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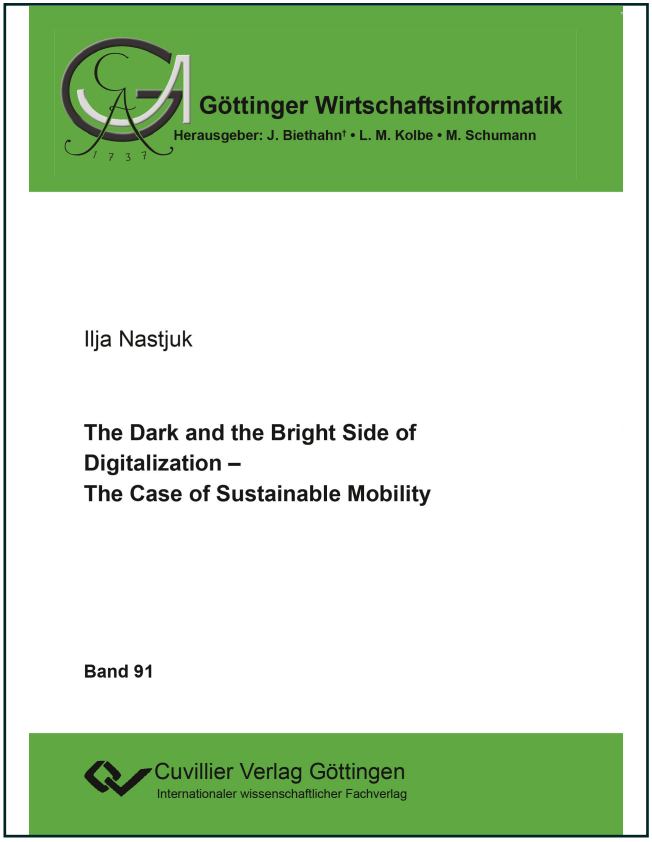
The Dark and the Bright Side of Digitalization – The Case of Sustainable Mobility



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1 Introduction

Section 1.1 describes the motivation and relevance for the research, followed by the research questions (1.2) and structure of the thesis (1.3). Section 1.4 explains the research design. Finally, Section 1.5 outlines the anticipated contributions for research and practitioners.

1.1 Motivation

The ongoing digital transformation of society can be understood as the changes resulted in several aspects related to humankind due to an increased pervasion of information systems (IS) in private and professional life (Ayyagari et al. 2011; Yoo 2010). As a consequence, the world is "increasingly experienced with, through, and by information technology" (Stolterman and Fors 2004, p. 689). This transformation has brought great advantages on an individual, societal, and organizational level. Digital networks and wireless mobile technologies become increasingly accessible and affordable, thus enabling connectivity over distances (Kolb 2008). IS support sociability through social networking platforms (Maier et al. 2011), convert the worldwide transferability of information and education into reality (Owston 1997; Roberts 2000), and contribute to individual's health and well-being (Lohaus 2010) as well as to the dissemination of electric vehicles (Eisel and Schmidt 2014). In the professional context, the widespread use of information and communication technologies (ICTs) have changed the way employees work in an organization; they have improved performance and productivity (Matteucci et al. 2005; Ravichandran and Lertwongsatien 2005; Velcu-Laitinen and Yigitbasioglu 2012).

However, these meaningful advantages possess a dark side (Tarafdar et al. 2015a), which reflects the individual's struggle in dealing with IS in a healthy manner (Brod 1984), thus adversely affecting not only individuals' well-being but also leading to heavy drawbacks for companies (Tarafdar et al. 2007). Within the IS community, this dark side has garnered popularity in association with the term technostress, which is defined as "any negative impact on attitudes, thoughts, behaviors, or body physiology that is induced either directly or indirectly by technology" (Weil and Rosen 1997, p. 5). Conditions in which IS lead to an increased workload for the individual, the perception of being permanently connected, or the feeling of not catching up with the frantic pace of IS development constitute powerful stimuli that lead to adverse psychological and behavioral responses (Ragu-Nathan et al. 2008; Tu et al. 2005). Psychological reactions are manifested in feeling exhaustion (Ayyagari et al. 2011) or reduced

satisfaction (Tarafdar et al. 2007; 2010), while behavioral responses are characterized by the intention to stop using a technology (Maier et al. 2014) or reduced end-user performance (Owusu-Ansah et al. 2016).

As illustrated, the increased pervasion of IS leads to effects that have a dual nature in general – apart from generating innumerable advantages for the individual, the interaction with IS might lead to negative reactions in terms of stress, which in turn, adversely affects psychological and behavioral responses. In this context, stress constitutes the main culprit of a variety of psychological and physiological health problems, including asthma, depression, burnout, or coronary heart diseases (Avey et al. 2003; House 1974; Marin et al. 2011; Vitaliano et al. 2002).

The sustainable transportation mode of battery electric vehicles (BEVs) is a paramount example, in which such a dual effect of IS can be observed. It has been suggested (Eisel and Schmidt 2014) that IS can be valuable to counteract a particular type of stress in drivers of BEVs, referred to as the worry of not reaching an intended destination due to a discharged battery (Tate et al. 2008). This psychological barrier, *range stress* (Rauh et al. 2015a), is mainly triggered by the limited driving range of BEVs of approximately 150 kilometers (Eisel and Schmidt 2014) and the underdeveloped charging infrastructure (Dong et al. 2014). To compensate or avoid the negative driving experience associated with range stress, users generally demand additional IS in and around BEVs (Nilsson and Habibovic 2013). Hence, research has proposed integrating additional context-specific IS in BEVs that display more range-related information than current IS in BEVs do (Ferreira et al. 2011; 2014; Rauh et al. 2015b). As users of BEVs – due to the electric propulsion – are usually confronted with different information compared to conventional vehicles (Stroemberg et al. 2011), it has also been proposed that the design of in-vehicle IS be adjusted in order to counteract range-related concerns (Jung et al. 2015; Lundstroem 2014).

With respect to the potential value offering of IS to the driver in general (see also Brandt 2013), especially in reducing range stress, it is not surprising that the degree of digitalization in and around BEVs has increased over the last years. Furthermore, it is expected to increase to a larger degree in the future (Abdelkafi et al. 2013; Burns 2013; Dijk et al. 2013). Yoo et al. (2010) state that "as most subsystems of an automobile are becoming digitized and connected through vehicle-based software architectures, an automobile has become a computing platform on which other firms outside the automotive industry can develop and integrate new devices, networks, services, and content" (p. 729). New paradigms, such as the Internet of

Things bring a new variety of functionalities into the automobile, thus enabling the communication between vehicles and other objects, further enhancing comfort and driver safety (Brandt 2013; Tielert et al. 2010; Vermesan and Friess 2014; Xie and Wang 2017).

However, apart from the enormous advantages of IS for drivers of BEVs in general, especially in reducing range stress, the increased digitalization in and around BEVs affects the interaction between driver and vehicle (Weng et al. 2016). In addition to the complex driving task itself, which requires high cognitive and physical skills (Young and Regan 2007), the secondary task of interacting with in-vehicle IS poses a further workload on the driver (Pereira et al. 2008). This extra workload relies on the same limited mental capacities needed for the primary task of driving (Bach et al. 2009), which in turn, leads to a certain degree of competition between these capacities (Ma and Kaber 2005). These effects limit the driver's attention regarding the traffic scene and hence may lead to driver distraction and stress (Bach et al. 2009; Horberry et al. 2006; Sheridan 2004). In-vehicle IS-related driver stress and distraction is an especially critical issue for users of BEVs, as the information presented by the in-vehicle IS is often confusing, thus boosting insecurity, frustration, and stress (Lundstroem 2014; Stroemberg et al. 2011; Wellings et al. 2011).

Posited within the context of sustainable mobility, i.e., BEVs, this thesis aims to shed light upon the dual role of IS with a focus on stress perception. As illustrated above, the increased presence of IS in BEVs bears the potential to overcome stress resulting from the limited range of these vehicles. Thus, the appropriate deployment of IS in and around BEVs can increase the acceptance of BEVs, since the limited range constitutes a main adoption barrier (Dimitropoulos et al. 2011; Duke et al. 2009; Egbue and Long 2012; Pearre et al. 2011). In 2015, for example, diesel and petrol vehicles accounted for over 97% of new sales in Europe (European Environmental Agency 2017). Moreover, BEVs have the potential to reduce carbon emissions in the road transportation sector (Tang et al. 2013; Thomas 2009). According to the European Commission (2016), the road transportation sector contributes to more than one-fifth of total carbon dioxide emissions in the European Union. As a response to the devastating consequences of the road transportation sector for the environment, BEVs are also increasingly integrated in sustainable business models, such as e-car sharing (Seign and Bogenberger 2012).

On the other hand, as explained above, the interaction with IS can lead to driver distraction and stress, thus increasing the risk of fatal car accidents (Brooks and Rakotonirainy 2007; Kontogiannis 2006; Neale et al. 2005). It is estimated that approximately 30% of the time that

a vehicle is in motion, drivers are distracted by secondary tasks (Ranney 2008). In this context, over 25% of crashes involve some degree of driver distraction, among which, the interaction with in-vehicle IS accounts for a high percentage (Horberry et al. 2006; Stutts et al. 2001). Birrell and Fowkes (2014) found that drivers spend on average 4.3% of their time on looking at the in-vehicle IS while driving.

Finally, the thesis aims to investigate the influence of IS-related stress on behavioral outcomes. In this context, behavioral outcomes can be conceptualized as an attitude towards performing a specific behavior, as the attitude construct plays a crucial role in predicting actual behavior (Ajzen 1991). In addition, the attitude construct constitutes a main component when explaining individual's acceptance related to technologies (Venkatesh et al. 2003; Williams et al. 2009).

To sum up, this thesis emphasizes the importance of considering both directional effects of IS on the perception of stress, as most research in the field of IS and stress has been dedicated to the sources, characteristics, and consequences of stress that results from the interaction with IS in an organizational setting (Riedl et al. 2012). A thorough understanding of the opposite effect, i.e., the value of IS for reducing stress in specific situations is missing in IS research. Apart from the lack of research regarding the potential positive effects of IS, a detailed understanding of the dual role of IS with a focus on stress perceptions and the resulting consequences on behavioral outcomes remains unclear. This is especially important, as it has been shown that IS-related stress negatively affects behavioral outcomes (Maier et al. 2014; Owusu-Ansah et al. 2016). A consideration of both directional effects could be useful to predict behavioral outcomes more accurately.

Despite deriving important implications for research, this thesis aims to support practitioners within the automotive industry. The mainly emerging market-driven digitalization in this sector (Gao et al. 2014) creates a new key challenge for designers in seeking a balance between introducing new in-vehicle IS to the driver and ensuring the primary task of safe arrival to a destination (Lisboa et al. 2016). Thus, this thesis addresses a fundamental difficulty, as emphasized by Kantowitz and Moyer (1999):

> "Although the designer is most often human, human-centered design does not imply that the system designer is a satisfactory surrogate for the end user. Information that the designer finds useful and interesting may not matter to the driver, and so should not be presented (p. 4).

1.2 Research Gaps and Research Questions

As explained above, the increasing pervasion of IS in professional and private life (Ayyagari et al. 2011; Hess et al. 2014) leads on an individual level to consequences that are dual in nature. This thesis aims to contribute to a better understanding of both directional effects of IS with respect to the perception of stress, using the research context of sustainable mobility, i.e., BEVs. Moreover, this research aims to elaborate on the effects that IS-induced stress has on the attitude towards using BEVs, thus providing important insights for researchers and practitioners regarding the individual's acceptance of this sustainable mode of transportation. With the rising importance of integrating BEVs in sustainable business models, such as e-car sharing (Seign and Bogenberger 2012), the thesis finally aims to extend the research context to sustainable business model, thus emphasizing the importance of the IS-stress relationship for the success of sustainable business models. Figure A-1 illustrates the research questions and the addressed topics of the thesis.

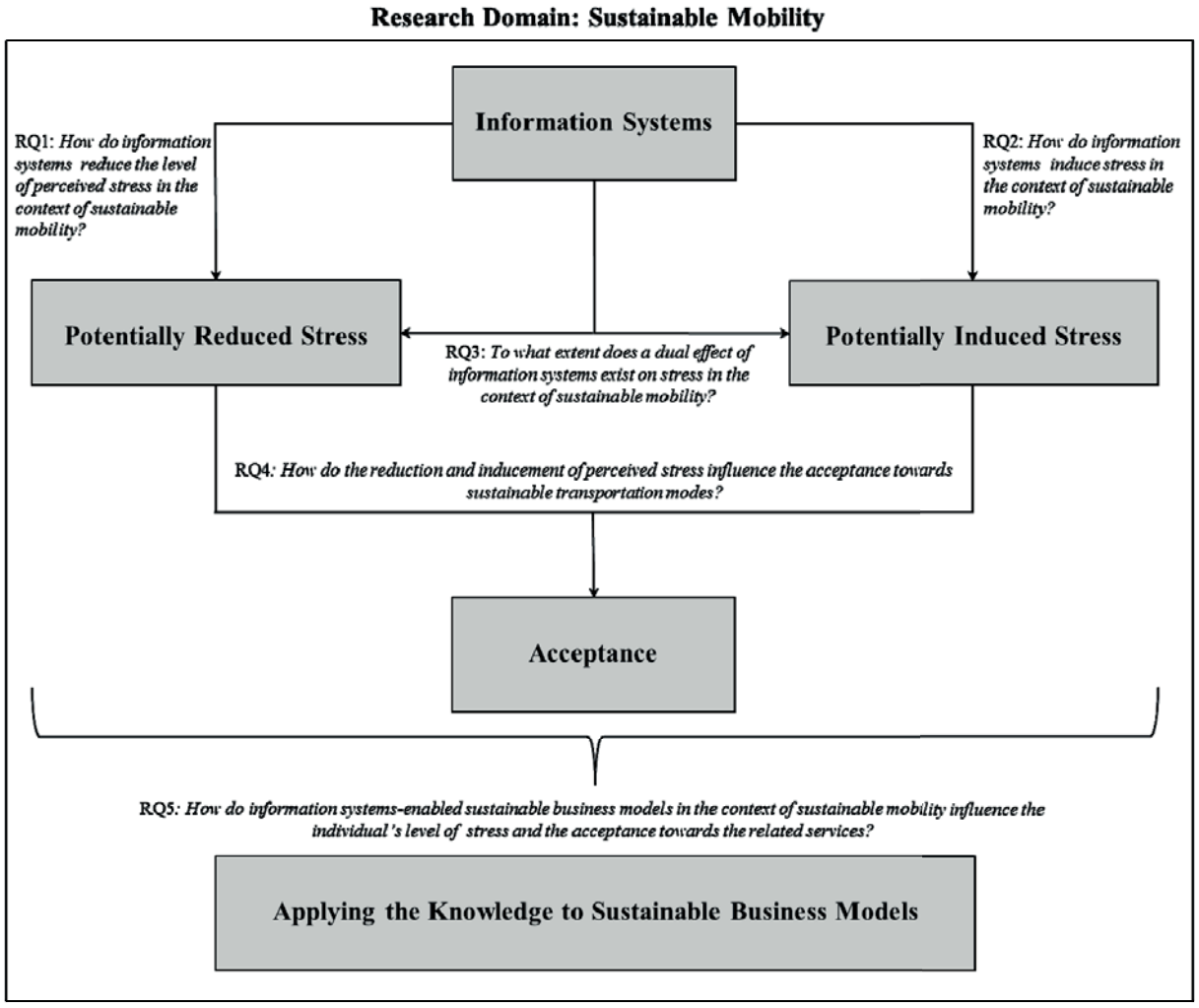

Figure A-1 Overview of Research Questions

Previous research in the field of IS and stress has mainly focused on the dark side (Tarafdar et al. 2015a) of IS usage, specifically, on the causes, characteristics, and consequences of stress resulting from interaction with IS in an organizational context (Riedl et al. 2012). Although much is known on stress that is induced due to the interaction with IS (e.g., Ayyagari et al. 2011; Ragu-Nathan et al. 2008; Tarafdar et al. 2007; Tu et al. 2005), the opposite effect, specifically, the potential value of IS to reduce stress in certain situations, is not well understood. Previous research indicates that IS could have a positive effect on stress perception regarding healthcare (Garg et al. 2005) or education (Lohaus et al. 2010). In the context of sustainable mobility, research has emphasized that the provision of timely and relevant information can be useful to reduce stress that originates from the uncertainty whether a final destination can be reached with the given range in a BEV (e.g., Eisel and Schmidt 2014; Ferreira et al. 2011; Rauh et al. 2015b). However, a thorough understanding of the ability of IS to reduce stress in specific situations with a particular focus on the underlying appraisal processes (Lazarus and Folkman 1984) is still missing in IS research. With its focus on BEVs as a sustainable means of transportation, this thesis contributes in the first step to closing this research gap by emphasizing the importance of IS to reduce stress, thus leading to the following research question (RQ):

RQ1: How do information systems reduce the level of perceived stress in the context of sustainable mobility?

While IS undoubtedly provide plenty of advantages in different contexts (e.g., Kolb 2008; Maier et al. 2011; Lohaus 2010; Roberts 2000; Velcu-Laitinen and Yigitbasioglu 2012), they demand high individual cognitive skills that might lead to the perception of stress (Ayyagari et al. 2011). As mentioned above, research in the field of IS and stress traditionally focused on the institutional context as a type of "stress experienced by end users in organization as a result of their use of ICTs" (Ragu-Nathan et al. 2008, pp. 417-418). However, in recent decades, the practical usefulness of IS has changed. Instead of being valuable exclusively for organizational users, the importance and field of application of IS for private consumers has increased, as emphasized by McKenna et al. (2013): "Today, the development and use of information systems is changing dramatically. Instead of being developed for (and used by) organizational "users", information systems are more and more being developed for consumers. The overriding concern when developing consumer information systems […] changes from that of efficiency and effectiveness to that of facilitating consumers' service encounter and how they experience it" (p. 248). This shift, moreover, describes a new interdisciplinary field in IS re-

search that is called *Digital Life*, reflecting the increased digitalization throughout everyday life (Hess et al. 2014). Hence, it is not a big surprise that the phenomenon of technostress has gained increasing importance in usage cases apart from the organizational context (Maier et al. 2015). In the context of sustainable mobility, previous research emphasizes the importance of IS in mitigating concerns resulting from the limited range in BEVs (Eisel and Schmidt 2014; Rauh et al. 2015b), but neglects that unreliable, too much, or too complex IS might lead to distraction and stress in drivers (Lundstroem 2014; Matthews and Desmond 1995; Pereira et al. 2008; Ragu-Nathan et al. 2008), which in turn, increases the risk of becoming involved in fatal car accidents (Harms and Patten 2003; Horberry et al. 2006). This thesis aims to emphasize this dark side, shifting the traditional organization-focused research stream of technostress to a new field of application. This leads to the second research question:

RQ2: How do information systems induce stress in the context of sustainable mobility?

Building upon both research gaps emphasized by RQ1 and RQ2, this thesis strives to break off the single point of view on the stress-IS relationship, emphasizing the importance of its ambivalent role (Califf et al. 2015; Lauwers and Giangreco 2016). To do so, this thesis connects the research stream of technostress with the paradigm of the potential value of IS in reducing stress, thus capturing both perspectives at the same time. As explained above, IS can, in the context of sustainable mobility, contribute to the reduction of range stress by providing relevant and accurate information but might, at the same time, lead to stress perceptions due to, for example, IS complexity or information overload. Considering both directional effects at the same time enables a more precise prediction of the outcomes associated with the usage of IS. Technology-induced stress can lead to adverse psychological and behavioral outcomes, for example, technology-related exhaustion or reduced performance (Maier et al. 2014; Tarafdar et al. 2011a; 2015b), while, at the same time, appropriate implemented IS bears the potential to reduce stress, thus lowering such adverse outcomes. To address both directional effects of the IS-stress relationship, this thesis aims at answering the following research question:

RQ3: To what extent does a dual effect of information systems exist on stress in the context of sustainable mobility?

IS research relies mainly on social psychological theories, for example, the theory of reasoned action (TRA; Ajzen and Fishbein 1980), its extension, the theory of planned behavior (TPB;

Ajzen 1991), or adaption of these theories, such as the technology acceptance model (TAM; Davis 1989) to explain individual's acceptance related to technologies (Venkatesh et al. 2003; Williams et al. 2009). In most of these theories, the attitude construct, which is defined as "a disposition to respond favorably or unfavorably to an object, person, institution, or event" (Ajzen 2005, p. 3) plays a major role in predicting behavioral intentions and thus actual behavior. While research traditionally focused on cogitation rather than affect when investigating the acceptance of technological innovations (Furneaux and Nevo 2008; Zhang and Li 2005), the integration of affective responses becomes increasingly important, especially in the consumer context, as stated by Kulviwat et al. (2007): "The emphasis on cognition might be appropriate for an organizational context where adoption is mandated and users have little choice regarding the decision. But it is an insufficient explanation for consumer contexts in which potential users are free to adopt or reject new technology based on how they feel as well as how they think" (p. 1061). The importance of IS-related affective responses in terms of emotions have been shown to be an important predictor of attitudinal dispositions (Brown et al. 2004; Djamasbi et al. 2009; Kulviwat et al. 2007). In the context of IS-related stress, it has been revealed that stress creating factors lead to adverse behavioral outcomes such as discontinuous usage intention and discontinuous usage behavior (Maier et al. 2015). However, the decision to initially accept a technology through, for example, a positive attitude towards using the technology, and the decision to continue using a technology is based on different theoretical foundations (Bhattacherjee and Lin 2014; Karahanna et al. 1999). Hence, the direct effect of IS-related stress on the initial acceptance decision has not been investigated in detail. Building upon both directional effects of the stress IS relationship in the context of sustainable mobility, as addressed in RQ1, RQ2, and RQ3, this thesis, therefore, elaborates on the following research question:

RQ4: How do the reduction and inducement of perceived stress influence the acceptance towards sustainable transportation modes?

While this thesis sets its focus on BEVs to explain the effects of the ongoing digitalization in a variety number of areas of life (Hess et al. 2014) on stress and behavioral tendencies, it goes, in the last step, beyond this usage case, aiming to apply the research knowledge to a broader context of sustainability, in particular, sustainable business models. Sustainable business models refer to business models that "creates competitive advantage through superior customer value and contributes to a sustainable development of the company and society" (Luedeke-Freund 2010, p. 23). In general, the diffusion of digital technologies (Yoo et al.

2010) and the growing range of digital infrastructure (Tilson et al. 2010) enables an increased connectivity, which in turn, is considered to facilitate sustainable business models (Chen et al. 2008). IS have demonstrably increased the viability of these business models, for example, by enabling access to information in real-time (Amey et al. 2011; Teubner and Flath 2015) or the potential to control and monitor the sustainable service offered (Hildebrandt et al. 2015). IS enable new sustainable business models, thus contributing to the overall environmental sustainability by, for example, transforming current practices in organizations in a sustainable manner (Chen et al. 2008; Elliot 2011; Seidel et al. 2013). While previous research in this field has centered on the organizational level, the impact for the individual level is scarce and must be considered (Bui and Veit 2015; Elliot 2011; Malhotra et al. 2013). Using the example of the sustainable business model of e-car sharing (Seign and Bogenberger 2012), this thesis aims to shed light on the extent to which IS – as a crucial enabler for this sustainable mode of transportation (Hildebrandt et al. 2015; Wagner et al. 2014) – influences the individual, placing a particular focus on stress and acceptance. This leads to the following research question:

RQ5: How do information systems-enabled business models in the context of sustainable mobility influence the individual's level of stress and the acceptance towards the related services?

1.3 Structure of the Thesis

This thesis is cumulative in nature and contains six parts. Part A is divided into two subchapters. Chapter A1 explains the motivation of the thesis (A.1.1), the research gaps and the research questions (A.1.2), the structure of the thesis (A.1.3), the research design (A.1.4), and the anticipated contributions (A.1.5). Chapter A2 provides the theoretical fundament for the thesis in Sections A.2.1-A.2.3, thus laying the foundation for Section A.2.4, which relates the respective parts of the theoretical background to one another in order to apply them to the specific focus of the thesis. Parts B, C, D, and E present the main body of the thesis (see Table A-1), covering the six integrated studies. While Part B includes two studies explaining the positive effects of IS with respect to the perception of stress, two studies point out the opposite effects in Part C. Part D integrates both perspectives from part B and C, presenting a study which emphasize the importance of considering both directional effects of IS on the perception of stress. Part E goes beyond the usage case of BEVs by extending the IS-stress relationship to the context of sustainable business models. All included studies provide evidence on the individual acceptance in terms of the tendency to perform a specific behavior.

Part F summarizes the results of the conducted studies (F.1), outlines the major contributions for research and practice (F.2), and concludes with the limitations and avenues for further research (F.3). Figure A-2 presents the overall structure of the thesis.

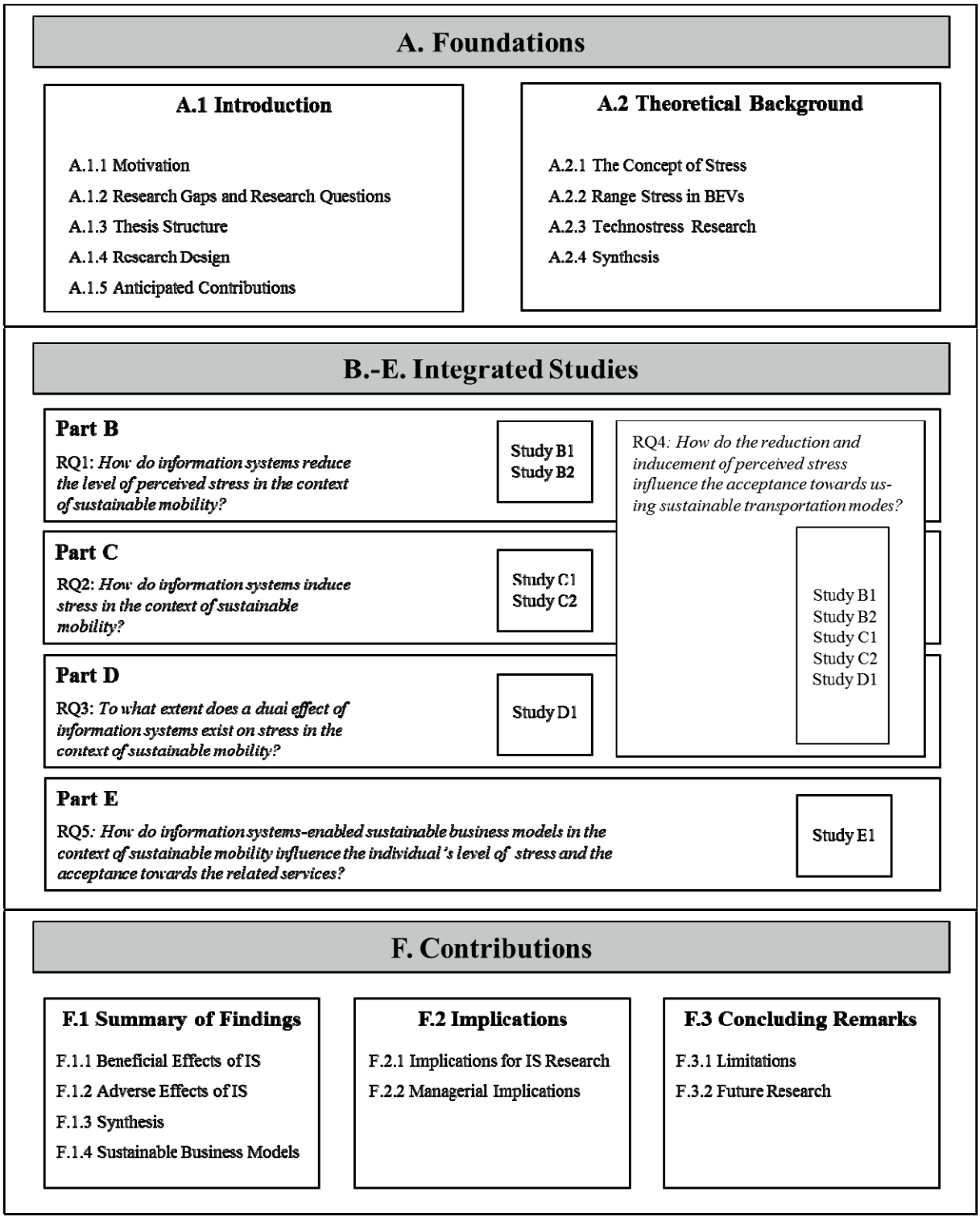

Figure A-2 Structure of the Thesis

Table A-1 Overview of Studies Included in this Thesis

No	Outlet	Status	Ranking	RQ	Chapter	Contribution
B1	International Conference on Information Systems 2014	Published	A / A	1; 4	B.1	Revealing the relationship between IS, stress, and acceptance research. Emphasizing the potential value of IS in the reduction of stress.
B2	Transportation Research Part F: Traffic Psychology and Behaviour	Published	n.a. / A	1; 4	B.2	Evaluating the congruence of psychometric and psychophysiological measurement methods when evaluating the perception of range stress.
C1	International Conference on Information Systems 2016	Published	A / A	2; 4	C.1	Insights regarding the impact of different in-vehicle IS categories on the perception of range-related stress and the willingness to use BEVs.
C2	Transportation Research Part A: Policy and Practice	1st round of review	B / A	2; 4	C.2	Suggestions for the design of range-related information with respect to the perception of range stress, trust, and acceptance against BEVs.
D1	International Conference on Information Systems 2015	Published	A / A	3; 4	D.1	Pointing out the importance of considering the dual effect of IS on stress perception with regards to behavioral tendencies.
E1	International Conference on Information Systems 2016	Published	A / A	5	E.1	Understanding the impact of IS on the perception of stress and behavioral tendencies in the context of IS-enabled sustainable business models.

Note: *The ranking is based on the VHB Jourqual 3 ranking / ERA 2010 and ABDC 2013 ranking*

1.4 Research Design

Information systems research is generally considered as "a discipline that concerns the use of information technology-related artifacts in human–machine systems" (Gregor and Hevner 2013, p. 339). Two main paradigms, namely design science and behavioral science, characterize this broad research discipline (Hevner et al. 2004). While design science is technology-oriented and aims at creating new artifacts that serves a specific human purpose (March and Smith 1995), the behavioral science paradigm (or natural science; see Hevner and Chatterjee 2010) is characterized by developing and verifying theories that aims at predicting individual or organizational behavior (Hevner et al. 2004). Kuechler and Vaishnavi (2008) conclude that in behavioral science research "the experimental procedure and apparatus are (ideally) constructed in such a way as to minimize confounds that might interfere with clear interpretation of the results; theory is either supported or disconfirmed" (p. 498), while in the design science

research “both the artifact and the experimental setting are intentionally complex (and thus confounded) in order to develop methods and artifacts that are useful in practice” (p. 498). This thesis follows the behavioral science paradigm, as it seeks to discover and justify the relationship between IS, stress and behavioral tendencies (March and Smith 1995) rather than creating new IS artifacts. Within this paradigm, this thesis can be assigned to the IS research stream of human-computer interaction (Banker and Kauffmann 2004), as it follows a user-centered instead of system-centered perspective by focusing on a task level on the match between user’s needs and the technologies functions (Booth 2014).

Epistemology refers to the study of knowledge acquisition (Hirschheim 1985) and can be classified in IS research in the following three categories: positivist, interpretive, and critical studies (Orlikowski and Baroudi 1991). Positivism can be characterized as an epistemology that is driven by the drive to search for regularity and causal relationship, which in turn, leads to a belief that is intended to be demonstrated by empirical testing (Hirschheim 1985). The interpretivism perspective is based on the assumption that the reality is a construct of interpretation by individuals, as emphasized by Lee (1991): “This school of thought takes the position that people, and the physical and social artifacts that they create, are fundamentally different from the physical reality examined by natural science. Unlike atoms, molecules, and electrons, people create and attach their own meanings to the world around them and to the behavior that they manifested in that world” (p. 347). The critical perspective assumes that although individuals are able to consciously change their social and economic environment, they are restricted by social, cultural, and political circumstances, which in turn, shifts the focus of research to a critical perspective, as emphasized by Myers (1997): “The main task of critical research is seen as being one of social critique, whereby the restrictive and alienating conditions of the status quo are brought to light. Critical research focuses on the oppositions, conflicts and contradictions in contemporary society, and seeks to be emancipatory i.e., it should help to eliminate the causes of alienation and domination” (pp. 241-242). This thesis is based on a positivistic epistemology, as it uses accepted scientific methods for the knowledge acquisition and validation (quantitative research), searches causal relationships for the studied elements (IS, stress, behavioral tendencies), uses data for the research that is experienced from the senses, relies on a value-free perspective for the research process, and bases its assumptions on logical reasoning (Hirschheim 1985).

Besides the distinction into positivistic, critical, and interpretive approaches, epistemology is moreover concerned with the question of research methodology (Gregor 2006). According to

Boudreau et al. (2001), laboratory experiments, field experiments, field studies, and case studies are common research methods in the top-ranked IS journals. Laboratory experiments occur in settings that are created by the experimenter, while field experiments take place in a natural setting in which at least one of the researched variables is manipulated. Field studies are non-experimental explorations in natural systems, in which none of the researched variables can be manipulated or controlled by the researcher (Boudreau et al. 2001). With the exception of studies B1 and D1, field experiments were used to study the relationship between IS, stress, and behavior. Field experiments have the advantage that they are carried out in a natural setting, thus participants often behave more normally (Eysenck 2000). Mental simulations experiments were used for studies B1 and D1, as the general set-ups for these studies were practically difficult to implement in field experiments. Mental simulations are characterized as mental activities in which the individual mentally create a hypothetical situation (Zeimbekis 2011). They are considered to be important in cognitive and emotional-related evaluation processes, as emphasized by Gavanski and Wells (1989): "To act purposefully on our physical and social environment, we must not only evaluate reality, but also imagine alternatives to reality. Our thoughts, emotions, and actions are guided not only by what is, but what might be and what could have been" (p. 315). The research design for each study is illustrated in Table A-2.

Table A-2 Overview of Research Design

No	RQ	Epistemology	Paradigm	Methodology	Data Analysis
B1	1; 4	Positivistic	Behavioral Science	Mental Simulation Experiment (Zeimbekis 2011)	Structural Equation Modeling and Mean Comparison
B2	1; 4	Positivistic	Behavioral Science	Field Experiment (Gerber and Green 2012)	Hierarchical Regression Analysis, Effect Size, and Mean Comparison
C1	2; 4	Positivistic	Behavioral Science	Field Experiment (Gerber and Green 2012)	Structural Equation Modeling, Effect Size, and Mean Rank Comparison
C2	2; 4	Positivistic	Behavioral Science	Field Experiment (Gerber and Green 2012)	Linear Regression Analysis, Effect Size, and Mean Rank Comparison
D1	3; 4	Positivistic	Behavioral Science	Mental Simulation Experiment (Zeimbekis 2011)	Structural Equation Modeling, Effect Size, and Mean Comparison
E1	5	Positivistic	Behavioral Science	Field Experiment (Gerber and Green 2012)	Structural Equation Modeling, Effect Size, and Mean Rank Comparison

1.5 Anticipated Contributions

By exploring the dual effect of IS on the perception of stress and its consequences on behavioral tendencies, this thesis is relevant to several stakeholders, including scientists in the fields of IS, behavior, and transportation science as well as designers and decision makers in the automotive industry.

First, the findings of the thesis provide important implications for the IS community, especially within the research stream of human-computer interaction (Banker and Kauffmann 2004). This research increases the understanding of how individuals perceive the interaction with IS, as the perceptual perspective constitutes an important view of technologies in IS research (Orlikowski and Iacono 2001). The thesis contributes to an understanding of the consequences of the increased pervasion of IS (Ayyagari et al. 2011) in the era of *Digital Life* (Hess et al. 2014). By emphasizing the potential adverse consequences of IS with respect to the perception of stress, this work responds to the recent research call on the dark side of IS which refers to as "a broad collection of 'negative' phenomena that are associated with the use of IT [information technology], and that have the potential to infringe the well-being of individuals, organisations and societies" (Tarafdar et al. 2015a, p. 161).

Previous research in the field of IS and stress has predominantly focused on technostress in an organizational context (Riedl et al. 2012). By emphasizing the significance of technostress in the new field of application of sustainable mobility, i.e., IS in BEVs, this thesis contributes to the increased recognition of the importance of this phenomenon in the private context (Maier et al. 2014; 2015b). Besides emphasizing the negative consequences of IS usage, this work also seeks to determine the potential value of IS in stress reduction, thus shedding light on the yet understudied opposite perspective in IS research. In addition, the thesis sets the objective to propose a comprehensive research model to capture both effects, thus providing a foundation for further research.

With its focus on the behavioral research paradigm (Hevner et al. 2004), this work aims to extend the knowledge base on behavioral research in information systems, in particular, technology acceptance research. Theories of human behavior, i.e., the theory of planned behavior (Ajzen 1991) serve as a fundament for explaining the acceptance of technologies (Venkatesh et al. 2003). The thesis intends to integrate the stress construct in such behavioral-oriented models of acceptance research, thus emphasizing the importance to consider affective components in this research domain (Furneaux and Nevo 2008; Kulviwat et al. 2007).

Moreover, the transportation science community, in particular, researchers concerned with sustainable mobility and the design of in-vehicle IS, are expected to profit from the insights of this work. In this context, this thesis aims to investigate the phenomenon of range stress (Rauh et al. 2015a) against the backdrop of the potential value of IS to mitigate this concern (Eisel and Schmidt 2014). At the same time, the research points on the danger that results from the interaction with IS in terms of technostress (Ragu-Nathan et al. 2008). By integrating physiological responses (Lykken and Venables 1971) into the assessment of IS-related stress, this thesis response to the research lack of using such measurement methods when assessing IS-induced stress (Riedl et al. 2012) and range stress (Nilsson 2011). By doing so, the thesis allows to generate insights to what extent physiological measures constitute a useful extension for psychometric assessment methods.

Apart from its expected contribution for research, the thesis aims to offer recommendations for practitioners in the automotive industry. With its focus on the dual role of IS on the perception of stress in the context of sustainable mobility, the work guides practitioners through the potential opportunities and challenges resulting from the digitalization in and around BEVs (Abdelkafi et al. 2013; Burns 2013; Dijk et al. 2013). In this context, this research strives at deriving practical suggestions for decision makers to find a balance between the dilemma of providing sufficient information to the driver to overcome range-related barriers, while not eliciting an information overload (Neumann and Krems 2016). A profound understanding of the influence of IS on the perception of stress is especially important because a higher level of stress might negatively affect the acceptance towards a technology (e.g., Maier et al. 2015), especially in the context of BEVs (Carroll and Walsh 2010; Dimitropoulos et al. 2011; Duke et al. 2009; Egbue and Long 2012; Rezvani et al. 2015).

Finally, the thesis supports managers concerned with the design of sustainable business models (Luedeke-Freund 2010) by outlining to what extent specific IS-enabled business model designs influence the individual perception of stress and acceptance of related services. Table A-3 provides an overview of the anticipated contributions for research and practitioners. At this point, it should be noted that the respective subdomains of research (information systems science, behavioral science, and transportation science) should not be considered as strictly separated parts, as they overlap to a certain degree.