reading mails, newspapers, and checking the smartphone), should receive the highest attention. Perceived technological risk plays only a minor role, uncovering a significant difference between public discussions in (social) media and actual customer acceptance. Even though the intention to buy exists for self-driving cars, concepts for shared mobility with a high level of convenience and individualization are necessary. The key challenge to satisfy increasing mobility demand is to establish new business models and enhance the attractiveness of alternative pay-per-use solutions.

[3] This chapter is based on a working paper co-authored by Alwine Mohnen that is currently under review for publication.

# 6 Conclusions

## 6.1 Summary of Main Results

This thesis aimed to provide an understanding of how transformational change in the automotive industry affects multiple actors in a socio-technical system in the context of transport innovations.

The first two articles (see publications in Chapters 3 and 4) are closely linked and based on the same qualitative dataset (expert interviews), examining the current developments in the mobility sector from an organizational perspective (i.e., that of a traditional car manufacturer). While the first publication analyses the transition in more general terms in order to provide an overview of organizational expectations and strategies with regard to changing mobility behaviors and framework conditions (Chapter 3), the second publication elaborates on these by applying a multi-level perspective to obtain deeper insights into what opportunities to seize and which challenges to counteract as an established company, so as to ultimately remain relevant as an important element in the future of transport (Chapter 4).

Additionally, in order to capture the customer perspective and verify the previously achieved results, a second quantitative study examines how shifting preferences affect the technology acceptance of future mobility concepts, i.e., self-driving cars. Investigating causal relationships based on an online questionnaire enabled the prediction and comparison of behavioral intentions regarding classical vehicle ownership versus the emerging sharing approach and is presented in form of a working paper in Chapter 5.

The key results arising from the analyses are summarized as follows.

**Summary of Qualitative Results (Research Question 1)**

The qualitative study comprising semi-structured interviews provides the data basis for Chapters 3 and 4. It contributes to the literature by critically examining the viewpoint of a traditional car manufacturer to provide an understanding of how to cope with challenges arising from transformational change. From an organizational perspective, the qualitative approach investigates these organizational challenges and finally identifies managerial implications. Although new competitors pose difficulties for established firms by introducing radically new products and services, it must also be acknowledged that competition triggers more innovative solutions to translate emerging technological

opportunities into a desired customer benefit. The findings suggest that it is essential to further promote the courage to explore new paths in order to meet the novel demands of a global society. Unintentionally, the studies uncover significant difficulties regarding a misleading steering system in established companies. Even though traditional management practices enhance productivity, they might also inhibit creativity, which is indispensable in times of change. Existing organizations need to "reinvent" themselves by changing established institutional structures and going beyond the traditional scope of the firm. Exploring new approaches, instead of repeating past actions and processes, is indispensable in a shifting market for satisfying more individual customer needs and remaining successful in the future of urban transport. According to the insights gained from the expert interviews, classical accounting measures and the sole focus on traditional incentive systems are contradictory to innovative activities. They do not promote the necessary tolerance for failure, where mistakes are dealt with constructively and, ultimately, result in more creative proposals for the future of transport: *"[…] when financial figures are prioritized at the cost of product substance, the organization is risking a promising alignment of the portfolio"* (interviewed expert, Case R).

***Result 1: There is a strong need to broaden and reinvent the steering system to further promote innovation activities and the development of new products and services. Adding creativity enhancing measures should complement already existing performance targets, ultimately facilitating a higher tolerance for failure and creative proposals.***

Additionally, new business models need to provide a better mobility experience and be supported by customers, who ultimately wield the power in the market. Electrification is already reaching the tipping point of widespread adoption and the development of shared usage approaches is observed in a wide variety of industries (e.g., entertainment, tourism). Carsharing leads to a notable growth in the mobility market while, in the long term, simultaneously reducing the absolute number of cars, thereby providing considerable relief for urban environments. Additionally, experts agree that *"people will love"* driverless vehicles that enable improved quality of life. Hence, the results in Chapters 3 and 4 show that, shared and autonomous vehicles constitute important enablers of a more diverse and efficient portfolio of transport options. Further advances in technology and cost reductions will, ultimately, lead to the satisfaction of individual customer needs on higher levels of comfort and flexibility.

***Result 2: High expectations are placed upon the integration of electric, shared, and autonomous vehicles as a profitable solution to counteract grand societal challenges, such as increasing urban transport problems from an organizational and constitutional point of view, as well as for the fulfillment of more sophisticated mobility demand by customers.***

While changing demographic conditions are shaping new forms of customer demand, increasing legal requirements (e.g., emission standards) force the industry to rethink known patterns. Whereas, on the one side, unpredictable political decisions and increasing protectionism require quick reactions and high flexibility in strategic decision making in organizations, state support through incentives is a strong factor positively influencing changes in customer behavior. Hence, the legislator is a powerful actor in guiding developments on different levels and setting the necessary standards regarding a suitable legal framework and liability regulations for autonomous vehicles.

***Result 3: Regulation is of high importance in shaping the future of transport on both supply and demand sides. To some extent, unpredictable decisions challenge the industry.***

**Summary of Quantitative Results (Research Question 2)**

The insights and conclusions presented above form the foundation for a further investigation of hypothesized causal relationships. The main objective of the quantitative study is to predict and compare behavioral intentions and thereby, anticipate the acceptance of self-driving cars. The fundamental question that is asked is whether shared driverless vehicles will be able to satisfy the sophisticated mobility desires of modern societies and thereby, replace the paradigm of private property and classical vehicle concepts. Comparing purchase and usage intentions indicates that the usage approach is slightly preferred, requiring alternative concepts that ensure a comfortable and flexible way to cover short as well as long distances while being relieved from the driving task and obligations of ownership. However, purchase intentions are still anticipated to exist even for self-driving cars. It can, therefore, be assumed that individually owned premium vehicles will remain appealing for certain target groups that feel an emotional attachment to premium products.

***Result 4: The behavioral intention to use a self-driving car is higher while the intention to buy still exists. Perceived usefulness remains an important determinant but loses its dominant role in the technology acceptance of self-driving cars.***

Perceived usefulness remains a strong indicator of behavioral intentions. However and unexpectedly, the most influential determinant increasing technology acceptance is the enjoyment perceived from being driven in an autonomous vehicle. Individuals are shown to be aware that the relief from exhausting driving conditions can ensure a new level of comfort and independence. Since a negative effect of perceived enjoyment while driving conventionally cannot be confirmed, it is assumed that its substitution by an automated system does not lead to rejection. Although the traditional driving task is still anticipated to be enjoyable in certain situations, it is likely that, in the future, the pleasure of driving will be replaced by that of being driven. The positive psychology of productivity and the ability to engage in other activities should, therefore, receive the highest attention in developing and implementing self-driving cars.

***Result 5: Perceived enjoyment while driving autonomously is the most influential determinant positively affecting the acceptance of self-driving cars. However, a negative influence of perceived enjoyment while driving a conventional car cannot be confirmed.***

Risk perceptions regarding self-driving cars dominate public discussions in the political environment and social media. However, findings indicate that perceived technological risk is of less relevance than expected. The missing legal framework, liability issues, or concerns about technical reliabilities play only a minor role for customer acceptance. Hence, the perception of gains and positive consequences attributed to self-driving cars seem to already overrule various concerns presumed to hinder adoption. Nevertheless, it remains important to further emphasize on the benefits and reduce the uncertainties associated with safety matters and/or equipment failure.

***Result 6: Perceived risk has a rather low (intention to use) or no influence at all (intention to buy) on the acceptance of self-driving cars, indicating that the importance of this fact is overestimated in public discussions.***

Overall, the results support the strong need for established organizations to further engage in the development and implementation of future mobility concepts. To counteract increasing problems of urban transport and environmental impacts as well as to meet

regulatory requirements and individual customer needs, it is necessary to provide mobility on demand alternatives that free individuals from the burdens associated with ownership and tense traffic situations. The key challenge is to break away from existing conventions especially within an organization and to find the best and most profitable solutions in line with customers' perceptions, intentions and acceptance to actively shape the future of transport.

## 6.2 MLP and TAM - a "bigger picture"

As stated by Smith et al. (2010), exploring "the bigger picture" is the unique allure of the multi-level perspective on socio-technical transitions (p. 435). The main objective of this thesis is to draw this "bigger picture" by analyzing the organizational as well as the customer perspectives as so to better understand the evolutionary process from classical car ownership to shared, electric, and autonomous vehicles. The typology of transition pathways and adaption to historical case studies (i.e., the transition from horse-drawn carriages to automobiles) has already been introduced in Section 2.1. Following Frank Geels (2002), as one of the most renowned experts in the field of transition research, the multi-level perspective of the transition in the mobility sector helps to evaluate and transfer past developments into future scenarios of urban transport. Building on that, the results of the semi-structured interviews with experts from a traditional car manufacturer as well as the study on technology acceptance, allows the elaboration of such possible future scenarios and necessary framework conditions for innovative mobility concepts. Ultimately, the approach contributes to an understanding of transformational changes currently occurring in the transport sector and extends the theory by combining transition and acceptance research. Hence, based on achieved results, an illustration of potential system developments is drawn and illustrated in Figure 6.1.

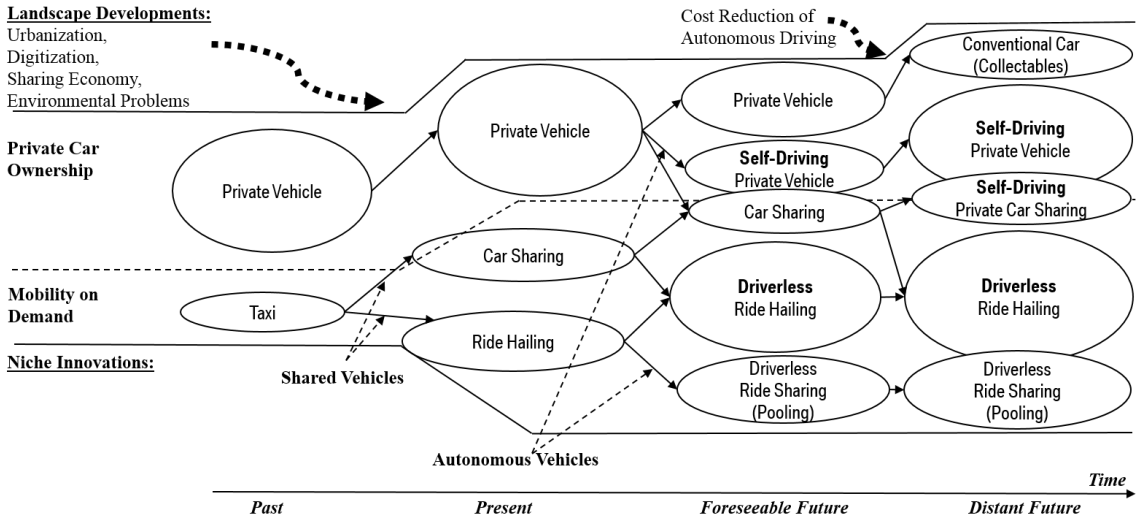


**Figure 6.1: Predicting the Future of Car Transport (own illustration)**

As illustrated, the *past* and traditional regime configuration has been a simple split of two options for car usage: private vehicle ownership and taxi services.

Already, as of *today,* we are observing alternative options and additional players (e.g., Uber, ShareNow) seizing new opportunities to satisfy an increasing demand for individual and urban mobility. However, for now, the level of private car ownership remains stable and is supplemented by additional mobility services on demand.

In the *foreseeable future* towards the diffusion of autonomous vehicles, it is assumed that a more disruptive shift would lead to increased attractiveness of ride hailing services. Due to lower costs of driverless services and the obligation to counteract increasing problems of urbanization (e.g., traffic and lack of space), ride hailing may represent a truly attractive option to move from one place to another. At the same time, privately owned vehicles might be either the conventional sort, which require the driving task, or self-driving for early adopters and for those who are willing to pay a certain price premium.

Imagining the *distant future,* self-driving vehicles may become affordable for a larger segment of the population, due to cost savings. Traditional vehicles might slowly, but surely, become collectors' items for individuals who still possess a driving license and perceive the traditional driving task as enjoyable. Due to increased traffic and lack of space in urban areas, carsharing and ride hailing may represent an even more important component of urban mobility. Another possibility and analogous to the housing market or tourism industry (e.g., Airbnb), is to finance the costs associated with ownership by sharing a personally owned car with peers or visitors from other cities and countries. In summary, the transport options might further increase providing more flexible and individual alternatives at different prices and convenience levels.

## 6.3 Limitations and Recommendations for Future Research

The assessment of various influencing factors on the future of transport, related organizational activities and changing customer behaviors leads to a preliminary insight and has important implications for future research. The combination of a qualitative analysis of the organizational perspective with a quantitative approach investigating customer acceptance of emerging technologies enhances the understanding of a socio-technical transition on different levels and elements. Although this thesis chooses a multi-method approach and is thereby able to provide a comprehensive overview, it does not allow for a complete description of the current transition in the automotive industry. Even though results are made predictable and comprehensible, they are limited to a single organization and specific sample of the German population. Hence, a certain disadvantage with regard to external validity is recognized and the level of generality is limited. However, generalizability can be enhanced by conducting the same type of analyses for multiple cases, i.e., other car manufacturers, other samples in different countries, and in a greater variety of contexts, i.e., other industries.

Since this thesis investigates the organizational and the customer perspective, it is suggested to also take a closer look at the institutional level. Investigating strategies and expectations of the legislator, can provide deeper insights into regulatory challenges and opportunities. Setting specific standards and applying incentive schemes can provide solutions to increasing urbanization and ultimately prevent problems in terms of less available time and space. Examining which legal framework can best encourage industry and society towards more sustainable forms of transport will have environmental and societal benefits. Quantitative and experimental approaches should be used to determine how the promotion of integrated mobility solutions can accelerate the implementation of shared, autonomous vehicles in order to benefit from its positive consequences more rapidly.

The fact that the currently applied management system with its dominance on financial figures might be the best solution for traditional fields of activity but hinders creative ideas and innovative approaches in an organization, is the most unexpected finding. Future research should be done in order to develop an adjusted steering system which adds creativity-enhancing measures to the classical performance incentives.

Additionally, future research could elaborate on the findings by analyzing the influence of demographic variables and social influences. Although no significant differences regarding

the acceptance of self-driving cars controlling for age, gender, residential area or education can be observed, one might wonder if a younger person living in a mega city shares the same mobility preferences and requirements than an already retired person living in a rural area.

## 6.4 Implications for Practice

Due to the described multi-faceted interlinkages and differing perceptions it is difficult to foresee the developments in the automotive industry affecting both: production and consumption. However, adopting a broader perspective allows to draw a picture of a future scenario of urban mobility and innovative solutions for transport as well as to provide an understanding of how to satisfy changing customer demand.

Especially within younger generations a shift to more flexible and shared usage behaviors can be observed. In the future it will be less important to own something as long as it can be used, implicating a strong need to further extend the product and service portfolio with holistic mobility on demand solutions. However, it is assumed that there will still be a certain demand for individually owned premium vehicles, where convenience remains to be the key selling proposition. Nevertheless, it is indispensable to further develop innovative technologies such as autonomous driving features to profit from the numerous benefits of combining shared usage approaches and driverless cars. Future generations aim for products and services that are supposed to make life easier and offer a high level of flexibility. Being chauffeured in a self-driving car is perceived as being enjoyable, providing a new level of comfort and independence. Hence, new vehicle concepts for the future of transport should include features that are enjoyable to use, and be seamlessly connected to smart devices. Time spent in a car with the ability to engage in other activities should receive the highest attention to satisfy more versatile and sophisticated forms of customer demand.

Existing organizations have a great chance to enhance their businesses even more. In order to do that, they need to perform whilst transform and, simultaneously explore a parallel path to seize the opportunity to develop new concepts beyond their traditional offering portfolios. To remain successful in an increasingly competitive market environment and to better exploit existing knowledge and core competencies, established firms need to closely work together and build strategic alliances even if this means losing a part of their independency. As demonstrated by Tushman and Anderson (1986): “[…] technology evolves through periods of incremental change punctuated by technological break-throughs

that either enhance or destroy the competence of firms in an industry" (p.439). In order to enhance innovative capabilities and organizational structures, alternative approaches for the steering system are necessary. Since new technologies and alternative approaches usually do not meet the same profitability standards, innovation activities require different incentive schemes than merely aiming for performance improvements. A higher tolerance for failure and long-term rewards might motivate people to take bolder steps in developing and implementing courageous solutions.

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