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Market adoption barriers of multi-stakeholder technology: Smart homes for the aging population

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ABSTRACT

For more than a decade, the Smart Home has promised to offer a better quality of life by connecting in-house devices and monitoring their usage. Such platform-based configurational technology has demonstrated the potential to improve comfort, healthcare, safety and security, and energy conservation — both at home and in the office. Moreover, since these technologies foster users' independence, Smart Homes can be both an answer to an aging workforce and a large market for an aging customer base. Nonetheless, so far market adoption has mostly been limited to the luxury segment and the more basic stand-alone technologies. Therefore, the main question driving this study is why Smart Home technology is so scarcely implemented despite its benefits to an aging population. From the literature we derive key market barriers in Smart Home value networks. We expand on these findings by means of a value network analysis of a Dutch smart home implementation case. In addition, we conducted 14 interviews that provide more insight into the value network of specific Smart Home services. Based on our case findings we develop a generic value network for Smart Homes and propose opportunities to improve market adoption of Smart Home technologies.

1. Introduction

The world population in both developing and developed countries is aging due to increased longevity and declining birth rates. This effect is further exacerbated by the baby boom that took place in many countries after the Second World War. The larger absolute and relative number of the elderly will have substantial societal implications, ranging from the workforce to the funding of governmental arrangements. Technology may play a key role in alleviating a number of these problems (Peine et al., 2014).

While being of value in an office environment, such assistive technology can have an even greater impact in the home environment. Smart Home technology has the potential to prolong the independence of the elderly and could increase their wellbeing (Barlow et al., 2006; Mynatt and Rogers, 2001; Nugent et al., 2008). The demand for such technology will be rapidly rising due to the increase in elderly consumers (Peine et al., 2014), and thus Smart Homes provide a substantial growth market. Moreover, government may need to turn to Smart Homes to battle ever increasing (health) care costs, if they are not already forced to do so by their aging constituents. Yet, the elderly already constitute a substantial market and have considerable political clout. One might gather that the technology is then perhaps not mature enough. However, the technology already exists for decades, evidenced by the almost classic notion of the 'Home of the Future.' Why then are Smart Homes so scarcely implemented, in particular considering its benefits to an aging population?

Indeed, age has various effects on technology acceptance and use (Peine et al., 2014; Venkatesh et al., 2003). For example, both the expectation that performance is improved by technology and the expected effort when intending to use a technology are negatively influenced by age. On the other hand, the effect of facilitating conditions, in the form of organizational

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and technological infrastructure, on use behavior is positively influenced by age. In other words, despite lower performance and effort expectations in relation to intended use, actual use will be higher for the elderly with the proper support (Venkatesh et al., 2003). Likewise, despite concerns about user-friendliness, lack of human response and the need for training, older adults were found to have an overall positive attitude to Smart Home technologies (Demiris et al., 2004).

Perhaps, the hampered implementation lies in the complexity of the involved technology. For the delivery of Smart Home services a substantial amount of different types of technologies needs to be combined (Mynatt and Rogers, 2001; Peine, 2009). Moreover, multiple stakeholders are involved in the delivery of these services adding further market complexity. Actually, Smart Homes have more-or-less become a key example in the literature of the market issues surrounding complex platform-based technologies (Barlow et al., 2006; Peine, 2008, 2009).

Yet, although the implementation of innovations such as Smart Homes is hampered by user and technology issues, especially organizational and market issues are still rather poorly understood (Arthur, 2009; Murmann, 2003). In this paper we will therefore study organizational and market related barriers and propose ways to overcome these barriers. For this purpose we will draw on the notion of value networks to analyze the multi-stakeholder business ecosystem surrounding the Smart Home technology platform.

By mapping the value creating system in this way, we can analyze the value network around a specific product or service offering. Also, we can determine which is the best way to manage the value network in the case of Smart Home technologies. By combining our findings from literature and our own empirical study, we can determine barriers in Smart Home implementation in the value creating system and propose ways to overcome these barriers.

The structure of the paper is as follows. First, we explain the Smart Home concept and go into further detail on the specific intricacies of implementing multi-stakeholder technologies mentioned. Then, based on these intricacies, we discuss relevant theoretical concepts related to market acceptance such as platform markets, business ecosystems and value networks. In the methods section, we describe our two-step research design. Based on the collected data we present our findings with regard to implementation barriers and opportunities for Smart Homes in the results section. Based on our findings we propose ways to overcome such Smart Home barriers and draw wider implications for the market adoption of complex multi-stakeholder technologies.

2. Theory

To understand the Smart Home phenomenon and its related issues, we first provide a succinct overview on what is known about Smart Homes. More detailed information on Smart Homes can be found elsewhere (see, e.g., Alam et al., 2012; Nikayin and De Reuver, 2013; Nugent et al., 2008; Peine, 2008, 2009; Van de Kaa et al., 2009). Next, we discuss the literature on platforms and business ecosystems. Then, we specifically focus on value networks as a way to signal, and potentially overcome, organizational and market barriers when implementing specific Smart Home platform service offerings.

2.1. Smart Home and associated services

Much research attention has been devoted to connected in-house devices and their monitoring usually labeled as Smart Homes, but also known as smart house, home automation, domotique, intelligent home, adaptive home, and aware house (see Alam et al., 2012). The reason for this large interest is that Smart Homes carry a large promise for many domains ranging from more cost-effective healthcare to highly increased comfort at home and in the office. Consequently, Smart Homes can be the answer to a number of pressing, and less pressing, social issues. But what exactly are Smart Homes? Peine defines the Smart Home concept as "*the use of Information and Communication Technology (ICT) in the home to facilitate the interoperability of household products and services in a built entity*" (Peine, 2008, p. 514).

However, the services offered under the guise of Smart Homes are at least as important to understand organizational and market barriers. Alam et al. (2012) demarcate four categories of services that are central in Smart Homes. First of all, services that provide comfort are getting more common in the home and are rapidly becoming less of a high-end luxury product. Examples of functionalities are wireless connected entertainment devices and integrated light and heat control. Second, security and safety services can be used for monitoring of both inhabitants and undesired visitors. Examples of functionalities are wellness monitoring, fall and immobility identification, and activity tracking. Third, services related to intelligent energy usage or energy conservation can be identified. Such services are for example smart electricity smart metering and energy control. Fourth and final, healthcare services form a major part of Smart Home developments. Not only do healthcare services overlap with some of the aforementioned services, but most of the research in the Smart Homes domain is conducted in relation to healthcare services. Especially, the domain of telemedicine has attracted quite substantial research attention (see, e.g., Barlow et al., 2006; Kijl et al., 2010).

2.2. Technology–stakeholder constellations

All four aforementioned service domains depend in various degrees on a complex constellation of both technologies and stakeholders. Peine particularly emphasizes the configurational nature of Smart Homes, where "*configurations are the subset of technical systems for which the pattern of how to arrange the components can only be defined when the requirements of a specific application become known*" (Peine, 2009, p. 396). For example, interoperability and compatibility of devices and systems are important as devices and systems are usually not provided by the same firm (Nugent et al., 2008). Consequently, numerous consortia are attempting to define protocols and standards for Smart Homes (see, e.g., Van de Kaa et al., 2009).

Furthermore, regulation is needed to prevent market failures from happening (Fransman, 2010). Also, when devices get connected, especially outside of the home, privacy issues are of concern (Alam et al., 2012). Finally, government plays a key role in supporting Smart Home adoption by joint development projects, regulations, and funding for commercialization (Nikayin et al., 2013). In other words, the accompanying social and economic-institutional systems are at least as important for the market adoption of technologies like Smart Homes because

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