Government Information Quarterly 41 (2024) 101915

Contents lists available at ScienceDirect

Government Information Quarterly

journal homepage: www.elsevier.com/locate/govinf

Exploring services in a smart city through socio-technical design principles: Revealing five tensions in a smart living context

Karin Axelsson *, Ulf Melin, Malin Granath

Linköping University, Department of Management and Engineering, Linköping SE-581 83, Sweden

ARTICLE INFO

Keywords:
Smart home
Smart city
Smart living
Socio-technical design principles
Services
Tensions

ABSTRACT

Smart cities have been studied for many years, but smart homes and the citizens' actual living in these smart homes are less researched. We argue that for digital government research, and for governments to be successful in smart city development in practice, it is necessary not only to understand living on a societal level, but also living aspects in the narrow context of homes. Citizens populate the smart city and are the ones who are supposed to use the services provided by the government. In this article we explore and analyze digital and analogue services in smart homes developed in a new city district. We have conducted observational studies in 53 apartments during an urban living expo which we analyze by applying a set of socio-technical design principles. The research question that guides the analysis is: "What tensions between values in digital and analogue services for a smart living can be revealed by a socio-technical perspective?". We identify five tensions between: 1) being in control and being controlled, 2) intended and undesirable use of personal data, 3) digital and analogue smartness, 4) smart home visions and practices, and 5) environmental and social sustainability. By revealing these tensions, we contribute to an understanding of the complexity of smart living. We also contribute by highlighting the importance of applying a perspective that captures both technology and citizen and user issues (i.e., social aspects) when developing services in the smart home context.

1. Introduction

Smart cities have been researched for years now, both by information systems (IS) and digital government researchers and other disciplines (e.g., Hollands, 2008; Albino, Berardi, & Dangelico, 2015; Anthopoulos, 2015; Gil-Garcia, Zhang, & Puron-Cid, 2016; Angelidou, 2017; Neumann, Matt, Hitz-Gamper, Schmidthuber and Stürmer, 2019; Clement, Manjon, & Crutzen, 2022; Ben Rjab, Mellouli, & Corbett, 2023), but the living that takes place in 'the smart home', e.g. within a smart city, is a context that has so far drawn less interest from researchers in those linked areas (Ismagilova, Hughes, Dwivedi, & Raman, 2019). Balta-Ozkan, Davidson, Bicket, and Whitmarsh (2013) define the smart home as "…a residence equipped with a communications network, linking sensors and domestic appliances, and other electronic and electric devices, that can be remotely monitored, accessed or controlled, and which provide services that respond to the needs of its inhabitants" (p. 362). A similar definition is given by Aldrich (2003) who defines the smart home as "…a residence equipped with computing and information technology, which anticipates and responds to the needs of the occupants, working to promote their comfort, convenience, security, and entertainment through the management of technology within the home and connections to the world beyond" (p. 17).

A smart home, within a smart city, is dynamic and heterogenous. There are ongoing processes of developing a city to improve and fulfil certain, and sometimes conflicting, goals, such as offering its citizens possibilities to live a good life. Gil-Garcia et al. (2016) describe this as "ICT-enabled public sector innovation made in urban settings" (p. 526). As is true for all IT development processes, the outcome depends on how well the users' needs and demands are understood. In smart city development there are many different stakeholders involved which makes the policy and development processes even more complicated (Axelsson & Granath, 2018). When focusing on smart living, the citizens are the key users and smart city policies therefore need to be citizen-centric and include issues such as livability, services, and information for citizens (Gil-Garcia et al., 2016).

The smart home could be seen as an intersection point (an arena), not only for digital infrastructures, but also for many of the public services that the city is supposed to provide, e.g., electricity, water, heating,

* Corresponding author.
E-mail addresses: karin.axelsson@liu.se (K. Axelsson), ulf.melin@liu.se (U. Melin), malin.granath@liu.se (M. Granath).

https://doi.org/10.1016/j.giq.2024.101915
Received 13 January 2021; Received in revised form 12 February 2024; Accepted 17 February 2024
Available online 24 February 2024

fiber, broadband, and garbage disposal. Smart homes, thus, consist of both digital and analogue solutions and services that together support and form citizens' *smart living*. An important subset of citizen services is the digital services, which are becoming more common and embedded in cities and homes. Digital services are an important component when a city, or a home, is claimed to be "smart". Digital services in a city context are of many kinds, ranging from public digital services in the urban environment to personal digital services in the homes (Yeh, 2017). In this article, we focus on the latter, digital services that citizens use in their homes to support smart living.

Research on smart homes and smart living could be divided into different strands, where one strand focuses on environmental issues, e.g., using digital technology to control indoor air quality (Schieweck et al., 2018), home automation systems to manage energy (Filho et al., 2019; Zhou, Fu, & Yand, 2016), and home electricity systems (Li et al., 2018). This research often has a technical focus, yet with ambitions to influence human behaviour and ensure energy efficiency (Sovacool & Furszyfer Del Rio, 2020). Another research strand focuses on health and well-being, where digital services often are viewed as solutions to problems related to an aging population and scarce resources within health and social care (e.g., Marikyan, Papagiannidis, & Alamanos, 2019; Skouby, Kivimäki, Haukipuro, Lynggaard, & Windekilde, 2014). We also see examples of research that apply a more holistic view of the smart home by focusing on smart home systems pointing out several application areas, e.g., security/alarm system, and lighting (Robles & Kim, 2010). A common characteristic of smart home research, regardless of the strand, is its technical focus, while socio-technical perspectives are seldom considered (ibid.; Sovacool & Furszyfer Del Rio, 2020; Li, Yigitcanlar, Erol, & Liu, 2021). We recognize this technology focus and techno-optimism also in early, general, digital government research (e.g., Bannister & Connolly, 2012; Heeks & Bailur, 2007).

From a more recent perspective, the post-pandemic working life has increased the importance of the home. Borders between time for work and leisure as well as between private and professional activities are in practice more blurred than ever (Maalsen & Dowling, 2020). The home has become an arena for already established, but also new activities, many of which include social as well as smart (technical) dimensions. This calls for a socio-technical perspective as stated above, and potentially guidelines (e.g. Clegg, 2000), in the understanding and design of usable services in this domain.

When developing a digital public service, it is important to understand citizens' needs and how the service will be used (Axelsson, Melin, & Lindgren, 2013), but also what makes citizens willing to participate in the development process (Holgersson & Karlsson, 2014). In smart city service development, citizen participation is often discussed in terms of e-participation, co-production, citizen-sourcing, and crowdsourcing, (Allen, Tamindael, Bickerton, & Cho, 2020). Citizen involvement is an often-claimed approach to successful public e-service development (Axelsson, Melin, & Lindgren, 2013), but when developing digital services for smart homes citizens more seldom participate (Axelsson & Granath, 2018). We argue that this is a problem that could lead to digital services that do not fulfil the users' needs and might end up not being used. The risks associated with a low degree of participation and involvement are evident in digital public service research (Holgersson & Karlsson, 2014) and have been well-reported for long also in general IS research (e.g., Iivari & Lyytinen, 1998; Lynch & Gregor, 2004). One way to address the risks of insufficient user participation and involvement is to apply a socio-technical perspective, which helps to focus on both human and technological aspects. Thus, an understanding and analysis of smart home and smart living from an established socio-technical perspective could give valuable insights to future urban planners on living aspects, policy, and practice dimensions, and at the same time contribute with new knowledge to research in smart city literature, beneficial for several research strands and foci, and digital government research in general.

In contrast to mainstream smart home research, discussed above, much IS and digital government research approaches digitalization in a way that includes contextual and user aspects, i.e., applies a socio-technical perspective (e.g., Mumford, 2000; further elaborated below). Since recent technical research trends in the smart home context indicate a lack of understanding of socio-technical aspects of technology (Li et al., 2021; Sovacool & Furszyfer Del Rio, 2020), we explore and analyze digital and analogue services in smart homes in a new city district through a set of socio-technical design principles. We have conducted observational studies in 53 apartments during an urban living expo three weeks in the fall of 2017 and the analyzed services are present in this empirical material. The research question that has guided the analysis is: "What tensions between values in digital and analogue services for a smart living can be revealed by a socio-technical perspective?". By revealing five tensions in the analysis, we contribute with an understanding of the complexity of smart living. We also contribute by highlighting the importance of applying a perspective that captures both technology and citizen and user issues (i.e., social aspects) when developing digital services in the smart home context.

After this introduction, the article is organized in the following way: In Section Two we first discuss related research on smart homes as an important entity within smart cities, followed by an overview of the socio-technical perspective. The research design and method are described in Section Three. The empirical findings from our case are presented in Section Four and discussed in Section Five. The contributions are concluded in Section Six, in which we also make some suggestions about the need for further research.

2. Related research

In this section, the smart home concept is first placed in the wider context of the smart city. We argue that the smart home is of central concern when understanding elements of smart cities. By identifying different meanings of the smart home and informing these with a subset of design principles from a socio-technical perspective, smart homes and smart living are then investigated.

2.1. The smart home in the context of smart city research

The smart city has become a popular phrase in practice, used by city officials, construction companies, and technology providers, as well as in research (e.g., Albino et al., 2015; Angelidou, 2017; Anthopoulos, 2015). Yet, there are few agreed-upon definitions of the smart city (Anthopoulos, 2015; Ismagilova et al., 2019) and the concept has often been stated as hard to define with precision (Gil-Garcia, Pardo, & Nam, 2015; Granath, 2016; Hollands, 2008). The concept covers many application areas, such as economy, transport, environment, and living (Giffinger et al., 2007) and many times hopes are tied to smart cities to solve urban challenges (Alawadhi et al., 2012) and to attain sustainability and better quality of life (Kievani, 2010). Urbanization and climate change are pointed out as challenges that will put pressure on traditional networks and services. Many of these networks, e.g., transport, electricity, water, and waste, are critical infrastructures and important public utilities and services that are crucial in our daily lives. Modernization of traditional networks and services is today associated with digital systems and services (as parts of information and communication systems and platforms) and often with the prefix smart or intelligent, e.g., smart grids, smart mobility, smart cities, and smart homes. Smart, in the context of smart cities, is used as an epithet to emphasize a holistic view of urban planning, that includes both infrastructures and applications when planning and developing cities (Granath, 2016).

Similar to smart homes, we note that some smart city definitions focus on technical aspects and data-driven decision-making (e.g., Kitchin, 2014), and other also emphasize economic and social aspects, e.g., investments in human capital (Caragliu, Del Bo, & Nijkamp, 2011). The technical definitions appear to focus on how digital systems are or

can be used to monitor, manage, and regulate city processes (cf. Kitchin, 2014), while a social focus appears to focus on how human and social capital together with different kinds of infrastructure can create economic growth and high quality of life (cf. Caragliu et al., 2011). In many of the existing definitions, there are synonyms for the smart concept, e.g., digital, intelligent, wired, and connected indicating some sort of capacity or capability associated with the city (Granath, 2016). Altogether there is a spectrum of definitions covering the smart city's core components organization, management, and technology (e.g., Chourabi et al., 2012; Yigitcanlar et al., 2018) to different degrees.

Smart living is pointed out as a part of smart cities (Giffinger et al., 2007; Ismagilova et al., 2019) and we argue that the smart home is an important, but in smart city research often neglected, component of smart living. Much of the living in the smart city takes place in the smart home. Like the smart city, the smart home concept also emphasizes how information and communication technology is used to connect different devices to make life convenient and services more efficient (Marikyan et al., 2019). When using the smart concept as a prefix to the home, instead of the city, there are both similarities and differences. Technology, in terms of, e.g., digital services, sensors, control systems, and cameras, is used to create value and reach certain goals both on the city and home levels. Besides the smart home definitions provided by Balta-Ozkan et al. (2013) and Aldrich (2003), referred to in the initial framing of this article, a comparable definition is given by Marikyan et al. (2019) who state that "A smart home is a residence equipped with smart technologies aimed at providing tailored services for users." (p. 139). Thus, we see many resemblances between typical smart home technology narratives and smart city narratives, where both target a higher quality of life. However, in smart homes the narrative is more concretely connected to convenience and efficiency in different forms (cf. Albino et al., 2015; Caragliu et al., 2011; Gil-Garcia et al., 2015; Li et al., 2021; Marikyan et al., 2019; Yigitcanlar et al., 2018).

A main difference is, thus, that while smart city definitions often focus on resource efficiency or optimization of resources, smart home definitions highlight residents' comfort, safety, entertainment, or other needs are important features in the smart home (Aldrich, 2003; Balta-Ozkan et al., 2013; Marikyan et al., 2019). There is, thus, a more explicit user-oriented perspective in smart home research that we argue would be useful also when studying the relations between government and citizens in the development of information policies and services connected to smart living in a smart city.

One underlying motive for building smart homes is to increase energy efficiency (which also is in line with the smart city ambitions), but there is also a wish to make life more comfortable (Darby, 2018) for future residents (cf. quality of life in smart cities). As Gram-Hanssen and Darby (2018) show in their literature review, technical and future-oriented research publications tend to emphasize the smart home mainly in terms of security and control as well as activities. Research publications focused on conceptual and evaluative aspects, on the other hand, more often discuss relations, values, and identities in relation to the smart home (ibid.). This difference in focus could be interpreted as research stemming from a technology knowledge tradition that understands smart homes mainly in terms of buildings that are equipped with, for example, energy management technology. Another, still rarer, research line with a social perspective focuses on the home as a place to live and where smartness is related to relations and identity. In line with Gram-Hanssen and Darby (ibid.), we claim that both these views on the smart home are necessary to gain a more multi-faceted picture of the smart home and how it relates to the broader governmental smart city concept. For policymakers and strategists, in the public and private sectors, to achieve sustainability goals, residents must change their behaviour regarding resource consumption. This implies that it is not enough to focus on smart buildings, public policymakers also need to understand what happens inside the smart home, concerning the use of digital technology as well as the residents' social actions and habits. Both views are necessary if the smart home technology, which is rapidly developed and praised as the solution to many sustainability challenges, is to be accepted and used in people's everyday life.

2.2. A socio-technical perspective as an analytical lens

As stated in the introduction of this article, there is a clear predominance of a technology (artefact) discourse and practice within the area of smart cities (Granath, 2016; Kopackova & Libalova, 2017), and also in the emerging research on smart homes (Robles & Kim, 2010; Sovacool & Furszyfer Del Rio, 2020). We also identified that the actual living in the smart home, in smart city literature, so far has drawn little interest from IS and digital government research (Ismagilova et al., 2019). Based on these two observations we argue that there is a need for IS-informed research in the area of smart homes. There is, thus, an obvious potential to apply a socio-technical perspective to inform the general understanding and analysis of smart homes in relation to smart cities, which is also noted by Sovacool and Furszyfer Del Rio (2020). Applying a socio-technical perspective has the potential to highlight social and socio-technical aspects beyond a technology-driven and focused perspective, and to avoid socially or technologically deterministic views. Applying a socio-technical perspective in the smart home domain implicates the addressing of users, usage contexts (e.g., embeddedness below), and interaction between different users (e.g., people living in the same apartment or block), collective actions, and technology. Combining a socio-technical perspective with the meanings of the home concept will help us address socio-technical aspects of a smart home in a smart city context.

To understand the home as an arena, a socio-technical perspective can be applied. A socio-technical perspective is well rooted in the IS research tradition, and – in short – builds on the assumption that an organization (regarded as an open system) consists of two sub-systems; a technical one and a social one. A socio-technical perspective can be traced back to research and development work at the Tavistock Institute in London from the 1950s and 1960s, and the need to handle non-linear and unpredictable effects applying new technologies in organizations (e.g., Mumford, 2006; Trist, 1956; Woodward, 1965). The two sub-systems are interdependent and interact jointly (e.g., Bostrom & Heinen, 1977; Mumford, 2000). Two important points of departure are that none of the sub-systems are superior (ibid.) and that we need to consider both sub-systems and the fit between them (ibid.; Nograšek & Vintar, 2011) if IS designers and/or change agents or implementers want to achieve effective development processes and changes. A socio-technical perspective also rests on a set of premises. These can be articulated as follows: (1) a mutual constitution of people and technologies, also described above, (2) the importance of context (embeddedness), and (3) the importance of collective action (Sawyer & Jarrahi, 2015, p. 3).

The two sub-systems are labeled somehow differently in various sources, but if we hold on to Bostrom and Heinen (1977), the social sub-system consists of people and structures, and the technical sub-system consists of technology and tasks. A socio-technical perspective can be seen as a reaction to unbalanced implementation and change in different organizational domains and has received much attention in doing that. A socio-technical perspective "[…] eschews simplifying rationales that seek a single or dominant cause of change. Instead, socio-technical perspectives foreground both the complexity and the uncertainty involved in the process of technologically involved change. In contrast to the socially or technologically deterministic views, socio-technical perspectives require a detailed understanding of dynamic organizational processes and the occurrence of events over time in addition to knowledge" (Sawyer & Jarrahi, 2015, p. 6). A more in-depth study of how social analyses can be done is described in, e.g., Avgerou, Ciborra, and Land (2004).

Despite having a lot of merits, compared to more simplified, instrumental, and technology-dominated perspectives, the socio-technical perspective has also been criticized. Some of the critique is formulated in terms of having a too harmonic view of organizations and joint

interests when striving for optimization of the system (e.g., from more political and critical perspectives described by Bansler, 1989; Ehn, 1989; Land, 2000). The (clear) division between technical and social aspects is challenged from sociomaterial (without a hyphen [cf. socio-technical]) perspectives (Orlikowski, 2010; Orlikowski & Scott, 2008). Orlikowski (2010, p. 133) even argues that socio-technical perspectives "[…] downplay specific technological properties and affordances, focusing primarily on human interpretations and social actions". We acknowledge the critique of the socio-technical perspective but choose, in this article, to explore a classical socio-technical perspective to advance our thinking in the emerging domain of smart homes, and are aware of, e.g., the risk of not highlighting affordances enough. Applying a sociomaterial perspective in the understanding of smart homes is, however, an interesting topic for future research outlined at the end of this article.

Several socio-technical design principles have been generated by Clegg (2000, p. 465), and a subset is applied below, in an adjusted form, for the purpose of the analysis. We choose to focus the analysis on the *meta-principles and the content principles* (ibid.), and not the set of process principles (oriented towards the design practice). The process principles are important for socio-technical design, but not within the scope of this article since we are not focusing on the design process as such. The general purpose and functions of the design principles are, e.g., to "[…] raise questions of design and designers that demand and merit attention." (Clegg, 2000, p. 463) They identify well-designed socio-technical systems and can serve as a potential framework for evaluation. The meta-principles (italicized below) by Clegg are "[…] intended to capture a worldview of design, a Weltanschauung" (Clegg, 2000, p. 424) and involve, e.g., that the design is *systemic*, that *values* and mindsets are central to the design, and that the design involves making *choices* (for different stakeholders). The design should also reflect the *needs* of different stakeholders,[1] and is considered as a result and part of an extended *social* process, and is therefore socially shaped. Design should also be *contingent* according to Clegg's principles. A set of design principles are focused on the more specific content of designs. The content-oriented principles (also italicized below) are, e.g., that core processes should be *integrated*, entail different *task allocations* between humans and machines, be *congruent*, *simple* in design, and make problems *visible*. Problems should also be possible to *control* at the source and means of undertaking activities should be possible to specify in a flexible way.

Applying a socio-technical perspective, and coherent design principles, rooted and often used in an organizational domain (with professional roles, jobs, etc.), in the context of a home contains aspects of translations. One argument for using this perspective in a non-professional domain (a home) is that a set of meta- and content-oriented principles above should be possible to use in the latter context. Another argument is that the underlying values are context sensitive and possible to adjust to any study or design context. A third argument is that even homes are organized, by different stakeholders living there, but also by professional external stakeholders (such as technology providers, architects, stagers, etc.) taking part in development and design processes and, thus, affecting what can be done (and not) in smart homes. Recently, in the context of the post-pandemic situation, the home has become an arena where professional work also takes place more frequently, as a part of distributed or even more virtual organizations. We will, however, take the opportunity to briefly comment on our use of a socio-technical perspective below in this article, and also highlight some lessons learned.

The design of a smart home expressing the value of being "safe" in the home can be seen as an operationalization of meta-principles oriented towards *values* and *mindsets* in the door and lock design, which involves making *choices* (e.g., different alarm security levels and artefacts [physical keys, apps, etc.] to lock and unlock doors and control alarms) and reflects the *needs* of different stakeholders (e.g., children, adults, or seniors). The content-oriented principles to the same value can, e.g., be that the design of the functions and services to control doors and alarms are *simple* (and *flexible*) to handle (for different users) and communicate if *problems* arise (e.g., leaving doors unlocked or activating alarms). The value "social" is inherent in both the definition of a smart home and from a socio-technical perspective. A meta- and content-oriented principle can, e.g., represent the smart home being *social* in terms of allowing people to arrange for *different social processes* to take place (having different numbers of friends invited for dinner) and being able to adjust spaces for that in an inviting way. The value of being "modern" in terms of, e.g., the design of the home being sustainable and convenient can reflect the designers' view of different stakeholders' (i.e. residents') identity and their preferences reflected in materials and smart applications. These formulated values will be used to analyze different types of smart homes, below.

2.3. Research design and case introduction

To conduct this study, it is necessary to have access to a rather large number of homes that are defined as "smart". In this lies at least two challenges; not many homes are yet defined as smart homes, and it is difficult to first identify the smart home and then get access to study the home from the inside. Fortunately, we have had the opportunity to study a Swedish urban development project run by the local government in Linköping, a city with approximately 165.000 inhabitants, for five years. We have followed this project from the early policy-making and planning phase to completion. When starting the project in 2011, the municipality had a clear ambition to develop a new city district (called Vallastaden) based on the ideas of social and environmental sustainability. Ideas of social and environmental sustainability were manifested by diversity regarding types and designs of buildings, as well as by the development of, e.g., community houses, carpools, and smart grid technology. We have conducted a longitudinal case study from 2012 to 2017 where we participated in meetings during the development process, studied the project from an external perspective through policy and planning documents and media, and finally conducted observations in the new buildings (apartments and houses including digital artefacts and services) during an urban living expo which took place in the fall of 2017. The research approach has been qualitative and interpretative (Walsham, 2006) aiming to understand the planning and development of a smart city and the complexity of smart living.

In this article we focus on parts of our rich empirical data material, to explore how stagers and developers interpreted the criteria set by the urban development project (to increase social and environmental sustainability) and how these relate to smartness. The case has been selected because of its uniqueness in accessing these actors' interpretations and reflections of future homes. We see these interpretations as representations of ideas and potentials of smart configurations in the wider context of a smart city initiative. The chosen case also allowed us to, under a limited time, access 53 staged homes in a new district, which made the urban development perspective closer in mind.

When the first part of the urban development project, consisting of 1.000 homes, was finalized in 2017, Sweden's largest urban living expo was launched. The expo aimed to show how a city district could be designed and constructed realizing social and environmental sustainability goals. The expo was targeted towards an interested public, but also towards national and international visitors occupied with urban planning in municipalities as well as professionals within the building and construction sector. During three weeks in September 2017, 72 exhibitions at the expo were seen by 75.000 visitors. We used the urban living expo for data collection and visited all 53 homes (apartments and houses) that were open to the public. We also visited all showrooms of the latest technologies and ideas connected to urban planning and

[1] In order to contextualize the design principles from organizational arenas to homes we have, e.g., replaced "business, its users and their managers" with "stakeholders".

development, e.g., showrooms with energy solutions, future working and learning environments, and examples of social science research about living. In every home, we documented all instances of smartness that we identified. This could, for example, be household appliances with embedded smart technology, smart meters, distance working technology, and Internet connections. Every home was documented by notes and photos. Most of the homes that were shown had been staged by different creators as part of the urban living expo and as such they were not yet inhabited. This means that they were not formally anyone's homes yet, but the creators had envisioned different target groups (e.g., families, students, single-person households) when styling and performing the different apartments and houses. A smaller number of homes that were already inhabited were also shown during the expo. To complement data from our observations we have also had access to statistics about the new city district and a catalogue with descriptions of the expo area and exhibitions presented to the expo visitors.

Collected data was structured in a table where each visited home, observation notes, and photos taken to document the home were gathered. The data analysis was then conducted in three steps. The table content was first analyzed in a qualitative manner using open coding (Strauss & Corbin, 1990) to find different instances of smartness in the material. Second, via findings based on a categorization of smart living (Gram-Hanssen & Darby, 2018), the results of this analysis were finally (third) discussed by applying meta-principles and content principles from a socio-technical perspective (Clegg, 2000) generating five tensions between values in smart living. This is an example of a reflexive research approach (cf. Alvesson & Sköldberg, 2009) using the strengths of exploring an empirical material, but also using the power of applying a theoretical lens as a guide in the analysis (cf. Walsham, 1995), and iterate between these steps. Covering related research was also a part of the reflexive research approach and framing of the article, using a hermeneutic literature review (Boell & Cecez-Kecmanovic, 2014).

3. Findings

In this section we present our empirical findings structured by Gram-Hanssen and Darby (2018) categorization of smart homes; 1) home as security and control, 2) home as a site for activity, 3) home as a place for relationships and continuity, and 4) home as identity and values. We regard these four smart home categories as the arenas where smart living takes place. Gram-Hanssen and Darby note that few evaluative research studies on smart home technology also include an understanding of the smart home and the residents living there (ibid.). Here we use their categories as the basis for our socio-technical analysis and the five tensions between values in smart living that we outline in the analysis, below.

3.1. Home as security and control

We observed many digital services that could be placed in the category of home as security and control. We observed that residents could monitor both objects and activities and this could either be done remotely or in the home. Objects that could be monitored were, for example, different kinds of connected household appliances such as washing machines, ovens, and refrigerators. In the expo catalogue the connected items were portrayed by stagers as something that would let the residents be "in control of their home even when not being there" – a sort of control of their daily activities (which also falls into the next category – homes as a site for activity). A connected refrigerator, for example, would allow residents to digitally check its status and content regardless of time and place. Using the camera functions of a smart refrigerator would allow residents to go directly to the grocery store without having to stop by at home to check for necessary purchases of foods; an activity that priorly demanded physical presence and/or planning. Further, being able to remotely start objects in the home, such as the washing machine or oven, could also be seen as a sign of being in control. Remotely controlling the oven was, for example, portrayed by stagers as something that would make life with small kids less stressful. It was pointed out that parents could prepare dinner and put it in the oven before picking up their children at daycare or before returning home from work. Arguments put forward in this context were that parents of today are stressed and that the situation when coming home with children after a long day at work is stressful in itself. Thus, controlling or owning the situation by being time efficient was portrayed as something positive and convenient. The control and monitoring of household appliances in the home, as we observed it, presuppose the use of a mobile phone and one or several apps. During the expo visit it also became clear that the smart household appliances were connected to a larger system monitored by the vendors of the household appliances (e.g., Siemens and Electrolux). A stager explained to us that they had problems with the smart refrigerators when demonstrating them during the expo. The system had crashed a couple of times, so they had to "call the headquarters" to reboot the system. However, nothing was mentioned to presumed residents about security issues.

In addition to the connected household appliances, we also observed the use of different kinds of digital locks and alarms. Locks and alarms could be seen as typical representations of security in homes. We also noted that digital locks often entailed the use of digital keys or tags. About digital keys, we observed examples of digital displays in the entrance halls where residents could use their smart keys to book different functions in the building (e.g., laundry or community houses). The displays in the entrance halls could also serve as common planners and, thus, support another perspective of (social) control. Another form of control that we observed was represented in energy management solutions, e.g., control of temperature, energy consumption, and air quality.

3.2. Home as a site for activity

In addition to the smart home appliances, described above (which also infer traditional activities taking place at home), we observed several homes that supported another form of smartness, i.e., supporting a flexible and active type of living. The most striking and extreme example in this category was an apartment of 55 square meters that could be altered between a five-room apartment and a one-room apartment thanks to flexible walls. This apartment was presented as an experiment that on one hand tried to capture today's family situations where the number of family members at home could vary from one week to another and, on the other hand, tried to make efficient use of the surface. In this extreme example, called "the dream apartment", flexibility was mainly manifested in the physical design, e.g., movable walls, embedded functions (e.g., bathtub and storage embedded in the floor, sink embedded in the bathroom, and beds that could be flipped into the wall or raised to the ceiling). Hence, activities were in this case connected to ideas of how the surface in the apartment could be used and transformed for different purposes depending on the residents' varying needs, e.g., privacy when spending time in different rooms, altering the surface between social activities such as cooking and sleeping. None of these solutions included any digital services, instead, they were built around innovative architectural or build-in construction solutions.

Other examples of smart solutions that we observed in this category were homes where borders between working life activities and leisure activities were either stretched or blurred. For example, the concept "hoffice" was used as a notion to capture resource efficiency and to mediate a flexible home and working life. In this type of home, stagers either had interpreted smartness as a possibility for property owners to rent office spaces in their homes to someone or as a combination of a living space and an atelier/studio. Residents, who chose to rent a working space in someone's home, were in different settings described as self-employed workers. An argument put forward in this context was also financial benefits, where renting part of the home to someone was presented as a way to finance a larger apartment. The mediated

ambience in these homes was that future workers do not necessarily want to go to an office complex, but rather work in a home environment. This is of course a situation that became even more important when many people during the Covid-19 pandemic were advised or even restricted from visiting their office spaces and, thus, more or less forced to work from home, making the home even more important to study and understand in this context. We noted that these homes were seen as environments that also would fulfil social needs, e.g., to have "colleagues" to talk to and have coffee with. Using the home for both work and leisure presupposes efficient digital infrastructures and services, and in relation to infrastructures, we noted that almost all rooms were equipped with networking/broadband connections. A mirroring perspective of working life in homes was presented by other stagers under the label of future working spaces (thus, not homes). In future working spaces, we observed the use of robotic technology that allowed employees to sign into meetings, take part in daily activities, and "walk around" the office from a distance. We also observed digitalized and connected conference rooms. Moreover, we noted the increased use of digital displays in working spaces, e.g., displays for giving presentations, check bookings or room availability, videoconferencing, etc. Another example we observed within this category was connected terraces which would allow residents or employees to work outdoors.

3.3. Home as a place for relationships and continuity

As we mentioned in the case description above, the overall design of the district had a strong focus on social encounters. For example, the district was designed with small and narrow streets, open spaces, and special meeting points (parks and green areas). When it comes to the buildings and design of homes, we also observed a strong focus on social encounters. First and foremost, this was expressed in the buildings' physical design, e.g., focusing on living room and kitchen spaces making them bigger than other rooms. The most striking examples we observed in this category were the so-called community houses and spaces. The community houses were large greenhouses owned and used by its community members and functioned as an additional space to the home. The design of the district revealed an idea of one community house in each block, however, at the time of the expo not all the community houses were yet built. The community houses we visited consisted of one heated area and one unheated greenhouse area. Architects' ideas about how to use these houses were as overnight apartments, party venues, and cultivation, demanding a joint solution for booking. The community idea could also be observed in the park area, where community members could socialize when harvesting fruit in the fruit garden or when planting and cultivating common cultivation allotments.

Other examples of homes as places for relationships and continuity were found in the student housing, for example, a housing named the "Student Suite". This housing consisted of small apartment-like rooms combined with a large common living room and kitchen. Amusement media appeared to be at the heart of the design, for example, we noted a big roll-up home cinema projector screen in the center of the joint living room, and common WiFi was offered to students living there. Connectedness appeared as central both for physical social encounters (listening to music, watching movies) and virtual encounters (using social media). Another take on social encounters that we observed was in the apartment named "Table for Two". In this home, stagers communicated what they called an "air-dine" concept and service. The idea behind the air-dine service was that community members were offered to book a dinner in someone's home. The presented purpose was twofold; to get an extra income and to socialize.

3.4. Home as identity and values

Concerning the home as identity and values, we observed different types of values and expressions of modernity in the homes (and in the district as such) – ranging from resource efficiency to convenience and social needs. Concerning resource efficiency, a new infrastructure consisting of a 1.800 m underground high-tech culvert system was designed. The culvert contained all the infrastructure, in the form of electricity, district heating, IT infrastructure, water, sewage, and waste management, that was needed in the district. The underground culvert system made it possible to build the houses densely, something which was presented as innovative and modern. The culvert system also meant that maintenance could be carried out without affecting or disturbing residents (referring to blocking of streets because of maintenance work). The waste management system was built around an electronic tag giving residents access to the garbage system and at the same time weighing the garbage. Concerning the homes, we noted that they promoted different kinds of values pertaining to sustainability, e.g., environmental (green, resource-aware), social (engagement in the common, health focus with gardening possibilities on roofs and land allotments), and economic (focus on blended and affordable housing) values.

Further in this category, we observed that a modern high-tech home both offers and contains connected objects and digital services. Thus, the use of smart home appliances falls under this category as well. The connected home was also put forward as something that was suitable for the modern and time-efficient family. Connectedness was tied to time efficiency and illustrated by examples of how family members use their mobile phones, equipped with apps to remotely check or control artefacts in their homes. Another perspective of connectedness and modernity was presented in relation to future heating networks. Gathering and use of real-time data was put forward as something that would help to even out power peaks and, thus, contribute to reduced environmental effects. In this context, we also identified some examples of visualizations of power usage (or of energy flows) in homes and these visualizations often appeared to be connected to the use of solar panels. Yet another perspective on the modern high-tech home and the modern family could be seen in the apartment with the flexible design mentioned above, i.e., removable walls and multiple functions depending on the weekly needs of the family. High-tech in this context was not tied to the particular use of digital technology.

We also observed other signs of modernity. For example, we identified several homes that focused on green perspectives, and in these homes, technology often had a central role, e.g., checking and mediating information about air quality or checking and mediating information about the soil and water status in the mini greenhouses for indoor cultivation. In addition to different digital services, we also noted that green and modern were manifested in the physical design, e.g., in the community houses and the large greenhouses, the cultivation allotments, and different solutions for terrace cultivation.

4. Analysis and discussion

In this section, we analyze the findings by applying the socio-technical design (on meta- and content level) principles (Clegg, 2000), introduced above. Through these principles, a socio-technical lens has guided the five tensions between values in smart living that we reveal in this article. The tensions are between: 1) being in control and being controlled, 2) intended and undesirable use of personal data, 3) digital and analogue smartness, 4) smart home visions and practices, and 5) environmental and social sustainability.

4.1. Tension between being in control and being controlled

Many of the empirical examples, above, show digital services that are implemented in the smart home to monitor objects (such as household appliances, alarms, and locks), to monitor activities (such as booking and planning), or to monitor resource consumption (such as electricity, water, and waste). Control is also what characterizes the smart home technology narrative, which Sovacool and Furszyfer Del Rio (2020) point out, and important related to values, choices, and task allocations in a socio-technical perspective (Clegg, 2000). Monitoring is seen as an

enabler that offers the residents control of their homes and lives. By controlling objects, activities, and resource consumption, both remotely and physically, the efficiency and quality of life are supposed to increase. Residents are thus able to be in control, thanks to digital services, which offer flexibility and ease to a stressed life. By programming a digital service, for example, to set a scheme for the indoor and outdoor lighting or the heating in different areas of the home, the resident can personalize the home and, thus, at least in parts be free to form the life he or she wants (e.g. users' choices and needs addressed from a socio-technical perspective). The digital services facilitate monitoring and control (different task allocations between humans and machines [Clegg, 2000]) as well as create flexibility and freedom, which lead to positive consequences (e.g. social) for the resident. Thus, simple, visible, and personalised design appears to be central when selling ideas of digital services to monitor and control things in homes and the smart home technology builds on and reinforces current social structures inside (and outside) the home (cf. Clegg, 2000).

However, smart home services not only offer the resident control of the home, but they also allow others to control the resident based on sets of data from different platforms, sources, and devices (cf. Gram-Hanssen & Darby, 2018), further elaborated on below. The booking system in the entrance hall, for example, might become the new (digital) landlord who has social control and "knows" a lot about the residents. We also note that there is a particular relationship between digital services and spatiality in the smart home. A digital booking system might visualize where you are physically, for others to see. There is also a potential risk that digital locks or booking systems can be used against the resident's intention or will, for example by changing the code to the digital key or preventing him or her from booking the laundry or the community house if the rules were not obeyed. In a literature review conducted by van Twist, Ruijer, and Meijer (2023), there are several similar examples of residents being discontent with digital smart home services because of the notion of being controlled by others (e.g., the caretakers or government). Thus, balancing values and mindsets (Clegg, 2000) connected to efficiency and convenience in relation to integrity and risk is a delicate value-based matter in this type of development and, thus, an important aspect to consider when developing policies, designing, and implementing digital services in buildings and homes in practice, with a systemic and social perspective (ibid) in the core of socio-technical design principles.

By using digital services, the smart home can be monitored and controlled in different ways to give benefits to the resident, e.g., increase efficiency and safety. Simultaneously, the digital services can be used for, intentionally or unintentionally, controlling the residents. *This reveals a tension between being in control and being controlled that needs to be acknowledged when developing services for smart homes and smart living.*

4.2. Tension between intended and undesirable use of personal data

As discussed above, digital services generate a lot of data about residents' actions, location, and timing (cf. Gram-Hanssen & Darby, 2018; Kitchin, 2014). In the smart home context, this implies that personal data about the residents is gathered, data that the often private (third-party) vendors of the digital services possess. Big data sets, thus, facilitate new business models. In the studied case we identify this in the example where the key tag is used to open the garbage bins and the garbage for each family in apartment buildings is weighed to charge everyone according to their amount of garbage. Being able to gather data about resource consumption also makes it possible to use gamification ideas and set up competitions between neighbours. There are many ways that big data from residents in smart homes can be used to influence decision-making in the smart city context, e.g., for digital technology and service designers and developers, or policymakers and public officials (e.g., responsible for urban planning).

But there is also a balance between how much personal data citizens are willing to share with society and organizations and which benefits they get from sharing data (Sovacool & Furszyfer Del Rio, 2020). Furthermore, there is a question of whose needs, values, and mindsets that are put into play when implementing solutions like this (cf. Clegg, 2000). If the users are aware of and reflect upon the data sharing at all in terms of privacy or security, and who's choices (ibid.) that are exposed (visible) and for whom. In a study by van Zoonen (2016), contradictions between citizens' privacy concerns and privacy behaviour are discussed, which sheds light on the fact that there might be a paradox between citizens' opinions and actions. Also, many digital services in the smart home are embedded (cf. visibility in design) in different household appliances which makes it difficult for residents to know who the actors that gather, process, and use data are and for what purposes the data will be used. Our study also shows that residents are forced to accept the existence of digital services as they are already in place in the apartments before moving in. This dimension clashes with, e.g., socio-technical design principles promoting simplicity and the possibility to make choices for users.

Another issue is that digital services might look like standalone devices (e.g. apps) monitoring the alarm or the lighting, but they may be part of a larger platform or ecosystems monitored by vendor organizations or property owners. In this case, the design is systemic, but not visible for, and may not reflect the needs of, the user of the service. What if the home appliance vendor or the property owner not only knows when residents wash and cook but also what groceries they buy and when they leave home? Digital services used to monitor, control, and personalize living in the smart home generate a lot of data. Big data sets are often necessary to provide these digital services, but they can also be used by, e.g., digital technology vendors or property owners, to track and understand the residents' actions, choices, interactions, and consumption patterns. Even though the services are focused on certain stakeholders' needs and values (Clegg, 2000) the smart home is not visible but digitally black-boxed, vulnerable, and insecure, in the worst case generating data that satisfies other needs than what the users desire. *This reveals a tension between the intended and undesirable use of personal data that needs to be acknowledged when developing services for smart homes and smart living.*

4.3. Tension between digital and analogue smartness

Many activities in the smart home presuppose digitalization in one or another form. However, our study has shown that smart living does not always involve digital services. For an architect, for example, the flexible apartment in the studied case is the utmost smart without any digital technology involved. When focusing on the home as an arena for understanding what makes a smart home "smart", it becomes obvious that social dimensions and processes (cf. Clegg, 2000) of how smartness is perceived by residents are equally important as the technical dimensions of the designed services. It is when using technology in the home in ways that result in a desirable outcome that we can claim that technology has made the home and the living smart. Previous research on smart homes is to a large extent technology-oriented (cf. Filho et al., 2019; Li et al., 2018; Robles & Kim, 2010; Schieweck et al., 2018; Skouby et al., 2014; Zhou et al., 2016) and, thus, this insight could be missed or underestimated.

Compared to technology vendors, the building and construction sector has (not yet) embraced digitalisation in all aspects. Thus, to develop smart homes, construction companies need to understand and explore how digital services can be combined with analogue services in ways that create the intended benefits and values both for residents and society. An elaborated view on different dimensions of smartness, as offered by Gil-Garcia et al. (2016), can be helpful in this strive.

It is not only digital services that make a home smart, but also other innovative ideas of how to construct, design, and arrange the home to meet the residents' needs and wishes. Developing smart homes does not imply that as many analogue services as possible should be replaced by digital services, but rather that a feasible balance between digital and

analogue smartness should be strived for. The notion of comfort and convenience arises from the residents' total view of how smart living provides quality of life. The latter is linked to socio-technical design principles focusing on systemic and social dimensions (Clegg, 2000). *This reveals a tension between digital and analogue smartness that needs to be acknowledged when developing services for smart homes and smart living.*

4.4. Tension between smart home visions and smart home practices

When the studied urban development project was launched, social sustainability as a core value for design (cf. Clegg, 2000) was particularly highlighted by the policymakers, besides environmental and, to some extent, economic sustainability. This influenced the result a lot, for example in the buildings' and the city district's physical design, but also by providing a wide range of digital services for social activities. Stretched boarders between work and home are found in the social sustainability visions of the studied case. The Covid-19 pandemic made some of these, at the launch rather futuristic, ideas come true faster than expected, e.g., the home offices, while inviting unknown people to eat dinner in one's home, for the same reasons, were not realized. This shows that unexpected occurrences in the surrounding world, and thus situated social practices and processes (cf. Clegg, 2000), influence which policy-driven ideas in urban planning processes are realized or not. It is not possible to make policies, plans, and designs for a certain way of smart living, but rather provide the residents with opportunities to organize their life in line with the intended visions and needs. A similar notion is presented by Yeh (2017) who adopts a citizens' perspective on the design of digital smart city services and finds that citizens are more likely to accept and use the services if they are designed in ways that both secure privacy and offer high quality. This is an example of good socio-technical design principles put into practice.

Smart home visions to facilitate sustainability can be related to the value of modernity and connectedness, and so can also individualized and user-oriented services that facilitate monitor and control. However, rapid technological development impacts what is regarded as modern at a certain time. There will always be a group of early adopters who, for example, program and connect digital services in the home just because it is possible. Modernity does not necessarily focus on the technology itself. Sustainability is a contemporary value where digital services might play parts, but not necessarily have the lead role.

The design and development of smart homes in a smart city district are governed by public policies and political visions, not seldom are sustainability-oriented values an important part of these, as in our studied case. However, policies and political visions for the planned smart home do not necessarily mirror how the smart home is used in practice after construction. A society also encounters new challenges over time, which changes the priorities on policy and systemic levels. In addition, planned resident behaviour does not fully correspond with the actual living that takes place in smart homes. *This reveals a tension between smart home visions and smart home practices that needs to be acknowledged when developing services for smart homes and smart living.*

4.5. Tension between environmental and social sustainability

Smart city definitions (e.g., Chourabi et al., 2012; Yigitcanlar et al., 2018) often focus on values related to resource efficiency and optimization, while smart home definitions focus on convenience (e.g. simple to use), ease of living, personalization (addressing users' needs), and comfort as the intended outcomes (Aldrich, 2003; Balta-Ozkan et al., 2013; Marikyan et al., 2019). Smart homes and smart living are important elements of smart cities (Ismagilova et al., 2019) which makes it vital to balance these two main aims when designing smart homes in smart cities. Previous research indicates that very few residents would be interested in using smart home services that do not fulfil their needs and goals (cf. Clegg, 2000), even if they are very resource-effective (Li et al., 2021) on a systemic level. This is an important design insight that policymakers and constructors should acknowledge as a main difference compared to the design of technology and infrastructure on a societal level. In the studied case there was an intense focus on social sustainability to market the uniqueness of the new city district, even though environmental sustainability was also targeted in many of the observed apartments. While smart cities can be viewed from many different stakeholders' perspectives (politicians, policymakers, constructors, technology providers, public officials, etc.), the smart home has one main, multifaceted stakeholder – the resident (with a unique set of needs, values, choices, and situated social processes).

Smart homes cannot be designed in a way that promotes resource efficiency without being perceived as comfortable to live in. This is an example of conflicting design principles and the need for contingent design (cf. Clegg, 2000). Thus, from a resident perspective, the goals of environmental and social sustainability need to be balanced; with a systemic perspective using the homes as the major arena. *This reveals a tension between environmental and social sustainability that needs to be acknowledged when developing services for smart homes and smart living.*

5. Conclusion

In this article, we analyzed digital and analogue services in 53 smart homes with a set of socio-technical design principles, generated by Clegg (2000). We have two contributions; the first is the *tensions revealed* and the second is the importance of *applying a socio-technical perspective* when analysing *services for smart living*. Each of the contributions has theoretical and practical implications.

The analysis revealed five tensions between values that occur in smart living and shed light on the complexity that can affect service development in the smart home context. The tensions are empirically grounded and theoretically informed by the socio-technical perspective. The tensions have been acknowledged in previous IS and digital government research, as referred to above, but elaborated on and placed in the context of smart living setting in this article. The five tensions are a theoretical contribution that we have not encountered in previous research focusing smart living. The fact that smart homes have not yet been focused within the research on smart cities to the same extent (Ismagilova et al., 2019), implies that an empirical study that results in a theoretical construct that can help us to understand smart living and service development is a contribution useful for future research studies. The practical implication of this study is that digital (and analogue) service development could benefit much from acknowledging the identified tensions. Even though the tensions partially are contradicting or even paradoxical, i.e., they are difficult to "solve", much is gained from being aware of the tensions early in the design and development phases instead of realizing them after the service has been implemented, and beginning to be used, in the smart home. Therefore, this contribution has practical implications for several stakeholders involved in smart city (and home) service development, such as politicians, policymakers, constructors, technology designers and providers.

The second contribution of this study is to highlight the importance of applying a perspective that combines technology and social, user aspects when analysing services for smart living. Although socio-technical perspectives have been used in various contexts for several decades, we claim that applying socio-technical design principles when analysing smart homes helps to balance the technology-centred focus that is often dominating in these studies (Li et al., 2021; Robles & Kim, 2010; Sovacool & Furszyfer Del Rio, 2020) with the social-centered ditto. We therefore contribute with a socio-technical perspective on smart living that broadens the scope from digital service development to a user view where understanding the residents' needs also is crucial. By applying a subset of socio-technical design principles (Clegg, 2000), we highlight the relation between social and technical aspects of the smart home in a way that we argue helps to illustrate the two-fold perspective of smart homes. The translation of a socio-technical perspective from an organization to a smart home context could, as discussed above, be seen

as a challenging one. However, our findings show that a socio-technical analysis is relevant and fruitful in the smart home context. The meta-principles (ibid.) made it possible to capture the more holistic, systemic, design of the smart home. Different values are present in the design and depending on the needs of different residents, these values vary in importance for how the smart home is perceived. Further, the content-oriented principles (ibid.) focus on the relationship between technology and human behaviour, which is of utmost importantance in order to design digital services in a way that fulfils residents' convenience, comfort, and privacy needs. Without a match between technology design and human actions and use, the visions of smart living will not be realized. This implies that we contribute with a multi-faceted understanding of smart living which can be useful both for future research and the successful design and use of smart homes.

We argue that applying a socio-technical perspective on smart homes helps to understand the smart home's unique characteristics and its relation to the smart city in a wider context. Different aspects are in the foreground when comparing smart homes to smart cities. In a smart city context, common infrastructure and technology embedded in buildings are in focus. When zooming in on the smart home, of which there are numerous in the smart city, the needs and wishes of the residents are in the foreground while technology is a necessary enabler (as means and tools), but not the ultimate objective. To understand the smart home and how to successfully design it for smart living, policymakers, constructors, and technology designers and providers need to understand the varying needs and wishes of residents related to a smart home setting. The services must be designed with this in mind to be used and appreciated by residents. Infrastructure is vital, but not enough, to realize a smart home idea. Smart city research and practice have an important lesson to learn from the smart home context; that comfort and convenience on a micro-level (i.e., the resident in the home) constitute quality of life for that person, and beyond in the context of a smart city. Smart cities, as outlined in previous IS and digital government research and practice, will not reach their goals and potential (whether it is fulfilling sustainability goals or increasing efficiency through digital technology) if the smart homes in the smart city are not also offering the residents a comfortable and convenient smart living.

5.1. Limitations and future research

We are aware that the empirical findings from the urban living expo, even if embedded in a longitudinal research process, are snapshots from our visits to the apartments in 2017, where creators have staged homes according to their ideas of a future smart home. Also, the digital services present at the expo mirror the technology state-of-the-art at the time of the observations and this change of course over time related to development in use and technology as such. A particular area is also studied located in a certain geographical region, which also can be considered as a limitation. Therefore, the next step in the strive to better understand smart living will be to study residents' ongoing lives in smart homes. This will give us an increased and updated understanding of how the interplay between technology, needs, and wishes shape smart living. The latter is even more interesting to investigate, both from a research and practice point of view, when the smart home to a larger extent in the light of post-pandemic has become an arena for both leisure *and* work. This can also be challenged by studies in other geographical and national contexts. As stated above, our analysis has applied a socio-technical perspective. For future research, we outline that applying a sociomaterial perspective, also taking the fluidity in, e.g., work into account in the understanding of smart homes and smart living, is another interesting topic to investigate.

CRediT authorship contribution statement

Karin Axelsson: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Validation, Visualization, Writing – original draft, Writing – review & editing. **Ulf Melin:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Validation, Visualization, Writing – original draft, Writing – review & editing. **Malin Granath:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

This study has been financially supported by the Swedish Energy Agency (38839-1).

References

Alawadhi, S., Aldama-Nalda, A., Chourabi, H., Gil-Garcia, J. R., Leung, S., Mellouli, S., … Walker, S. (2012). Building understanding of Smart City initiatives. In H. J. Scholl, M. Janssen, M. A. Wimmer, C. E. Moe, & L. S. Flak (Eds.), *EGOV 2012, LNCS 7443* (pp. 40–53). Berlin Heidelberg: Springer-Verlag.

Albino, V., Berardi, U., & Dangelico, R. M. (2015). Smart cities: Definitions, dimensions, performance, and initiative. *Journal of Urban Technology, 22*(1), 3–21.

Aldrich, F. K. (2003). Smart homes: Past, present and future. In R. Harper (Ed.), *Inside the smart home*. London: Springer-Verlag. ISBN 1–85233–688–9.

Allen, B., Tamindael, L. E., Bickerton, S. H., & Cho, W. (2020). Does citizen coproduction lead to better urban services in smart cities projects? An empirical study on e-participation in a mobile big data platform. *Government Information Quarterly, 37*(1), Article 101412.

Alvesson, M., & Sköldberg, K. (2009). *Reflexive methodology: New vistas for qualitative research* (2 ed.). Sage.

Angelidou, M. (2017). The role of Smart City characteristics in the plans of fifteen cities. *Journal of Urban Technology, 24*(4), 3–28.

Anthopoulos, L. G. (2015). Understanding the smart city domain: A literature review. In *Transforming city governments for successful smart cities* (pp. 9–21). Cham: Springer.

Avgerou, C., Ciborra, C., & Land, F. (2004). *The social study of information and communication technology*. Oxford: Oxford University Press.

Axelsson, K., & Granath, M. (2018). Stakeholders' stake and relation to smartness in smart city development: Insights from a Swedish city planning project. *Government Information Quarterly, 35*(4), 693–702.

Axelsson, K., Melin, U., & Lindgren, I. (2013). Public e-services for agency efficiency and citizen benefit: Findings from a stakeholder centered analysis. *Government Information Quarterly, 30*(1), 10–22.

Balta-Ozkan, N., Davidson, R., Bicket, M., & Whitmarsh, L. (2013). The development of smart homes market in the UK. *Energy, 60*(C), 361–372.

Bannister, F., & Connolly, R. (2012). Forward to the past: Lessons for the future of e-government from the story so far. *Information Polity, 17*, 211–226.

Bansler, J. (1989). Systems development research in Scandinavia: Three theoretical schools. *Scandinavian Journal of Information Systems, 1*(9), 3–20.

Ben Rjab, A., Mellouli, S., & Corbett, J. (2023). Barriers to artificial intelligence adoption in smart cities: A systematic literature review and research agenda. *Government Information Quarterly, 40*(3), Article 101814.

Boell, S. K., & Cecez-Kecmanovic, D. (2014). A hermeneutic approach for conducting literature reviews and literature searches. *Communications of the Association for Information Systems, 34*(1), 257–286.

Bostrom, R., & Heinen, J. (1977). MIS problems and failures: A socio-technical perspective. *MIS Quarterly, 1*(3), 17–32.

Caragliu, A., Del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology, 18*(2), 65–82.

Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J. R., Mellouli, S., Nahon, K., … Scholl, H. J. (2012). Understanding smart cities: An integrative framework. In *Paper presented at the 45th Hawaii international conference on system sciences (HICSS)*. Maui, Hawaii, United States: Organized by the College of Business, University of Hawai'i at Manoa. January 4-7.

Clegg, C. W. (2000). Sociotechnical principles for systems design. *Applied Ergonomics, 31*, 463–477.

Clement, J., Manjon, M., & Crutzen, N. (2022). Factors for collaboration amongst smart city stakeholders: A local government perspective. *Government Information Quarterly, 39*(4), Article 101746.

Darby, S. (2018). Smart technology in the home: Time for more clarity. *Building Research and Information, 46*(1), 140–147.

Ehn, P. (1989). *Work-oriented Design of Computer Artifacts*. Hillsdale, New Jersey: Lawrence Erlbaum Ass.

Filho, G., Villas, L., Gonçalves, V., Pessin, G., Loureiro, A., & Ueyama, J. (2019). Energy-efficient smart home systems: Infrastructure and decision-making process. *Internet of Things, 5*, 153–167.
Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanovic, M., & E.. (2007). Smart cities ranking of European medium-sized cities. In *Report from Centre of Regional Science (SRF)*. Austria: Vienna University of Technology.
Gil-Garcia, J. R., Pardo, T. A., & Nam, T. (2015). What makes a city smart? Identifying core components and proposing an integrative and comprehensive conceptualization. *Information Polity, 20*(1), 61–87.
Gil-Garcia, J. R., Zhang, J., & Puron-Cid, G. (2016). Conceptualizing smartness in government: An integrative and multi-dimensional view. *Government Information Quarterly, 33*(3), 524–534.
Gram-Hanssen, K., & Darby, S. J. (2018). "Home is where the smart is"? Evaluating smart home research and approaches against the concept of home. *Energy Research & Social Science, 37*, 94–101.
Granath, M. (2016). The Smart City – how smart can 'IT' be? Discourses on digitalisation in policy and planning of urban development. PhD thesis. In *Linköping Studies in Arts and Science No. 693*. Linköping University.
Heeks, R., & Bailur, S. (2007). Analyzing e-government research: Perspectives, philosophies, theories, methods, and practice. *Government Information Quarterly, 24*(2), 243–265.
Holgersson, J., & Karlsson, F. (2014). Public e-service development: Understanding citizens' conditions for participation. *Government Information Quarterly, 31*(3), 396–410.
Hollands, R. G. (2008). Will the real smart city please stand up? Intelligent, progressive or entrepreneurial? *City: Analysis of Urban Trends, Culture, Theory, Policy, Action, 12*(3), 303–320.
Iivari, J., & Lyytinen, K. (1998). Research on information systems development in Scandinavia – Unity in plurality. *Scandinavian Journal of Information Systems, 10*(1&2), 135–186.
Ismagilova, E., Hughes, L., Dwivedi, Y. K., & Raman, R. (2019). Smart cities: Advances in research – An information systems perspective. *International Journal of Information Management, 47*, 88–100.
Kievani, R. (2010). Reflections on Rio: Perspectives on the world urban forum 5. *International Journal of Urban Sustainable Development, 2*(1–2), 141–148.
Kitchin, R. (2014). The real-time city? Big data and smart urbanism. *GeoJournal, 79*, 1–14.
Kopackova, H., & Libalova, P. (2017). Smart city concept as socio-technical system. In *Paper presented at the international conference on information and digital technologies (IDT) in Zilina, Slovakia*, 5-7 July 2017.
Land, F. F. (2000). Evaluation in a socio-technical context. In R. Baskerville, J. Stage, & J. I. DeGross (Eds.), *Organizational and social perspectives on information technology* (pp. 115–126). Boston: Kluwer Academic Publishers.
Li, M., Gu, W., Chen, W., He, Y., Wu, Y., & Zhand, Y. (2018). Smart home: Architecture, technologies and systems. *Procedia Computer Science, 131*, 393–400.
Li, W., Yigitcanlar, T., Erol, I., & Liu, A. (2021). Motivations, barriers and risks of smart home adoption: From systematic literature review to conceptual framework. *Energy Research & Social Science, 80*, Article 102211.
Lynch, T., & Gregor, S. (2004). User participation in decision support systems development: Influencing system outcomes. *European Journal of Information Systems, 13*(4), 286–301.
Maalsen, S., & Dowling, R. (2020). Covid-19 and the accelerating smart home. *Big Data & Society, 7*(2).
Marikyan, D., Papagiannidis, S., & Alamanos, E. (2019). A systematic review of the smart home literature: A user perspective. *Technological Forecasting and Social Change, 138*, 139–154.
Mumford, E. (2000). A socio-technical approach to systems design. *Requirements Engineering, 5*(2), 125–133.
Mumford, E. (2006). The story of socio-technical design: Reflections on its successes, failures and potential. *Information Systems Journal, 16*(4), 317–342.
Neumann, O., Matt, C., Hitz-Gamper, B. S., Schmidthuber, L., & Stürmer, M. (2019). Joining forces for public value creation? Exploring collaborative innovation in smart city initiatives. *Government Information Quarterly, 36*(4), Article 101411.
Nograšek, J., & Vintar, M. (2011). Technology as the key driver of organizational transformation in the eGovernment period: Towards a new formal framework. In M. Janssen, H. J. Scholl, M. A. Wimmer, & Y. Tan (Eds.), *Electronic government - proceedings of the 10th IFIP WG 8.5 international conference, EGOV 2011, Delft* (pp. 453–464). August 28–September 2, 2011.
Orlikowski, W. J. (2010). The sociomateriality of organisational life: Considering technology in management research. *Cambridge Journal of Economics, 34*(1), 125–141.
Orlikowski, W. J., & Scott, S. V. (2008). Sociomateriality: Challenging the separation of technology, work and organization. *The Academy of Management Annals, 2*(1), 433–474.
Robles, R. J., & Kim, T. (2010). A review on security in smart home development. *International Journal of Advanced Science and Technology, 15*, 13–22.
Sawyer, S., & Jarrahi, M. H. (2015). The sociotechnical perspective. In H. Topi, & A. Tucker (Eds.), *Vol. 2. Information systems and information technology*. (Computing Handbook Set), Third Edition, Taylor and Francis.
Schieweck, A., Uhde, E., Salthammer, T., Salthammer, L. C., Morawska, L., Mazaheri, M., & Kumar, P. (2018). Smart homes and the control of indoor air quality. *Renewable and Sustainable Energy Reviews, 94*, 705–718.
Skouby, K. E., Kivimäki, A., Haukipuro, L., Lynggaard, P., & Windekilde, I. (2014). Smart cities and the ageing population, *OUTLOOK*. In *, 12. Visions and research directions for the Wireless World* (pp. 1–12).
Sovacool, B. K., & Furszyfer Del Rio, D. D. (2020). Smart home technologies in Europe: A critical review of concepts, benefits, risks and policies. *Renewable and Sustainable Energy Reviews, 120*, Article 109663.
Strauss, A., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Sage.
Trist, E. L. (1956). Comparative study of some aspects of mining systems in a northern coalfield. In *Publication no. 434, Tavistock Institute of Human Relations, London*.
van Twist, A., Ruijer, E., & Meijer, A. (2023). Smart cities & citizen discontent: A systematic review of the literature. *Government Information Quarterly, 40*(2), Article 101799.
Walsham, G. (1995). Interpretive case studies in IS research: Nature and method. *European Journal of Information Systems, 4*, 74–81.
Walsham, G. (2006). Doing interpretive research. *European Journal of Information Systems, 15*(3), 320–330.
Woodward, J. (1965). *Industrial organization: Theory and practice*. London: Oxford University Press.
Yeh, H. (2017). The effects of successful ICT-based smart city services: From citizens' perspectives. *Government Information Quarterly, 34*(3), 556–565.
Yigitcanlar, T., Kamruzzaman, M., Buys, L., Ioppolo, G., Sabatini-Marques, J., Moreira da Costa, E., & Yun, J. H. J. (2018). Understanding 'smart cities': Intertwining development drivers with desired outcomes in a multidimensional framework. *Cities, 81*, 145–160.
Zhou, K., Fu, C., & Yand, S. (2016). Big data driven smart energy management: From big data to big insights. *Renewable and Sustainable Energy Reviews, 56*, 215–225.
van Zoonen, L. (2016). Privacy concerns in smart cities. *Government Information Quarterly, 33*(3), 472–480.

Karin Axelsson, PhD, is professor in Information Systems at the Department of Management and Engineering, Linköping University. Her research interests cover both smart city and e-government applications. She has conducted research in private and public organizations from an inter-organizational perspective for many years. She has led several research projects about public e-services and smart cities and published in e.g., Government Information Quarterly, Transforming Government – People, Process and Policy, and International Journal of Electronic Governance.

Ulf Melin, PhD, is professor in Information System as the Department of Management and Engineering, Linköping University. His research is focused on public sector digitalization, studying e.g., initiatives from policy to practice regarding digital services, open data, smart cities and process automation. Ulf has published in e.g., Government Information Quarterly, Transforming Government – People, Process and Policy, International Journal of Electronic Governance, International Journal of Public Information Systems, Information Technology and People, and Communications of the Association for Information Systems.

Malin Granath, PhD, is senior lecturer in Information Systems at the Department of Management and Engineering, Linköping University. Her research interests cover smart city development with focus on digitalization and sustainability issues. She has conducted research mainly in public organizations from an inter-organizational and stakeholder perspective.