Preserving Privacy in Smart Homes: A Socio-Cultural Approach

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Abstract
Smart homes are expected to reduce the time we spend on routine activities. Data becomes an enabler and asset, as smart devices collect and process it. Smart homes also have the potential to exaggerate bewilderment and resistance, feelings people express when their privacy is infringed. Because privacy is being influenced by socio-cultural factors and shaped by technology, this work argues for a thorough understanding of the home's socio-cultural context. We aim to provide a grounded-in-data, contextual smart home privacy model. The model will be applicable to product and policy design, and also inform future work in privacy research for ubiquitous computing settings.

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Introduction
While the smart home market is expected to continue its rapid growth [13], privacy is highlighted as one of the key adoption barriers [4]. In particular, the unobtrusive, ambient, and ubiquitous nature of technology, in the context of a home—which is perceived as one of the most private spaces—exaggerates the aforementioned situation and feelings which are reinforced by low privacy salience [9]. Large amounts of data which allow collectors to "learn" something about the home and its inhabitants become available. This leads to a complex problem: on the one hand, people often express "bewilderment, resistance, and sometimes resignation" [11, p. 3] towards dissemination and further processing of their data. On the other hand, they are entering an admittedly imbalanced information market as "seller" of personal information [1]. Nonetheless, the growing smart home market is indicative of expected benefits to individuals through the use of smart technology in the home.

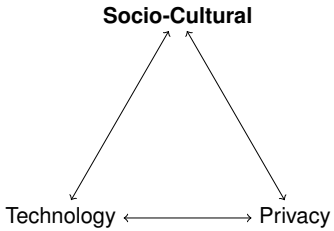

Figure 1: The relationship between socio-cultural aspects, privacy, and technology

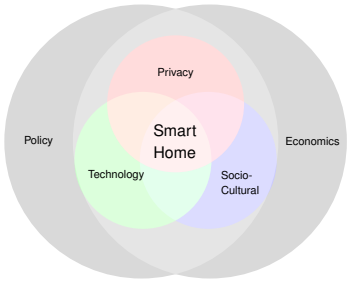

Figure 2: The smart home privacy context, including research dimensions of privacy, sociology and cultural studies, technology, economics, and policy

We approach this complex problem space from a socio-cultural perspective. The home can neither be limited to a single person household nor to a specific form of cohabitation. Flat-sharing, various forms of short-term lodging, dual-income families, and multi-generation households are all forms of cohabitation that raise new challenges. Socio-cultural differences also become evident in the use of technology [5, 9] and exist in relation to privacy (see Figure 1). Indeed, privacy is highly contextual, influenced by social structured settings [11] and shaped by technology over time [12]. Because research has to consider technology and privacy in a socio-cultural context, we emphasize the importance of understanding the latter.

Our research is framed by three research questions and split into three parts.

RQ - 1 What characterizes the smart home from a *socio-cultural* perspective?

RQ - 2 What is the nature of the relationship between socio-cultural aspects of cohabitation with technology and privacy in the smart home?

RQ - 3 How can the resulting model inform the work of policy makers and product designers?

Initial Results

A structured exploration of related literature covered 60 papers on privacy, the privacy paradox, and smart homes. Following a hermeneutic approach to document analysis, we defined the smart home privacy context (Figure 2) as the relationship between privacy, technology, and socio-cultural aspects, which is framed by policy and economics. The following highlights the most relevant aspects of our exploration.

Closest to our work are the contributions of Jacobsson and Davidsson [8]. They start with an analysis of the smart home context from a technical perspective, considering privacy and security. Subsequent contributions turn towards risk analysis and risk managements in the home. The Databox project by Haddadi et al. argues for more control by users [3]. They developed the Databox which contains an individual's personal data and allows them to grant or revoke access to third parties. Each request is supported by contextual information; however, their research does not consider aspects of cohabitation or its impact on their work.

Cohabitation is subject to its own social norms and rules. New technologies change the moral ordering of the home and conflict with what is seen as appropriate behaviours [5]. Other work considers the impact of a technology, in particular shared computers, on cohabitation [7]. They show how the existence, but also location of a desktop computer changes structured social settings in the home. Earlier case studies show how ambient technology shape our daily life to support social development and modern lifestyle [6]. Smith et al. provide an interdisciplinary review of privacy literature [12]. They show how privacy is shaped by technology over time. They report a gap of empirical studies on privacy and the internet of things, a situation that is highlighted by many. Activities in the home and attributed privacy antecedents point towards lower privacy salience in the home than, e.g., at work [9]. While this research provides insights of activities in the home, it does not consider socio-cultural aspects. Human behaviour and privacy, the privacy-paradox, was reviewed by various authors. Notable contributions highlight economic approaches [2], also considering information markets, and take a policy perspective in highlighting aspects of privacy and behaviour [1].

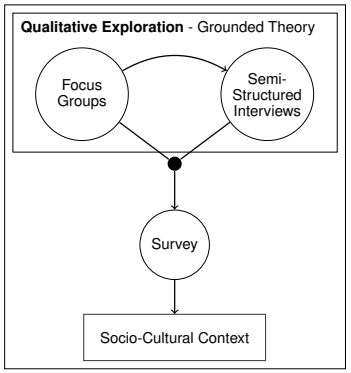

Figure 3: Qualitative and quantitative research into the smart homes socio-cultural context (Phase 1)

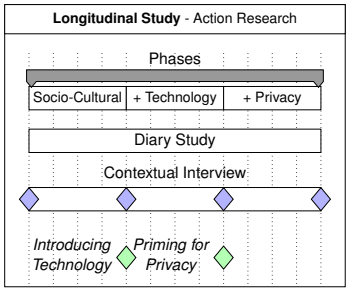

Figure 4: Longitudinal study using on action research, interviews, and participant diaries (Phase 2)

Research Design and Methodology

This holistic approach is informed by socio-cultural insights and empirical studies to provide a contextual understanding. The following outlines the research plan in three phases.

Phase 1 Our literature review informs research on the socio-cultural aspects of living in a smart home, e.g. [5, 9]. As Figure 3 shows, focus groups and interviews will provide insights into social and cultural aspects of the home, e.g. structured social settings (norms, hierarchies, power) [11]. We will use grounded theory to develop a model of activities. These activities will be compared across demographics, forms of cohabitation, and different cultures. We plan to compare Germany and the UK, which are economically close enough to be compared but far enough to reveal differences. Considering the diverse demographics, a subsequent survey will validate the model to generalise the findings.

Phase 2 Figure 4 depicts a longitudinal study that will shed light onto change introduced to smart homes. The study will use action research [10] to understand the impact of technology usage on existing patterns of activity, and to highlight emerging behaviours. Participants will provide accounts of activities, technology usage, and privacy antecedents in diaries. Our approach will be interpretivist to ground insights in data. Two groups of participating households will attend a 6-week study. Participants/households in the first group must already be living in a smart home whereas those in the second group do not.

The approach will involve three phases, separated by two interventions. At the start and end of each phase, participants in both groups will be interviewed. They will continue to write diaries throughout the study. The first phase will provide an account of structured social-settings in households. The second phase will assess the impact of technology on cohabitation, and the third phase will consider privacy as an additional aspect. In the first intervention, the researcher will introduce (new) smart home technology. The interview and diaries will start to consider usability, familiarity, and utility of the technology, without mentioning privacy, c.f. [14]. The second intervention, a demonstration by the researcher, will highlight contemporary and possible future privacy infringements caused by the household's use of technology. The diaries will now include privacy antecedents as an additional aspect. Thematic analysis will be applied to develop a holistic model of the smart home privacy context.

Phase 3 The researcher will evaluate the smart home privacy model in context of a product, taking its design process into account. Existing product design methods (e.g. privacy by design) will be compared with the smart home privacy model as a reference. Focus groups will be conducted to elicit how product designers understand and consider privacy, and which methods they apply. A case study will provide technical details on a smart device that was used during the interventions.

Another option to evaluate the model is to consider possible impacts on policy. GDPR will be enforced starting from May 25th, 2018. While organisations are taking measures to comply with the regulation, researchers and policy makers will need to work on future solutions. Hence, the smart home privacy model will be used to reflect on GDPR. We will discuss the model in focus groups with privacy legislation experts. Results of this discussion will concern shortcomings of the current legislation, regarding its understanding of privacy. Thematic analysis will be used to extract findings. These findings will be validated in an online survey.

Current Status and Next Steps

Work on Phase 1 of the project is currently ongoing and expected to finish by April 2018. Preliminary findings from the exploratory study (focus groups and interviews) are expected in early December, in time for the camera ready submission. Further results, including insights from the survey, will be available in March 2018.

Expected Contributions

⇒ A model of social (e.g. hierarchies, forms of cohabitation), and cultural (e.g. norms) aspects in the home

⇒ An extended model of privacy in the home, considering technology and the socio-cultural model

⇒ The longitudinal study design to assess privacy in context as described in phase 2

⇒ Implications for product or policy design as the model is validated in context

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