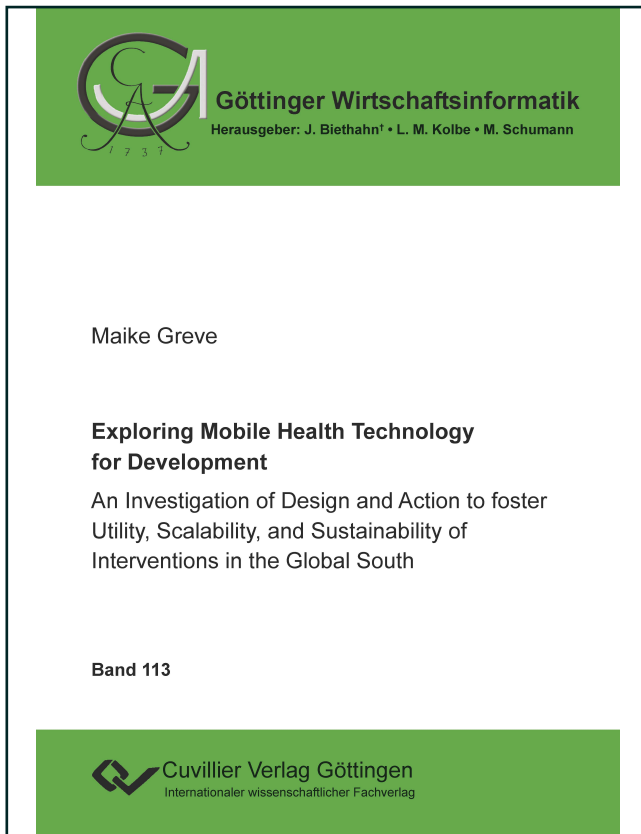




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Exploring Mobile Health Technology for Development

An Investigation of Design and Action to foster Utility,
Scalability, and Sustainability of Interventions in the Global
South



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I. Introduction

This section introduces the research topic and agenda of this thesis. In the first subsection (I.1), this research motivation and endeavor's relevance are highlighted. This is followed by an analysis of prevailing research gaps and formulating research questions (I.2). Following this, the structure of the thesis is outlined (I.3), and the research positioning, design, and space are discussed (I.4). Lastly, the introduction concludes with anticipating the contribution and implications of this thesis (I.5).

I.1 Motivation

“The use and scale-up of digital health solutions can revolutionize how people worldwide achieve higher standards of health, and access services to promote and protect their health and well-being.”

(World Health Organization (WHO), 2020)

From a historical perspective, human health has greatly improved due to advances in technology (e.g., modern sanitation, the advent of penicillin, vaccines, and magnetic resonance imaging) (Lehoux et al., 2016). This implies that research and technology have always been the main drivers of better health. Following this trend, today's digital technology is opening up new opportunities that are transforming the delivery of care, such as instant diabetes testing and telemedicine (Chiasson & Davidson, 2004). Propelled by the global ubiquity of mobile phones, digital technologies have also changed how people manage their health and gain access to healthcare services. For example, mobile devices enable people to (over)optimize their health through constant tracking of personal vital parameters (e.g., pulse) (Sim, 2019). Meanwhile, such technologies are no longer a luxury, as these are widely available and affordable worldwide (Middleton et al., 2014). Therefore, in low-resource settings such as countries in the Global South¹, digital health services address a diversity of persistent weaknesses in health systems by complementing traditional yet often scarce and limited healthcare (Blaya et al., 2010; Braa et al., 2007).

In terms of global health development, the United Nations' 2030 Agenda is one of the most important global agreements. At the core of this agreement are the 17 Sustainable Development Goals (SDGs), which recognize the world's most pressing challenges; one goal (SDG 3) explicitly strives for universal healthcare coverage and strongly emphasizes the need for health equity and “leaving no one behind” (UNDP, 2015). The use of digital

¹ The terms “Global South” and “Global North” are used to characterize the socio-economic and political characteristics of countries, where “Global South” refers to low- and middle-income countries (LMIC) and “Global North” refers to all other countries. There is a strong debate about this terminology; however, this thesis selected it for consistency reasons.

technologies can make a significant contribution to achieving the SDGs, especially regarding healthcare provision and services (Asi & Williams, 2018; Lozano et al., 2018). However, a key challenge is to ensure that all people enjoy the benefits of digital health services while confirming that innovation and technology help reduce inequalities in the world (Howard-Grenville et al., 2019; Rothe, 2020).

While the potential of such technology is especially evident regarding healthcare provision and support, the success and impact of various projects that rely on technology to enhance healthcare access are limited (Heeks, 2002; Riggins & Dewan, 2005; Walsham, 2020). The number of projects in the Global South that face implementation complexities is very high. These projects fail to move beyond their initial pilot phase and hence do not reach scale and are able to be sustained. The result is that such projects do not support and impact long-term developmental processes in healthcare. This is why the term “pilotitis” has emerged, which emphasizes the disease-like spread of technology projects that are discontinued after their pilot phase (Bhatia et al., 2020; Greve et al., 2021; Tomlinson et al., 2013).

To practically address this current phenomenon, a consensus statement, the “Principles for Digital Development,”² was developed in 2014, which supports practitioners in using digital technologies for development through nine generic guidelines (see section II.3) (Waugaman, 2016). Various global health and development institutions, such as the U.S. Agency for International Development and the Bill and Melinda Gates Foundation, have endorsed the consensus (Digital Development Principles Working Group, 2021). The principles reinforce the importance of effectively designing digital technology to be supportive for development programs. However, widespread confusion remains about how to put these relatively high-level principles into operational practice (Holeman et al., 2018; Waugaman, 2016).

From a research perspective, the complexity of implementing digital technology for healthcare is a common theme and of significant interest to information systems (IS) scholars (Anderson & Agarwal, 2011; Langtao Chen et al., 2019a). Further, the research field of information and communication technologies for development (ICT4D) is driven by the conviction that information and communication technologies (ICTs) foster development and explore how technology improves lives and creates a better world (Sein et al., 2019; Walsham, 2012, 2017). Bridging the complexities of healthcare (e.g., multiple stakeholders and sensitive data) and the complexities of the setting in the Global South (e.g., limited resources, high levels of illiteracy, and technological backwardness

² Principles for Digital Development, see <https://digitalprinciples.org/>

(Chaudhuri, 2012)), it is apparent that the intertwined relationship between digital technologies and such complexities presents a field of tension³. This is especially evident when fostering technologies as a driver of socio-economic transformation towards achieving development goals such as the SDGs (Chaudhuri, 2012; Sein et al., 2019; Walsham, 2012).

Research and practice particularly point to the potentials of mobile technology. Mobile applications (apps) and other mobile services (e.g. tracking devices) can support and address a variety of the weaknesses of healthcare systems in the Global South, such as the mediation of health information, connection to health advocates, and health self-management or monitoring (Chib et al., 2015; Latif et al., 2017; Motamarri et al., 2014). Nevertheless, it is apparent that previous interventions that aimed at implementing mobile technology are also suffering from the pilotitis phenomenon and are failing at early stages or showing limited success (Krah & de Kruijf, 2016; Schelenz & Pawelec, 2021). Therefore, the path to reaching the SDGs through these mobile health (mHealth) interventions is controversial (Asi & Williams, 2018; Rothe, 2020). Thus, the problem arises of how to design mHealth and how to implement it so that it endures the transformative processes towards development.

This thesis takes a problem-oriented perspective on the phenomenon of mHealth in the Global South, addressing, on the one hand, its design and, on the other hand, the actions that stakeholders need to take to overcome the challenges of long-term implementation and use. By appreciating the intertwining overlay of the research and practice of the topic (Schelenz & Pawelec, 2021), the focus is set on mHealth initiatives, i.e., specific projects or interventions⁴, which generate knowledge from a “doing” perspective while solving a specific healthcare development problem and guiding the learnings and best practices of mHealth initiatives towards a general understanding of the challenges that hamper scale-up and sustainability. In this way, this study aims to shed light on the promising but so far limited nature of mHealth for development (mHealth4D) to support the SDGs and link practical implications to research discourse.

I.2 Research Gap and Research Questions

This thesis seeks to address the described challenge emphasized by the SDG 3 agenda of improving healthcare in the Global South through an exploration of mHealth as a supportive asset for development. The overarching objective of this exploration is threefold and encompasses the derivation of an understanding of the status quo of prior research,

³ As a remark, the phenomenon of mHealth in the Global South is of a multidisciplinary nature. However, this thesis takes the IS research area as the major lens on this topic, where health research as well as development studies only serve to inform the scope.

⁴ The terms “intervention,” “initiative,” and “project” are used synonymously in this thesis.

the actual research in the Global South, and the synthesis of knowledge. Thus, three research questions with subsequent sub-questions are derived and discussed in the following.

First, research on mHealth is one aspect of the broader digital health research agenda (van Dyk, 2014). Overall, digital health is of substantial interest to the IS research community (Langtao Chen et al., 2019a). The research stream is called Health IS and addresses a variety of aspects—from the impact of digitalization on healthcare cost and quality to digital health services such as telemedicine—but it also includes research regarding health data exchange and data privacy (Langtao Chen et al., 2019a; Ostern et al., 2021). Thereby, digital health studies engage at different levels of intervention, such as the micro-level (e.g., acceptance of health apps for patients (Fox & Connolly, 2018) or individual health monitoring via fitness tracker (James et al., 2019)) or the macro-level (e.g., IS in hospitals for patient data sharing (Pouloudi et al., 2016) or healthcare expenditure control (Thompson et al., 2020)). Against this background, IS distinguishes between two paradigms: a) research that investigates the design of such systems and b) research that explores a system's use, management, and impact based on individual and organizational behaviors (Hevner et al., 2004). Both paradigms contribute to the studies in the Health IS stream and understanding the multifaceted nature of digital health, including mHealth.

As a whole, the knowledge base of the research agenda on Health IS research covers a wide range of application domains, forms of technology, and research foci. There is a need to review the existing body of research, synthesize prescriptive knowledge, and identify research gaps within the broader body of digital health literature to reach the overarching object of exploring the specific intervention of mobile technology to support healthcare in the Global South. Following the notion of “zooming in and zooming out” (Gaskin et al., 2014), the goal is to capture the broader scope of available health discourse in IS research and create an orientation map of promising research directions (vom Brocke et al., 2015) before “zooming in” to investigate the practically-motivated trajectory of mHealth in the Global South. To capture the complexity of healthcare systems as digital socio-technical systems (Ostern et al., 2021) and their discourse in research, the first research question of this thesis aims to analyze existing knowledge:

RQ 1: *What is the status quo of IS research on health, and what future research opportunities can be revealed?*

Second, while the adverse enhancements and potential of digital health become evident in research and practice, the complexity of the socio-technical systems of healthcare conceals challenges that limit its outcome and impact. This is especially seen in low-resource environments, such as the countries in the Global South (Heeks, 2014), where, on the one hand, technology has a tremendous potential to address the need to enhance

healthcare systems, and, on the other hand, a lack of success and sustainability of digital health projects is common and critiqued in research and practice (Schelenz & Pawelec, 2021). However, mobile technology can especially address shortages through increased availability, reachability, and affordability (Lichtenberg et al., 2019). Therefore, ICT4D research calls upon intervention studies where the theoretical knowledge base can be leveraged to design development initiatives (Sein et al., 2019). Thus, to design mHealth initiatives, there is a need to conduct studies that create knowledge while addressing actual health contexts in the Global South. Thereby, needs-based design and understanding are anticipated, which recognize the user and culture sensitively. This leads to the following research question:

RQ 2: *How can mHealth interventions be designed to address the challenges and conditions of the Global South?*

This research question is deconstructed into two sub-questions that recognize the specific research context. The first sub-question builds upon the design paradigm by conducting an Action Design Research (ADR) intervention study (Sein et al., 2011) to theorize the design knowledge of an mHealth app to be used by community health workers (CHWs). This user group is of special interest since hospitals and doctors are scarce in many LMIC and often centered in cities (Thondoo et al., 2015). Health-related counseling has shifted to lay CHWs promoting health and providing healthcare services to rural areas (Lewin et al., 2005). Overall, governments increasingly see CHWs as a key means of providing access to basic primary healthcare services (Geldsetzer et al., 2017); further, mobile technology provides a tool for empowering them by supporting their tasks of coordinating care and mobilizing communities (Holeman & Kane, 2020; Walsham, 2020; Whidden et al., 2018). However, too many mHealth projects falter due to simplistic assumptions about end-user preferences and activities (Holeman & Kane, 2020); therefore, there is a need for a human-centered design (Cooley, 2000) of such technology-based services (Holeman et al., 2018). The concept calls for hands-on engagement and iterative participatory design approaches that prioritize users' aspirations and experiences. So far, the design research of mHealth projects is so vast and jumbled that practitioners struggle to make use of the scholarly rigor (Holeman & Kane, 2020). Thus, ADR provides a methodological approach to solve real-world problems while gaining prescriptive knowledge, which is generalizable and transferable for both research and practice (Purao et al., 2013). The first sub-question focuses on gaining this knowledge by investigating the use case of non-communicable disease (NCD) prevention, especially diabetes and hypertension, through CHWs in eSwatini:

RQ 2.1: *How can an mHealth app be designed to support decentralized health systems and be usable for community health workers?*

The second sub-question addresses the social perspective by exploring cultural sensitivity and differences through a hypothesis-based experimental investigation on the micro-level. The focus is set on the security risks that arise when using digital technology to capture health data. The sudden introduction of internet-related technology in the Global South leads to increased security vulnerabilities, especially when using mobile technology (Fichman et al., 2011; McLeod & Dolezel, 2018). Data breaches are very common cybersecurity incidents in the health industry, which are particularly problematic because they affect the confidentiality of data (Masuch et al., 2021). While the risks of a data breach and the loss of personal health information are of practical relevance, research on addressing this security challenge in a culturally sensitive way is still limited (Adu et al., 2021).

Even in the Global North, where the use of digital technology in the health sector is built upon a long history of digital development and hence is more mature, data breaches are a daily occurrence (Goel & Shawky, 2009), and precautions to protect personal health information are a high priority, which is addressed, for example, through the General Data Protection Regulation (Angst & Agarwal, 2009; Broy, 2017). In contrast, many countries in the Global South do not build upon an established technology infrastructure and often lack regulated structures to govern data protection (Lewis et al., 2012; Sweetney, 2015). There is an emerging research direction that focuses exclusively on data breach response because the inevitability of these incidents requires business and customer reaction (Choi et al., 2016; Goode et al., 2017; Gwebu et al., 2018). However, this research is commonly focused on developed countries (i.e., the Global North), even though it is known that cultural differences play a key role in user interaction and communication (Dinev et al., 2009; Hui & Au, 2001). This means that current studies lack an in-depth understanding of how impaired customer perceptions of recovery are culturally conditioned (Goode et al., 2017). The second sub-question addresses this gap by conducting a cross-cultural comparative study between a country in the Global North and the Global South by examining people's response to the design of an announcement of a data breach in which personal health information is breached from an mHealth device (e.g., a fitness tracker):

RQ 2.2: *How can the security challenges of mHealth be addressed and dealt with in a culturally sensitive way?*

Third, building upon the knowledge base and investigation of mHealth intervention, the last step remains, which is to derive a general understanding of mHealth initiatives for development. Leveraging such development projects to create knowledge is an opportunity for research that copes with reflection and learning (Sein et al., 2019). One can argue that the research conducted on RQ2 represents microcosms of empirical contestations. However, such is needed to “zoom out” and analyze broader development processes (Sahay et al., 2017). Therefore, the third and last research question builds upon

the learning and best practices of various mHealth initiatives to derive a synthesis of mHealth scalability and sustainability, as both are of high (practical) relevance and are rigorously embedded in research (e.g., Braa et al., 2004). However, as the pilotitis phenomenon indicates, there is a need to generate findings so that stakeholders and the general public can benefit from them (Ilavarasan, 2017; Schelenz & Pawelec, 2021). Thus, the last research question aims to address this need:

RQ 3: *How can mHealth interventions reach scalability and sustainability?*

Figure 2 provides an overview of the research questions and their interdependencies, which are described above. The detailed theoretical background to all relevant topics is provided in section A.II.

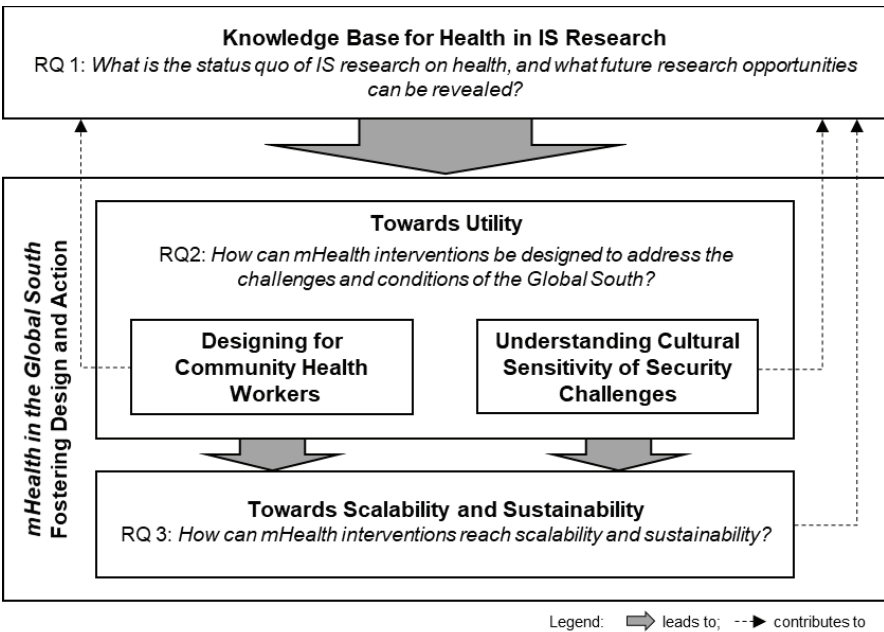


Figure 2: Research Overview

I.3 Structure of Thesis

This cumulative thesis builds around four standalone studies. It is structured in three main parts, as depicted in Figure 3.

Part A provides the foundation of this research by providing an introduction (A.I) and the research background (A.II). The introduction starts with the general motivation of the research (A.I.1.) before deriving the research questions (A.I.2) that seek to be answered in this thesis. This is followed by the structure of the thesis (A.I.3) and the research positioning and design (A.I.4). The introduction ends with a description of the anticipated contributions (A.I.5) of the thesis' research. The background section introduces of the advent of mobile technology (A.II.1) and discusses such in the context of Health IS research (A.II.2) and IS research aiming to support development in the Global South (A.II.3). Lastly, a synthesis of mHealth4D is presented (A.II.4).

Part B encompasses the four studies as the main part of this thesis. The studies provide a faceted view on mHealth in the Global South and address the formulated research questions to contribute to closing the selected research gaps (Table 1). Part C addresses the contribution of this thesis, starting by summarizing and synthesizing the findings of the individual studies included in this thesis (C.I). Building on this, the implications for research and practice are discussed, as well as a recognition of its limitations (C.II). This thesis ends with some concluding remarks (C.III).

Table 1: Overview of Studies Included in this Thesis

| No. | Outlet | Status | Ranking ⁵ | Section | RQ | Main Contribution |
|-----|---|---------------------------------------|----------------------|---------|----|---|
| 1 | Proceedings of the 54th Hawaii International Conference on System Sciences (2021) | Published ⁶ | C | B.I. | 1 | Overview of the status quo of Health IS research with a focus on social, organizational, and environmental contexts to synthesize existing prescriptive knowledge |
| 2 | European Journal of Information Systems ⁷ | Submitted (under Review) ⁸ | A | B.II | 2 | Exploration of the design of an mHealth app for CHW in decentralized healthcare systems. |
| 3 | Proceedings of the International Conference on Information Systems (2020) | Published | A | B.II | 2 | Understanding of the cultural sensitivity on the impact of security challenges of mHealth through a comparison of Bolivia and Germany |
| 4 | Information Systems Journal | Submitted (under Review) ⁹ | A | B.III | 3 | A process model of reaching scalability and sustainability for mHealth projects in the Global South. |

⁵ According to VHB-JOURQUAL 3

⁶ Invited for Resubmission in the Journal of Information Technology (VHB A)

⁷ Previous version published at ECIS 2020 (VHB B)

⁸ Previously received valuable feedback in the Revision (2nd round) at the Information Systems Journal (VHB A)

⁹ Previously received valuable feedback in the Revision (2nd round) at the European Journal of Information Systems (VHB:A) and invited for Resubmission in the Journal of the Association of Information Systems (VHB A)

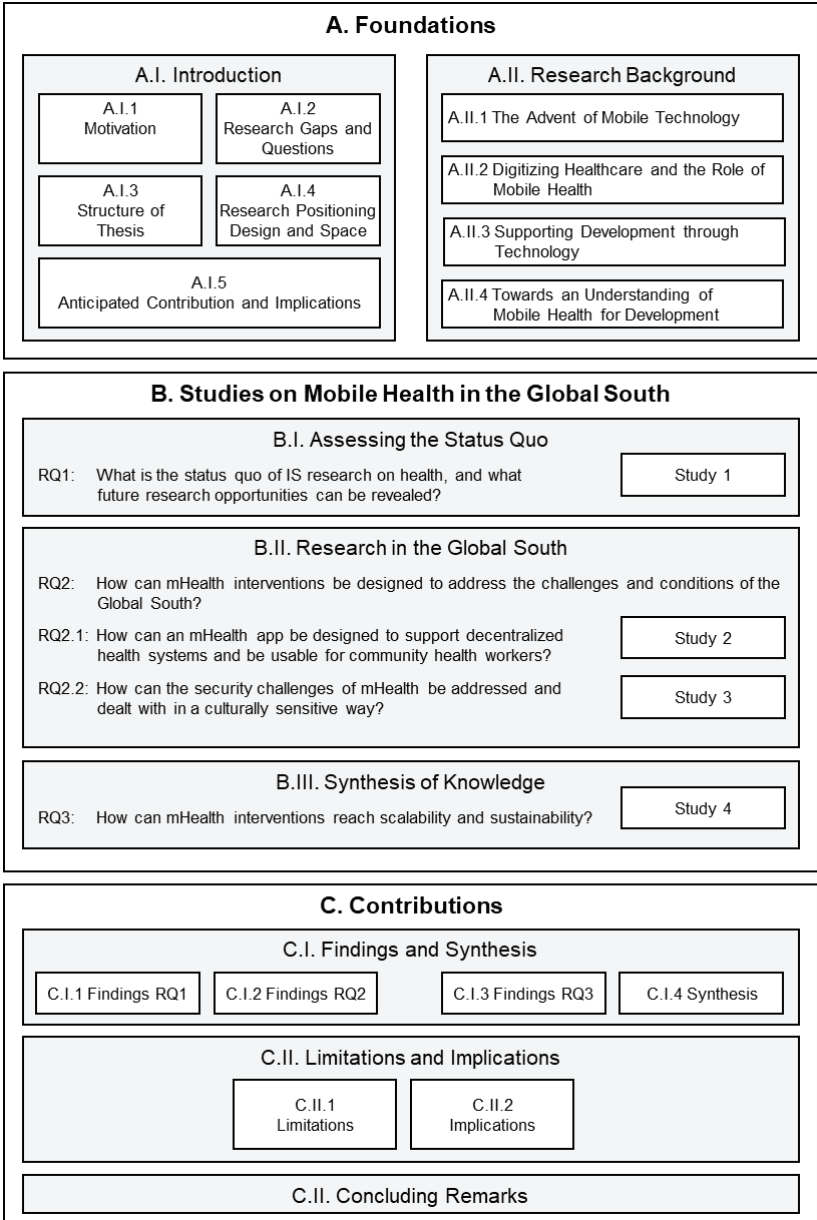


Figure 3: Structure of this Thesis

I.4 Research Positioning, Design, and Space

Generally speaking, “research is a problem-solving or phenomenon-exploring exercise” (Berthon et al., 2002, p.421) that generates knowledge in and through the process of solving such problems and exploring such phenomena. In this general notion, IS research explores “how to understand, interpret, adapt to, and effectively manage” the role of (emerging) technologies as phenomena themselves or in relation to or as supportive tools in problem-solving (Banker & Kauffman, 2004, p.294). The IS discipline has made a considerable effort to provide some structural guidance, such as an overview of research streams (Banker & Kauffman, 2004) and theory types (Gregor, 2006), to position research within the growing body of IS research.

In the following, this thesis’ positioning within the IS discipline is discussed (see section I.4.1). Furthermore, the research design of the individual studies of the thesis is analyzed (see section I.4.2). This includes a detailed review of the methodological approach of each study. Based on this, the overall research space of the thesis is elaborated (see section I.4.3).

I.4.1 Research Positioning

An overview of the discussed positioning criteria, which are established and well discussed in the IS discipline, is depicted in Table 2. The individual criteria are briefly explained and further discussed in the context of this thesis and its four independent studies.

Table 2: Overview of Positioning Criteria in the IS Discipline

| Epistemology | Positivism | Interpretivism | Critical Realism | <i>Pragmatism</i> | |
|------------------------|-------------------------------------|-------------------------|--------------------------------------|-------------------------------------|-----------------------------|
| Paradigm | Behavior-oriented | | <i>Design-oriented</i> | | |
| Theory Type | I. Analysis | II. Explanation | III. Prediction | IV. Explanation and Prediction | <i>V. Design and Action</i> |
| Research Stream | Decision Support and Design Science | Value of Information | <i>Human-Computer Systems Design</i> | <i>IS Organization and Strategy</i> | Economics of IS and IT |
| Research Method | Case Study | <i>Conceptual Model</i> | Mathematical Model | <i>Literature Analysis</i> | Survey |
| | Secondary Data | <i>Design Science</i> | <i>Experimental Research</i> | Interview | Content Analysis |

Note: *Italics* indicate Characteristics of Positioning Criteria that are Mainly Acknowledged in this Thesis

Four main perspectives are differentiated in the IS discipline to classify the epistemological stance of the research (Goldkuhl, 2012; Orlikowski & Baroudi, 1991). These stances shape the research since they concern how the researcher perceives and views the world. Most common in ICT4D research is the positivist approach, which assumes an objective apprehension of the world (often considered for theory testing and prediction), and the interpretive approach, which assumes a subjective socially constructed world (often considered for field studies that examine the interplay of various stakeholders with