1 Introduction

The motivation for this cumulative thesis and overall relevance is described in Section 1.1, with research gaps and questions (1.2), and thesis structure (1.3) following after that. Furthermore, the research design is summarized in Section 1.4, followed by Section 1.5, which outlines the anticipated contributions for research and practitioners.

1.1 Motivation

Recently, economic development across the globe has steadily increased the percentage of the population living in urban areas. As the World Urbanization Prospects of 2014 reports, 54% of the world's population currently lives in citified areas (cities with a population of around 500,000 inhabitants). This report likewise assumes an increase in the percentage of people living in urban areas up to 66% by 2050, in addition to a stable accumulation of mega-cities that contain over 10 million residents (UN-DESA, 2014). 80% of today's global greenhouse gas emissions are already tied to cities. Furthermore, CO2 emissions, which are primarily responsible for global warming, continue to rise, while a substantial amount of that is associated with transportation in general (Firnkorn and Müller, 2015; World Bank, 2013; Y. Xu et al., 2018).

Correspondingly, the transportation sector is one of the central sources of the European Union's greenhouse gas emissions because it is responsible for nearly a quarter (23%) of energy-related CO2 emissions (IEA, 2018). Thus, this issue resides at the center of the strategies put forth by the European Commission to reduce greenhouse gases. Currently, almost one billion cars exist around the globe—an amount that has the possibility of doubling by the year 2030 (Dargay et al., 2007; Firnkorn and Müller, 2015; Perboli et al., 2014)—while passenger land transport demonstrates the highest share of the CO2 emissions (Creutzig et al., 2015).

It becomes problematic when attempting to find an aspect of a globalized society that is more influential and in the same vein as mobility. Given these significant global challenges, the question arises as to how the Information Systems (IS) community may contribute to avoiding, lowering, or optimizing the current mobility sector regarding CO2 emissions in order to make it more sustainable while also making cities more habitable again. The high costs of using individual vehicles within car-centric cities demonstrate several challenges for the infrastructure associated with urban transport, which include higher energy consumption, congestion, fewer available parking spaces, noise and environmental pollution, waste, and other inefficient uses of land (Berger et al., 2014; Freese and Schöneberg, 2014; Hackney and Neufville, 2001). That being said, the traditional idea of mobility must change and is currently changing. As there continues to be an increase in population density and CO2 emissions, today's widely used fuel vehicles and forms of private transportation will not be as practical (Nijland et al., 2015; Nykvist and Whitmarsh, 2008; Pavone et al., 2012).

Issues such as these have paved the way for the emergence of behavior that is more environmentally conscious, in addition to prioritizing environmental protection during decision-making (Stern, 2000). Consequently, contemporary mobility practices have become intolerable for reasons related to safety, the environment, and natural resources (Dikmen and Burns, 2016; Herminghaus, 2019). Thus, the demand is increasing for innovative and new sustainable mobility services. New valuable propositions, influenced by economic, social, and ecological factors, have been emerging. The future of mobility is shifting at a rapid rate.

At the forefront of this development are especially two disruptive trends which are considered in the automotive industry and also form the research context of this cumulative thesis—taking advantage of the sharing mindsets and autonomous driving (AD) to successfully address the challenges listed above (Kuhnert et al., 2019; Sovacool and Axsen, 2018).

Shared mobility signifies transportation that is shared, for example, carpooling and ridesharing, sharing the vehicle itself (carsharing), or in a broader sense, public transport as rides that are also shared with other people (Cohen and Kietzmann, 2014; Hamari et al., 2016). As for sharing mobility, carsharing and ridesharing, which have both equally risen in importance due to digitization, are prime examples for digitized mobility services because IS make them more efficient and increasingly available (Furuhata et al., 2013; Remane et al., 2016). Thus, these Digital Shared Mobility Services (DSMS) serve in attaining an improved sustainable mobility infrastructure, especially when the successful spread of DSMS leads to an increase in the proportion of shared journeys, thus reducing CO2 emissions, and additionally, it intersects with the future disruptive trend of AD, which also has several ecological benefits itself (e.g., Barth et al., 2014; Cohen and Kietzmann, 2014; Furuhata et al., 2013; Hamari et al., 2016; Lang et al., 2017; Shanker et al., 2013; Sovacool and Axsen, 2018).

AD is defined as a system within the vehicle having the ability to create and handle any situation on its behalf. Driver intervention or supervision is not mandatory, which allows non-driving activities for the passengers and, technically, driving without a driver (SAE International, 2018;

Sovacool and Axsen, 2018). Especially for the field of AD, drastic changes are becoming apparent. AD, the next significant development, is known to provide several benefits on a societal and an individual level, including better road safety, condensed traffic congestion, and an enhanced ecological footprint by refining energy efficiency (Beiker, 2012; Bertoncello and Wee, 2015; Brown et al., 2014; Diclemente et al., 2014; Nath, 2013; Shanker et al., 2013). Significant advances in computerization and IS have allowed for cars to make decisions on behalf of humans. AD is the succeeding mobility-related disruptive innovation and is projected to enter the mass-market in fewer than ten years (Nieuwenhuijsen, 2019; Roland Berger, 2014). It can substantially shrink the ecological footprint of vehicles down, with functions such as optimized braking and acceleration, being able to progress traffic flow, therein reducing both carbon dioxide emissions and fuel consumption (e.g., Brown et al., 2014; Greenblatt and Saxena, 2015; Greenblatt and Shaheen, 2015; Milakis et al., 2017). In combination with DSMS, it could in particular help to increase the flexibility of access to public transport (lack of flexibility is the decisive factor why users choose not to use it (Gray et al., 2006) and act as a kind of similar to “self-driving taxis” (Brendel et al., 2017) in order to support the use of more emission-friendly public transport and reducing individual transport, thus achieving emission savings and making a further significant contribution to addressing the challenges outlined (e.g., Acheampong and Cugurullo, 2019). Thus, in order to reap the benefits of AD, it might be advantageous to introduce AD initially as a publicly shared mobility solution, e.g., as a public bus system. Mainly as autonomous vehicles (AVs) are best used commercially by a model that collects passengers at any given point and routes them to their respective destinations (International Transport Forum, 2015; Münzel et al., 2018), making such AD-related DSMS a direct competitor of companies such as Uber and Lyft and at the same time inspire sustainable public transport. An additional societal benefit could result from an alteration toward AD-related DSMS because it could lower the overall costs surrounding autonomous rides, therein possibly decreasing overall vehicle ownership, longer trips and journeys, and the number of parking spaces available (Litman, 2018). Besides, AD itself can enhance safety by nearly eliminating all chances for human error, which come about due to factors such as aging, disability, stress, tiredness, drug abuse, or inexperience (Beiker, 2012; Shanker et al., 2013; Winner, 2018). Those who support AD approximate that the extensive use of driverless cars on a worldwide scale could decrease the number of driving-related deaths by up to 90% by 2050 (Bertoncello and Wee, 2015).

In the field of AD, research is primarily focusing on topics such as technological development, while a comprehensive knowledge about the technology acceptance is currently relatively rare

(Rosenzweig and Bartl, 2015). However, focusing on only product design and its development is insufficient, and an all-inclusive approach is thus necessary in order to ensure market success (Dikmen and Burns, 2016). Moreover, the only way for innovative technology to get introduced successfully is with the acceptance of its end-users (Davis, 1989; Madigan et al., 2016). Thus, the potential user's inclination to accept and receive the new technology is in itself a precondition for societal and ecological change via DSMS and AD. The inclination of acceptance remains a critical aspect within the background of innovation, and knowing its drivers is indispensable for successfully establishing AD-related DSMS in the future (e.g., Nordhoff et al., 2019; Rosenzweig and Bartl, 2015). Meanwhile, decision-makers have also recognized that the area of user acceptance regarding AD-related DSMS requires more detailed investigations in order to ensure future success within society (Meyer, 2019).

The explanations as mentioned earlier have shown that wider dissemination of DSMS and in the future an introduction of AD in combination with DSMS seems particularly sensible, as this development allows additional rides to be shared, leading to a reduced level of individual traffic, thus having positive effects on the social and ecological level with an additional leverage effect with a future AD combination (Brendel et al., 2018; Greenblatt and Shaheen, 2015; Merfeld et al., 2019b). However, as also described above, positive technology acceptance is required to enable the successful market establishment of AD and its combination with DSMS. In general, comprehending individual acceptance, adoption, and use of technologies is altogether one of the most vital and already established subjects within IS research (Beaudry and Pinsonneault, 2010; Brown et al., 2010; Chan et al., 2010; Davis et al., 1989; Negoita et al., 2012; Rosenzweig and Bartl, 2015; Venkatesh et al., 2012). For investigating the acceptance of AD-related DSMS, it is first necessary to build up knowledge about the general end-user acceptance of AD before applying it to a specific usage context like DSMS. This approach is reasonable, as research has shown that the usage context, e.g., sharing rides, leads to different costs and benefits to users, and thus the factors that shape the user's acceptance might differ (Acheampong and Cugurullo, 2019; Lee et al., 2019).

Nevertheless, previous research on general AD acceptance has shown that a comprehensive understanding is currently lacking and still has gaps. While some studies have revealed important relationships between psychological factors and the willingness and intention to use AD (e.g., Choi and Ji, 2015; Gkartzonikas and Gkritza, 2019; Panagiotopoulos and Dimitrakopoulos, 2018; Payre et al., 2014), Lee et al. (2019) and Xu et al. (2018) state that prior studies reveal incongruent and conflicting findings on the factors that influence the acceptance of AD. Thus, comprehensive knowledge about the acceptance of AD is still missing. Consequently, it is evident that recent research regarding the application context of DSMS in combination with AD also lacks knowledge about a comprehensive understanding of the end-user acceptance (e.g., Acheampong and Cugurullo, 2019; Moták et al., 2017; Nordhoff et al., 2019, 2017).

Therefore, this thesis aims to contribute from an IS research perspective to these shortcomings by (1) providing new insights into the relationships between the psychological factors and their impact on the intention to use, building a holistic understanding about the general acceptance of AD, (2) transferring and adjusting the knowledge of AD acceptance to the sharing context of AD-related DSMS while using mixed-method approaches, as well as (3) providing evidence for previously missed or unsupported concepts (e.g., life circumstances) and construct hypotheses within AD acceptance research. Thus, the overarching goal of this thesis is to give a holistic view on specific acceptance criteria for AD-related DSMS. Therefore, the outcomes of this thesis may support an effortless introduction of AD-related DSMS in the future and pave the way for more sustainable mobility in order to solve the described challenges of urbanization and mobility-related CO2 emissions of tomorrow.

In summary, this thesis addresses critical and relevant research gaps at the intersection of Behavioral Science, IS Acceptance, Sharing Economy (SE), and Smart Mobility and thus forms a convergence of these areas (Curran et al., 2010) (see Figure A-1).

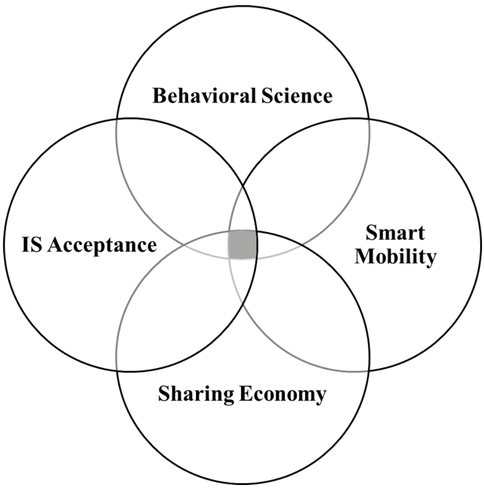

Figure A-1 Thematically Interconnected Research Domains in this Thesis

1.2 Research Gaps and Research Questions

Recent developments have shown that without a significant change in mobility, humanity will not be able to sufficiently reverse climate change (Y. Xu et al., 2018). Consequently, the way must be paved for new forms of mobility that promise corresponding sustainability (see Section 1.1).

SE has emerged as an economic-technological marvel, in part due to the introduction and innovation surrounding digital platforms like Uber and Airbnb, which continues to build upon the evolution of Information Technology (IT) and IS. Furthermore, anxiety about climate change has brought more consumers toward collaborative consumption, a keystone of SE (Hamari et al., 2016). Concerning the mobility sector, DSMS, in particular, are rising in popularity because they concurrently address the issues surrounding the adequate availability of parking spaces or vehicle occupancy rates at a decline (Willing et al., 2017) while also having the capacity to effectively replace the market of privately owned vehicles (Martin et al., 2010). Moreover, the expanded accessibility of mobile internet alongside an interchanging environment of smartphones and applications offers a suitable source of information capable of determining its users' locations and vehicles (Freese and Schönberg, 2014). Thus, DSMS and IS cement themselves as essential attributes for smart cities (Brandt et al., 2016), with IS and data analysis cooperatively used to improve cityscape, balance sustainability with overall living conditions (Kapoor et al., 2015).

For the last several years, IS research has been examining DSMS within several different research streams, including that of Decision Support and Design Science, and Human-Computer Systems Design (Banker and Kauffman, 2004). For instance, vehicle relocation (Brendel et al., 2017a) and platform design (Tan et al., 2017) have been topics of IS research. Nevertheless, existing literature reviews on DSMS with a specific focus on IS research remains rather low and nearly obsolete, in part due to several rapid developments within the same time frame. The basic DSMS, specifically carsharing (Degirmenci and Breitner, 2014), bikesharing (Fishman et al., 2013), and ridesharing (Furuhata et al., 2013), has been investigated only in the context of individual services. As for the context of more than one service under consideration in combination with the trend of AD, specific reviews are still quite rare (Brendel and Mandrella, 2016), despite the fact that a holistic examination of the current status of several DSMS is valuable, especially to learn from research between individual DSMS and to transfer knowledge to other DSMS. Thus, the potential for improving DSMS in general and paving the market success through IS research is up-and-coming and should likewise be an area of focus within the IS literature. To this end, this dissertation opens the field of IS research and shows where IS community can provide guidance and insights to ensure a successful diffusion of DSMS while identifying research gaps for this doctoral thesis, thus leading to the following first RQ of this thesis:

RQ1: How has IS research addressed the future widespread of DSMS, and what research gaps can be revealed for this dissertation project?

Before the end-users' technology acceptance of specific AD-related DSMS (e.g., autonomous and shared buses for public transport systems) can be investigated (a research potential that might be followed very well from the IS acceptance research (e.g., Banker and Kaufman, 2004; Davis, 1989)), profound knowledge of the general acceptance of AD is indispensable (see also Section 1.1). Since great hesitations toward AD exists and this innovative technology has to be injected into the market on a mass scale (Haboucha et al., 2017; König and Neumayr, 2017), comprehending the individual's intentions and the individual's attitudes toward AD is crucial and even more important if any success is to come about for this technological innovation (Choi and Ji, 2015; Nordhoff et al., 2016; Xu et al., 2018). This is in line with the argument that the most significant barrier of widespread adoption of AD is psychological, not of technical nature (Shariff et al., 2017; Xu et al., 2018). Thus, knowledge of the user's acceptance of AD is exceptionally essential for developing AD into a realistic part of future transportation (Eimler and Geisler, 2015; Eugensson et al., 2013; Panagiotopoulos and Dimitrakopoulos, 2018; Z. Xu et al., 2018), while the derived and comprehensive knowledge can then be transferred to more specific user scenarios related to DSMS.

Nordhoff et al. (2016) emphasize the crucial position of user acceptance for any success surrounding AD, observing that without acceptance, AVs will not be used, and any potential benefits will expire. However, the key factors affecting people's acceptance of autonomous transport, as well as their interest in the subject, remains relatively unknown, with Nielsen and Haustein (2018) requesting that additional research should take place. Previous studies have already demonstrated valuable policy recommendations necessary for increasing the progress toward widespread AD (e.g., Fagnant and Kockelman, 2015) as several concerns about self-driving vehicles having arisen in media coverage and other research (e.g., Litman, 2018).

Despite there being several studies in broader literature that have recognized that it is necessary to research the factors that determine the acceptance of AD (e.g., Anania et al., 2018; Buckley et al., 2018a; Panagiotopoulos and Dimitrakopoulos, 2018; Wu et al., 2019; Xu et al., 2019), insight into the end-users' acceptance of AD is insufficient, and there should be more research for understanding the psychological determinants of user acceptance comprehensively (Buckley et al., 2018a; Xu et al., 2018). Gkartzonikas and Gkritza's (2019) literature review showed that the majority of research focuses on specific acceptance factors such as trust, driving pleasure, or safety to gain a better understanding of the acceptance of AD. The authors mentioned how "most studies have examined the behavioral characteristics, perceptions, and attitudes related to AVs using descriptive analysis or some sort of econometric analysis" (p. 335). Based on that, they state that future research should focus on the relationships between these factors and their behavioral outcomes. In order to resolve this disparity, future research could apply behavioral models. Lee et al. (2019) and Xu et al. (2018) deduce from their research that the existing studies show discrepant or contradictory conclusions based on the factors influencing the willingness to use AD, and based on that, they call for more research in this field. Notably, there "is a need to study several psychological factors together to extend the understanding of user perception of autonomous vehicles" (Lee et al., 2019, p. 412). Merfeld et al. (2019a) and Buckley et al. (2018b) point out a further limitation of previous studies as most of these insights have only been quantitively assessed (see also Becker and Axhausen (2017) as well as Gkartzonikas and Gkritza (2019)), leading to a call to use mixed-method approaches as some acceptance factors may have been overlooked. Especially as relevant user aspects are often missed since most research pursue a literature-based approach (Venkatesh et al., 2013; Wu, 2012). Accordingly, there should be future studies on individual perceptions of AD, e.g., also integrating qualitative methods in order to gain insight of related acceptance factors holistically (Buckley et al., 2018b; Merfeld et al., 2019a; Nordhoff et al., 2019).

Thus, the next objective of this cumulative thesis after showing that IS research can contribute in the area of DSMS and AD acceptance is to generally examine the acceptance of AD to gather knowledge on the underlying factors that influence user acceptance from the end-user. In the further course of the thesis, this holistic acceptance model, in turn, is intended to be an extensive knowledge base for investigations for specific application scenarios of AD-related DSMS. The acceptance model to be conceptualized (e.g., through a mixed-method approach) should serve to identify and verify relevant constructs that influence the general acceptance of AD that have not yet been looked into in previous research. This arises the following RQ:

RQ2: How can a holistic acceptance model for AD be conceptualized and what general end-user related acceptance factors can be derived?

If the advantages that AD offers are to be capitalized on, it might be beneficial to present AD as a shared mobility solution (e.g., Acheampong and Cugurullo, 2019; Kaur and Rampersad, 2018; Madigan et al., 2017; see also Section 1.1). Therefore, one option could be to introduce AD via a public bus system as autonomous electric buses (AEBs), thus making use of the other disruptive trend of sharing as well. Regarding commercial use, AD vehicles are best employed by a model that can pick up passengers at any location and drive them to their destinations (International Transport Forum, 2015; Münzel et al., 2018), which creates a direct competitor for companies such as Uber and Lyft. ABEs combine the aspects of public transport with that of a system that is environmentally friendly due to its efficient driving system.

However, research in the context of AD has been, for the most part, focused on those vehicles that offer solutions on an individual level, investigating users' attitudes and preferences (e.g., Bonnefon et al., 2016; Jamson et al., 2013; Payre et al., 2014; Waytz et al., 2014). This neglects shared and public transportation options such as AEBs. Only a few studies integrated the shared usage context within their investigations. For example, Wien (2019) compared a trip's relative preferences operated with a self-driving bus to those operated with a regular bus, while Földes et al. (2018) looked into the user expectations of mobility services based on AVs. Thus, in cases, studies take up the idea of sharing and examine AVs in public transport, they currently lack a holistic view on the specific acceptance factors of AD-related DSMS (e.g., Acheampong and Cugurullo, 2019; Kaur and Rampersad, 2018; Madigan et al., 2017). Moreover, if research investigates user acceptance of AD-related DSMS like AEBs, studies have only worked with data collected after AEB use (or intention to use) in a closed environment, i.e., not in real-world traffic situations (e.g., Kaur and Rampersad, 2018; Moták et al., 2017; Nordhoff et al., 2017, 2018). Although research has recognized and involved the noteworthy topic of acceptance of AD-related DSMS, it can only be considered as rudimentary because it lacks evidence from real-world circumstances. A distinction like this highlights the potential to investigate user acceptance under less restricted circumstances in future research and could lead to more natural and holistic results.

In summary, there is still limited knowledge about the key factors affect people's interest in autonomous transport in the sharing context, a fact that motivated Nielsen and Haustein (2018) to call for further research in this area. To the best of the authors' knowledge, no AEB holistic behavioral model is using newly available data from riders in the real-world traffic environment. Furthermore, there has yet to be research conducted that addresses how user-centered acceptance criteria should be merged into the decision-making processes of policymakers and fleet operators or car manufactures for ensuring a successful, smooth transition, and to increase

AD-related DSMS penetration, consequently making, e.g., public transport an even more sustainable endeavor. As a solution, this thesis intends to make context-specific adjustments based on the holistically conceptualized acceptance model for AD (see RQ2) in order to thoroughly investigate the acceptance factors for AD-related DSMS, highlighting a holistic overview of factors affecting end-user acceptance of AEBs as an autonomous DSMS. Thus, leading to the following RQ:

RQ3: What drives the specific acceptance of AD-related DSMS?

Researchers from the fields of urban planning, travel behavior, and geography have recently shown increased interest in life-oriented factors that affect the dynamics of travel-related decisions (e.g., Beige and Axhausen, 2012, 2008; Chatterjee and Scheiner, 2015; Clark et al., 2016; Delbosc and Nakanishi, 2017; Fatmi and Habib, 2016; Müggenburg et al., 2015; Oakil et al., 2011b, 2011a, Scheiner, 2014, 2018; Scheiner and Holz-Rau, 2013; Schoenduwe et al., 2015; Verhoeven et al., 2007, 2005b, 2005a; Wang et al., 2018). Such studies use the life-oriented approach to investigate the correlation between decisions on mobility and those relating to other phases of life. It has been shown that mobility decisions are intertwined with a person's other life choices, and that mobility behavior is thus influenced by a person's life circumstances (Beige and Axhausen, 2017; Zhang and Van Acker, 2017).

In order to introduce an innovation successfully to the market, it is vital to define the target groups and know their specific values, needs, preferences, and behavioral choices (e.g., Egmond and Lulofs, 2010; Gossling et al., 2005; Kotler, 2002; Zenker, 2009). Overlooking this step for AD-related DSMS, such as AEBs, would most likely result in unhelpful and detracting arguments, as is currently at play for the topic of trams (Lo, 2012). Thus, knowledge about specific AEB acceptance factors of an initial target groups (e.g., by differentiating based on age) is essential for a pervasive diffusion, and the investigation of life circumstances can aid this process.

For several years, young people were characterized as one of the most—if not the most—car-oriented age groups in Germany, "serving as a bellwether for a trend toward more car-oriented lifestyles of all groups of society" (Kuhnimhof et al., 2012, p. 443). Investigations before this assumption had established that earning a driver's license and car ownership could be distinguished as expected changes for this age group. However, after observing more recent trends, there remains a declining interest in car ownership and its usage among German young people, as well as some other developed countries (Litman, 2006; Millard-Ball and Schipper, 2011;