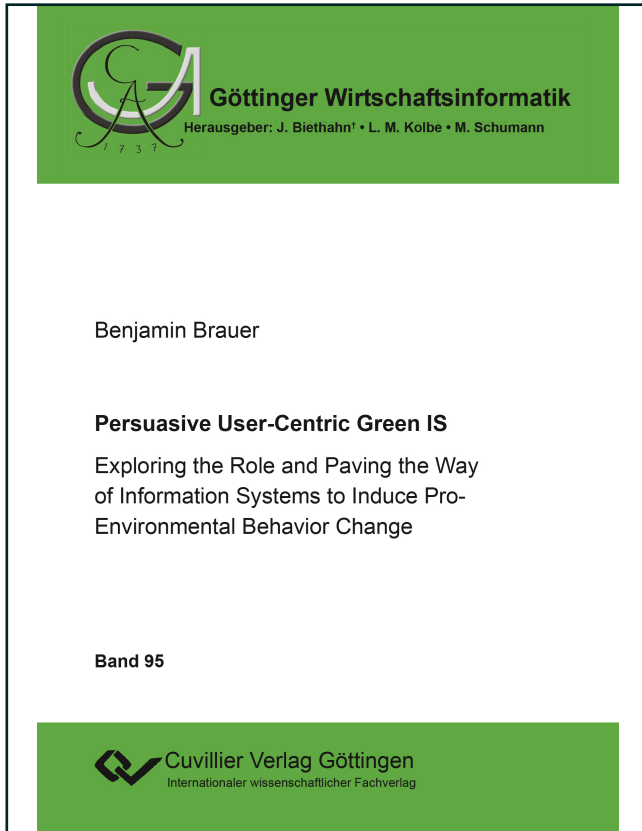




Benjamin Brauer (Autor)

## **Persuasive User-Centric Green IS**

Exploring the Role and Paving the Way of Information Systems to Induce Pro-Environmental Behavior Change



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Telefon: +49 (0)551 54724-0, E-Mail: [info@cuvillier.de](mailto:info@cuvillier.de), Website: <https://cuvillier.de>

## **A. Foundations**

This cumulative thesis is structured into three parts. The first part serves as an introduction to the corpus of this thesis located in Part B. The foundation encompasses an introduction and a chapter outlining the theoretical background of this thesis. The introduction chapter (A.I) is further subdivided into five sections. The first section (A.I.1) outlines the motivation and relevance of this thesis. Section A.I.2 presents the core research questions examined in this dissertation, followed by a structural overview (A.I.3) of the thesis based on the presented research questions. Section A.I.4 describes the research context and design as the foundation of the studies conducted in Part B. The foundation chapter closes with the presentation of the anticipated contributions of this cumulative dissertation.



## I. Introduction

The first section of this chapter gives a short introduction to the topic and highlights the motivation behind this cumulative thesis. Afterwards, the central research questions are presented and followed by a presentation of the structure of the thesis. The next section outlines the greater research context and the fundamental research design to establish a comprehensive overview of the studies conducted and their respective connection and synergy. The chapter closes with a summary of the anticipated contributions pursued by this cumulative thesis in terms of theoretical and practical findings.

### I.1 Motivation

Environmental sustainability has become a topically and important subject more than ever before. Nearly no week goes by without news with political statements about the importance of the protection of the environment – reinforced by reports on natural disasters and their aftermath caused by climate change. Manmade CO<sub>2</sub> emissions lead to an increase of the worldwide temperature (Filcak et al. 2013; IEA 2007) caused by, e.g., transportation, energy use, purchase behavior, etc. The same applies to extensive resource consumption, not only in the industry – but also in the private sector. Moreover, unnecessary high consumption of water, fossil fuel, or food caused by people's behavior contribute to environmental degradation (Simpson 2012). These negative impacts on the natural environment are of concern for the entire society and it is the responsibility of every single person to prevent the harmful consequences on the environment (IPCC 2007; Vlek and Steg 2007).

In order to mitigate environmental pollution, governments and research develop and introduce initiatives and policies to raise awareness about environmental topics, and sanction the negative effects of environmental harmful actions in the organizational and private sector (Chen et al. 2009; Gifford 2011). In the organizational context these regulations show promising results because companies are forced to improve their CO<sub>2</sub> footprint or they will be fined for non-compliance of the specified regulations (Chen et al. 2009). However, in the private context such regulations and penalties are difficult to enforce (Gifford 2011). Although a person can get directly fined for, e.g., littering, or indirect in case of paying increased taxes for gas, or driving an old environmental harmful car in general. However, this sort of punishment and its impact is not comparable with organizational policies and their consequences. Personal penalties might serve as an educational tool and will possibly prevent a person from littering in the future, and could also possibly provoke the consideration of buying a new – more sustainable – car. However, these penalties and tax regulations do not convey and exhibit the negative impacts on the environment of these behaviors and attitudes, and also do not raise awareness and educate about other environmental harmful behavior in other areas, e.g., energy and water consumption or the purchase of CO<sub>2</sub> neutral food and goods.

Behavioral change and the preceding intention of an individual to engage in a behavior change process is a complex circumstance (O'Conner et al. 1999). This pertains nearly every area where behavioral change is of pivotal interest, i.e., education, health, and also pro-environmental behavior (Tscheligi and Reitberger 2007). However, when highlighting the



aforementioned three areas it is apparent – for the majority of people – that the negligence of educational and health-influencing actions directly affect a person’s literacy and well-being. While there is also an effect of the degradation of the environment on the same individual – these impacts are predominantly long term and not likewise perceived as a threat with the same intensity (Gifford 2011). Moreover, compared to educational and sanitary concerns, environmental causations and repercussions are more likely to be attributed to the fault of others than to one-self (Gifford 2011). People might have the mindset that other people elsewhere have a bigger share in environmental degradation, leading to a lack of motivation to give additional effort and to accept restrictions on the private lifestyle, whereas others do not take their part in saving the world (Gifford 2011). This shows that many factors come into play when pro-environmental behavior change is pursued although a general awareness persists.

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*“If so many people are concerned about climate change, the environment, and sustainability, why are more of us not doing what is necessary to ameliorate the problems?”*

—Robert Gifford, “The Dragons of Inaction”, 2011

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This multitude of reasons that prevent people from engaging in pro-environmental behavior – despite the general perception of prevailing issues – can be both: a curse and a chance. A curse in that way, that there are so many barriers hindering a person to seek for change – but also so many starting points to address the issues, in multiple ways.

Another important fact that distinguishes the seek for pro-environmental behavior from other domains where behavioral change is desired, is that there is predominantly no clear positioning of individuals regarding the topic. People cannot be strictly assigned to groups that strongly believe in climate change and will do anything in their power to act as pro-environmental as possible. On the other hand, there is no confined group that knocks down every effort towards environmental improvement (O’Conner et al. 1999). The answer lies somewhere in-between, giving the opportunity to convince people, by any chance. However, regardless of individual attitudes, raising awareness about the causes of climate change is an effective way to convey the aftermath of environmental degradation, and to spark behavioral intentions (O’Conner et al. 1999).

Based on this, it is the challenge to discover options to raise awareness and to guide people through the change process. In this context, information systems (IS) have proven to be a promising tool to support people in behavior change tasks.

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*“Information systems are an important but inadequately understood weapon [...] for environmental sustainability by enabling new practices and processes in support of belief formation, action formation, and outcome assessment.”*

—Nigel P. Melville, “Information Systems Innovation for Environmental Sustainability”, 2010

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In health care people use mobile apps to stop smoking, monitor and track exercise performance, or optimize their diet (Lehto and Oinas-Kukkonen 2015; Toscos et al. 2006; Yoganathan and Kajanan 2013). In education, pervasive micro-learning apps are available



for nearly every imaginable subject. However, the use of information technology and systems to improve the natural environment is still underexplored (Corbett and Mellouli 2017; Loeser 2013; Pernici et al. 2011). Green Information Systems (Green IS), are a first approach in IS research to investigate the potential of computer technology to ameliorate environmental problems (vom Brocke et al. 2013b; Chen et al. 2008; Melville 2010). Though, emerging from the organizational context, Green IS historically focuses on optimizing enterprise processes towards sustainable practices (Flüchter and Wortmann 2014; El Idrissi and Corbett 2016; Loeser 2013; Loock et al. 2013). A user-oriented approach with the goal to directly address people's behavior is an uncommon procedure in Green IS research (Corbett and Mellouli 2017), despite single advances (Flüchter and Wortmann 2014; Froehlich et al. 2009; Hilpert et al. 2013; Loock et al. 2013).

Hence, the focus on individuals utilizing IS to trigger pro-environmental behavior is a rare phenomenon in IS research. Therefore, it is necessary to explore and expose the field of user-centric Green IS, and to derive possible advancements to utilize IS for pro-environmental behavior change. Thereby, IS will help to unleash the great potential for positive environmental change by activating a comprehensive resource in form of people all around the world.

Thus, the goal of this cumulative thesis is to gain insights in the use of information systems to improve environmental sustainability in a user-centric manner, to analyze and evaluate existing approaches and solutions, and to identify shortcomings and gaps from existing research. In this vein, the concept of user-centric Green IS is examined in deep detail in order to pinpoint appropriate measures to foster pro-environmental behavior and to determine the suitability and perception of pro-environmental solutions and their acceptance by potential users.

## **1.2 Research Questions**

The exploration of user-centric Green IS in this cumulative thesis is divided into three building blocks in order to provide a clear structure. The three building blocks constitute the corpus of this dissertation and are located in Part B. The first building block gives insight in the status quo of user-oriented Green IS solutions (B.I Status Quo), followed by the examination of appropriate theories and mechanisms applicable for successful user-centric Green IS design (B.II Theories and Mechanisms). The last building block (B.III User Acceptance) covers design recommendations of user-centric Green IS with emphasis on user acceptance.

As briefly mentioned in the preceding motivation, Green IS constitutes a well-established research domain in the IS community. Originating in the organizational context, Green IS research is primarily concerned with the pro-environmental redesign of business processes, supply chains, etc. in order to improve the organizational CO<sub>2</sub> footprint (Loeser et al. 2012).

However, besides the industry, cities and their citizens have a great share on global carbon emissions and resource consumptions (Neirotti et al. 2014). Hence, the huge potential of addressing individuals to induce behavioral change towards pro-environmental behavior



poses a promising approach. This thesis answers the call from multiple Green IS researchers from the IS community to perform more research on this topic and to diversify the perspective within this research field (vom Brocke et al. 2013b; Melville 2010; Watson et al. 2013).

The aim of the first research question is to give an overview of the current state of Green IS research outside the organizational context in the IS community and thematically adjacent domains, e.g., urban planning and energy management. Momentarily, Green IS research is predominantly bound to the organizational context (Chen et al. 2009; Loeser 2013), and thus poses a strong restriction for the potential of Green IS (vom Brocke et al. 2013b).

The analysis of the status quo in Green IS research within this building block constitutes the starting point for detailed research approaches throughout the remainder of this thesis and helps to set the focus on the revealed research gaps. Moreover, the practical perspective on user-centric Green IS with the goal to support pro-environmental behavior is of interest. Thereby, both perspectives: theory and practice are covered within this first part of this thesis.

This first research question not only addresses the status quo of user-centric Green IS solutions but also reveals further research gaps in this area (vom Brocke et al. 2013b). These gaps identified add to the research stream of Green IS and help other researchers to structure future studies (vom Brocke et al. 2013b).

*RQ1. How do information systems contribute to environmental sustainability and what solutions exist to address user-centric approaches of Green IS?*

After drawing a comprehensive picture of Green IS research and practical approaches in course of the first research question, the second part of this cumulative thesis illuminates the perspective on pro-environmental behavior change processes. The process of pro-environmental behavior change poses a very complex topic (Gifford 2011; Kurz 2002) and is widely under-represented in the Green IS research domain despite its huge credited potentials (Boudreau et al. 2008; vom Brocke et al. 2013b; Butler 2011; Dedrick 2010; El Idrissi and Corbett 2016; Pernici et al. 2011).

The central research question of this second building block draws upon the determination of behavioral theories and concepts particularly suited for pro-environmental behavior change, and sheds light on the technical implementation of suitable behavioral theories towards ecological behavior. In this part of the thesis the focus is set on the individual person and how s/he can be convinced for engagement in pro-environmental behavior with the aid of IS.

Existing research outlines the importance of information feedback to the individual in order to successfully pursue pro-environmental behavior (Gifford 2011; Kollmuss and Agyeman 2002; Kurz 2002). Thus, information technology and systems are predestined as information provider for the support of this information provision process (Shevchuk and Oinas-Kukkonen 2016). However, research on the interaction between system and user is still low regarding the effective and efficient design and use of persuasive feedback systems for pro-



environmental behavior change (Dedrick 2010; Lehto et al. 2012; Shevchuk and Oinas-Kukkonen 2016).

Moreover, motivational processes take a key role in the engagement process of people for behavioral change (Kollmuss and Agyeman 2002; Shevchuk and Oinas-Kukkonen 2016). Hence, it is of great importance to match motivational theories and mechanisms with information systems as an instrument to motivate people for the use of Green IS to improve their pro-environmental behavior (Froehlich et al. 2010; Shevchuk and Oinas-Kukkonen 2016). Because of the lack of research with focus on user oriented Green IS design and evaluation (Dedrick 2010; Melville 2010) there is little to no concrete literature serving as a foundation for user-centric Green IS research (vom Brocke et al. 2013b; Dedrick 2010).

In conclusion, the goal of this second research question is to structure existing knowledge on behavioral change in general and in the ecological context, and make suggestions for the implementation of IS-based solutions helping to induce IS-driven pro-environmental behavior change of people. The findings from this part of the thesis contribute to the deduction of concepts for the design of user-centric Green IS and build the foundation for future research endeavors in the field of user-centric Green IS.

*RQ2. Which theories and mechanisms need to be considered to support people towards IS-aided sustainable behavior change?*

Finally, the third research question takes the analysis and findings from the preceding two research questions one step further towards the conceptual design of user-centric Green IS with particular focus on system acceptance. In contrast to the second research question with focus on the design of interaction and motivation processes to improve the persuasiveness of user-centric Green IS – the third building block is concerned with the acceptance and adoption process of these systems. Here, the prime goal is to increase the acceptance rate of these systems for frequent use in people's everyday life.

The effective and efficient design and technical implementation of the concrete processes to support system interaction and motivation alone (RQ2) does not guarantee the use of user-centric Green IS. An information system is only successful if the user is willing to use it voluntarily and enjoys doing so (Shevchuk and Oinas-Kukkonen 2016).

Acceptance research constitutes an elaborated research field in the IS community with a consistent growing number of studies (Bagozzi 2007; Barki 2007; Sun and Zhang 2006; Venkatesh et al. 2000, 2003, 2012). This growing number and the results of these studies indicate the relevance of analyzing user acceptance of information systems in order to build effective and efficient IS with high likelihood for long-term system adoption by the user. Particularly in a relatively young research area with little knowledge and evidence about the overall successful design of user oriented information system it is fundamental to gain and create insights for future research endeavors and practical projects.

Hence, the third and last research question of this cumulative thesis answers the question:

*RQ3. How should user-centric Green IS be designed to achieve user acceptance?*



The gradual approach from the presentation of the state of research in this domain and the identification of research gaps, over the examination of behavioral theories and models, to the derivation of design patterns with the proposition of user acceptance draws a holistic picture of this research topic. Only the combination of these three research areas lead to a profound overall picture providing broad Insights to the comprehensiveness and potential of the user-centric Green IS research area.

### **I.3 Structure of the Thesis**

The thesis is structured in three main parts (Part A, Part B, and Part C) as illustrated in Figure A-2. Each of these parts is further subdivided. Part A consists of two chapters (A.I and A.II) and both Part B and Part C are further sub-divided into three chapters (B.I-III and C.I-III).

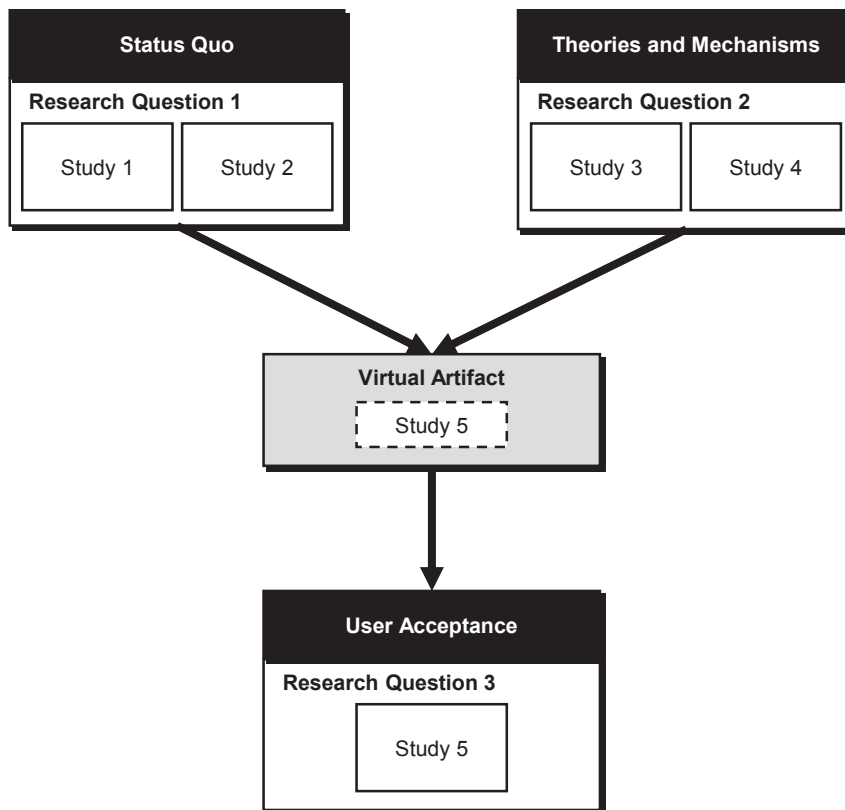
Part A covers the foundation of this thesis. It starts with an introduction (A.I) to this work. Within the introduction, the motivation behind this research endeavor is presented (A.I.1), followed by a short presentation of the central research questions (A.I.2) and a structural overview (A.I.3). Afterwards, the research context and research design is outlined by positioning this thesis in terms of the underlying IS research stream and epistemology (A.I.4). Chapter A.I closes with a peek into the anticipated contributions of this thesis.

The second chapter of Part A delivers insight into the theoretical background (A.II) required to understand the general idea of this thesis. The overarching goal of user-centric Green IS is to change people's behavior. Therefore, it is helpful to first understand what constitutes behavior change, and how behavior change can be provoked. Thus, this chapter starts with the presentation of fundamental behavior change theories and models (A.II.1) in order to convey the complexity of this domain and gives insight into the socio-psychological realm of behavioral change. Subsequently, the concept of the use of information systems to foster environmental sustainability by inducing pro-environmental behavior is introduced. The IS research domain Green IS is briefly defined, as well as the concept of persuasive systems as a prospective approach for IS-driven behavior change initiatives (A.II.2). Finally, the chapter gives insight into the theory behind user acceptance research in context of information system adoption (A.II.3).





Figure A-1: Overview of the thesis' building blocks and the comprised studies



The actual studies on user-centric environmental sustainable information systems are composed in Part B and embody the core component of this thesis. The studies composed in this thesis help to answer the three research questions specified above (Section A.1.2). The assignment of the studies conducted to their respective building block is illustrated in Figure A-1. The structure of Part B aims to convey the constructive idea of this thesis. The findings of the two studies conducted in building block B.I (Status Quo) as well as the two studies of the second building block B.II (Theories and Mechanisms) are incorporated into the third building block B.III (User Acceptance) in course of the design of an virtual artifact that is analyzed regarding the acceptance decision of potential users. The building blocks and their studies are further outlined in the following.

The first two studies give an overview about the current state of research and practice on the topic of user-centric Green IS. In the first study (1) two literature analysis are performed based on articles from different research areas. Within the first review, the leading IS journals and conference articles are screened for Green IS solutions. The second review analyzes articles without restrictions regarding the research field. Thus, the results of this analysis give a holistic view on the state of research on the use of Green IS outside organizational boundaries. The second study (2) of this building block (B.I Status Quo) covers the practical perspective. The study explores the Google Play Store for mobile applications that help people to improve their personal pro-environmental behavior. Furthermore, the apps discovered are analyzed regarding their purpose and properties to draw a picture of existing real-world implementations of user-centric Green IS, aside from the sole academic research point of view.



The following two studies are attributed to the building block (B.II Theories and Mechanisms) of this thesis. Both studies take on the socio-psychological prospect of this topic by focusing on behavioral theories and mechanisms applicable in the context of pro-environmental behavior change. The first study (3) of this building block provides a framework for the establishment of sustainable communities based on the potential synergy of socio-psychological theories for behavior change and the capability of information systems to address and ultimately change people's behavior. The other study (4) in this building block analyzes an existing solution to foster pro-environmental behavior in communities by utilizing IS to motivate bicycle use regarding its effect.

Finally, the third building block of this cumulative thesis outlines the user acceptance (B.III) of user-centric Green IS. The study in this part of the thesis explores the suitability of persuasive design principles for user-centric Green IS solutions. This study examines the influence of different functional implementations of these established persuasive design principles (see A.II.2) on the acceptance of system use from the user's perspective. Table A-1 illustrates the five containing studies and summarizes their main contribution.



Table A-1. Overview of studies in this thesis

No.	Outlet	Ranking <sup>1</sup>	Section	RQ	Main contribution
1	Pacific Asia Conference on Information Systems (PACIS)	C	B.I	1	Structured overview of the implementation of Green IS practices and solutions in the smart city domain, and the deduction of a research framework to identify and address existing research gaps in this research field.
2	Pacific Asia Conference on Information Systems (PACIS)	C	B.I	1	Insights about the status quo of existing user oriented solutions on the market with the goal to foster and/or change environmental sustainable behavior on an individual level, and the analysis of these existing solutions.
3	Americas Conference on Information Systems (AMCIS)	D	B.II	2	Identification of prevailing problems and psychological barriers, possible counter measures, and the potential of information systems to support environmental sustainable behavior change with the development of a conceptual framework.
4	European Conference on Information Systems (ECIS)	B	B.II	2	Function oriented analysis of motivational processes and user experience in the use of persuasive information systems to support environmental sustainable behavior.
5	International Conference on Information Systems (ICIS)	A	B.III	3	Acceptance analysis of persuasive design principles for the development of user oriented environmental sustainable information systems and the effect on system adoption.

At last, Part C summarizes and reflects the key findings of the presented studies regarding the research question's building blocks (Section C.I.1-C.I.3) and provides a holistic view on user-centric environmental sustainable information systems based on the combined results of the collated studies (C.I.4). These results are further elucidated regarding their implications for research (C.II.1) and practice (C.II.2). As concluding remarks of this cumulative thesis the limitations (C.III.1) of the studies are discussed and future research opportunities (C.III.2) of this research topic are outlined at the end of this work.

<sup>1</sup> The ranking is based on the VHB Journal 3 ranking (<http://vhbonline.org/service/jourqual/vhb-jourqual-3/>; 2015)