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RESISTING OR EMBRACING THE SMART HOME?

FROM INDUSTRY VISIONS TO EVERYDAY LIFE

**BY
LINE KRYGER AAGAARD**

DISSERTATION SUBMITTED 2022



AALBORG UNIVERSITY
DENMARK

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AALBORG UNIVERSITY
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AUTHOR CV



Line Kryger Aagaard has a bachelor's and master's degree in Anthropology from Copenhagen University. She is trained in qualitative methods including ethnographic research and field studies. Her master's thesis explored acquired brain injury and rehabilitation trajectories within the Danish welfare state, building on three months of multi-sited fieldwork. She graduated in 2019 and began her PhD at Aalborg University's Department of the Built Environment the same year. Here, she is part of the research group Sustainable Cities and Everyday Practices (SCEP) which works empirically and theoretically with everyday life, social practices, housing, energy consumption, emerging technologies, and sustainable transitions.

Line's PhD is part of the research project eCAPE (new Energy Consumer roles and smart technologies – Actors, Practices and Equality) financed by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (Advanced Grant agreement number 786643). The overall research objective of the project is to explore the link between a low-carbon transition in the energy system and the increasing use of smart home technologies. In this, Line's PhD explores the smart home from both a user and a professional perspective. Her research spans from studying smart home technology development and industry visions to everyday user practices, domestic roles, and relations, and critically engages with themes such as gender, technical competence, and learning.

ENGLISH SUMMARY

Technologies in the home are steadily advancing. Voice assistant speakers, robotic vacuum cleaners, automated heating, and smart lighting are just a few examples. The smart home technologies in rapid development can be independently combined in DIY (*do-it-yourself*) solutions, bought in ready-made systems, or even integrated from the start, as increasingly seen in new housing constructions. The smart home market is currently expanding, not least in Denmark, which holds the European record when it comes to the daily use of smart home technology.

Smart home technology is defined as being connected in a network and remotely controllable. The technology is promoted as an enabler for enhancing standards in convenience, entertainment, security, and energy efficiency. Smart home technology not only changes the materiality of the home, but also affects everyday practices and has social implications about which more knowledge is required. The aim of this PhD dissertation is to explore these matters: *How smart home technology is implemented in households and the implications this has for everyday practices.*

The dissertation is based on qualitative studies including interviews with households and technology developers and auto-ethnographic material. In including both professional perspectives from the smart home industry and those from everyday life, the dissertation provides an insight into the relationship between the visions behind the technology on the one hand and everyday practices on the other. With a point of departure in theories of practice, the dissertation explores how smart home technology becomes part of both new and existing household practices, how the latter are reconfigured with smart technology implementation, and how domestic roles and consumption are affected in this process. Thus, the analytical focus is on social practices, materiality, routines, competences, and change, finding expression in various themes including housework, learning, and gender.

The dissertation comprises four journal papers, each shedding light on different aspects of the main research question. Paper 1 is based on interviews with 11 professional actors from the smart home industry, representing different positions and companies within the field. The paper explores the meaning of convenience as a prevailing smart home vision and shows how this vision is embedded in professional practices and relations. Convenience is closely related to the notion of interoperability, indicating that the technologies are intended to be mutually compatible, thus enabling the integration of and connection between an increasing number of technologies in the home. Furthermore, the paper demonstrates how the vision of convenience is closely related to a view of smart home users as passive in their interactions with the technology. This can have problematic consequences by potentially increasing users' energy and resource consumption.

Paper 2 explores how smart home technology becomes part of new and existing household practices when it is implemented in the home. Based on home tours and interviews with 26 participants divided between 15 households, the paper demonstrates that the ‘digital housekeeping’ (the installation and ongoing management of the technologies) appears to be primarily a male domain, which can influence how also manual housework is gendered. The performance of digital housekeeping, however, also involves practices traditionally associated with femininity, including home decoration and cognitive labour. Thus, digital housekeeping is able to both reinforce as well as modify traditional gender roles.

Paper 3, written with Line Valdorff Madsen, compares the above-mentioned empirical study with a similar study by Madsen of households with smart heating installed (12 participants divided between eight households). This latter study illustrated more equal divisions of digital housekeeping demonstrating how gender roles and divisions of labour are neither natural nor fixed but rather are expressions of particular competences, understandings, and meanings. An awareness of how the technologies are implemented in everyday practices and of the importance of competences and meanings is therefore critical to include in the development of more inclusive technologies and to preventing both gendered and digital inequality.

Paper 4, written with Toke Haunstrup Christensen and Kirsten Gram-Hanssen, is based on the latter’s auto-ethnographic diary. The paper explores how smart home technology implementation involves particular processes of learning. For that purpose, a number of concepts from theories of practice are presented to illuminate how a carrier and performer of practices is confronted in the interaction with new technologies, resulting in new learning objectives. The outcome of learning is augmented operability in the performance of practices and emerges in the interplay between existing learning biographies, remote assistance, and in interactions with materiality and social relations.

Overall, the dissertation illustrates the discrepancy between smart home industry visions of smooth automation on the one hand and lived smart home experiences on the other. The implementation of the technology involves challenges, negotiation, and conflicts in the home with implications related to gender, control, and power. The dissertation demonstrates how analysing social practices can deconstruct visions behind the technology. To understand the social implications of smart home technology, it is not sufficient to evaluate its material properties. Rather, we must consider how the technology enters into *practices* and how it relates to particular competences and meanings.

DANSK RESUME

Teknologier i hjemmet bliver til stadighed mere avancerede og spænder bredt fra stemmestyrede højttalere til robotstøvsugere, automatiseret varmestyring og tidsindstillet lyssætning for blot at nævne et par eksempler. 'Smart home'-teknologierne er i hastig udbredelse og kan sammensættes både enkeltvis i gør-det-selv-løsninger, købes i færdige systemer eller endda bygges ind i boligen fra start, som det i stigende grad ses i nybyggeri. 'Smart home'-markedet vokser således stødt i disse år, ikke mindst i Danmark, som ligger i toppen blandt europæiske lande, når det kommer til den daglige brug af de smarte teknologier.

'Smart home'-teknologier defineres ved internetforbundethed og fjernstyring og bliver promoveret i form af øgede standarder inden for såvel komfort som underholdning, sikkerhed og energieffektivitet. Teknologierne skaber imidlertid ikke blot materielle ændringer i hjemmet, men påvirker også hverdagspraksisser og samværsformer med sociale implikationer, som vi stadig mangler viden om. Formålet med denne Ph.d.-afhandling er netop at undersøge dette: *Hvordan 'smart home'-teknologier implementeres i husstande, og hvilke implikationer dette har for hverdagspraksisser.*

Afhandlingen er baseret på kvalitative studier, herunder interviewundersøgelser med husstande og med teknologiudviklere samt autoetnografisk materiale. Ved både at inddrage perspektiver fra 'smart home'-industrien og fra det levede hverdagsliv giver afhandlingen indblik i sammenhængen mellem visionerne bag teknologien på den ene side og den daglige hverdagspraksis på den anden. Med en praksisteoretisk tilgang undersøges, hvordan 'smart home'-teknologier indgår i både nye og eksisterende hverdagspraksisser, og hvordan disse rekonfigureres med teknologiernes indtog, samt hvordan roller og forbrug påvirkes i denne proces. Det analytiske fokus er således på sociale praksisser, rutiner, kompetencer, materialitet og forandring og kommer til udtryk i temaer som husarbejde, læring og køn.

Afhandlingen omfatter fire videnskabelige artikler, der hver især belyser forskellige aspekter af det overordnede forskningsspørgsmål. Artikel 1 er baseret på interviews med 11 professionelle aktører fra 'smart home'-industrien, repræsenterende forskellige positioner og virksomheder. Artiklen undersøger betydningen af 'convenience' som en udbredt vision for det smarte hjem og viser, hvordan denne vision er forankret i professionelle praksisser og relationer. 'Convenience' er tæt knyttet til idéen om interoperabilitet, som indebærer, at teknologierne skal være kompatible, således at stadigt flere teknologier kan integreres og forbindes i hjemmet. Artiklen viser ydermere, at den udbredte 'convenience'-vision hænger sammen med et syn på 'smart home'-brugere som værende passive i deres omgang med teknologierne. Dette kan have u hensigtsmæssige konsekvenser i form af et potentielt øget energi- og ressourceforbrug.

Artikel 2 undersøger, hvilke nye og eksisterende praksisser 'smart home'-teknologien bliver en del af, når den implementeres i hjemmet. På baggrund af hjemmebesøg og interviews med 26 personer fordelt på 15 husstande viser artiklen, at det 'digitale husarbejde' (installation og løbende varetagelse af teknologierne) fremstår som primært et mandligt domæne, og at dette kan have konsekvenser for, hvordan også manuelt husarbejde fordeles mellem kønnene. Det digitale husarbejde indebærer dog også områder, som traditionelt forbindes med femininitet, herunder dekorationspraksisser og kognitivt arbejde. Således kan det digitale husarbejde bidrage til at forstærke såvel som modificere traditionelle kønsroller.

Artikel 3, skrevet med Line Valdorff Madsen, sammenligner ovennævnte empiriske undersøgelse med et lignende studie foretaget af Madsen af husstande med smart varmestyring (12 personer fordelt på 8 husstande). Sidstnævnte studie viser imidlertid en mere ligelig kønsfordeling i det digitale husarbejde, hvilket demonstrerer, hvordan kønsroller og arbejdsdelinger hverken er naturlige eller fastgjorte, men snarere giver udtryk for bestemte kompetencer, forståelser og interesseområder. Viden om teknologiernes optagelse i praksisser og betydningen af kompetencer og motivation er således vigtige at inddrage i udviklingen af inkluderende teknologier og i forebyggelsen af køns- og digital ulighed.

Artikel 4, skrevet med Toke Haunstrup Christensen og Kirsten Gram-Hanssen, bygger på sidstnævntes auto-etnografiske dagbog. Artiklen undersøger, hvordan implementeringen af 'smart home'-teknologier indebærer forskellige læringsprocesser. Til dette formål præsenteres en række begreber fra praksisteorien, som kan belyse, hvordan man som bærer og udfører af en hverdagspraksis bliver konfronteret i mødet med nye teknologier, hvilket skaber nye læringsbehov. Resultatet af læring er en øget mestring i udførelsen af praksisser og opstår i spændingsfeltet mellem eksisterende læringsbiografier, assistance udefra og i interaktioner med materialitet og sociale relationer.

Samlet set viser afhandlingen, at der er langt mellem 'smart home'-industriens visioner om friktionsløs automatisering og så det levede liv, som det udspiller sig i de beskrevne hjem. Teknologiernes implementering medfører udfordringer, forhandling og uoverensstemmelser i hjemmet og har implikationer, der berører køn, kontrol og (af)magt. Afhandlingen demonstrerer, hvordan analysen af sociale praksisser kan dekonstruere visionerne bag teknologien. Når betydningen af 'smart-home'-teknologi skal kortlægges, er det således ikke tilstrækkeligt at tage materialiteten i betragtning. Snarere må teknologierne undersøges, som de indgår i *praksis* sammen med bestemte kompetencer, viden og motivation.

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Doing a PhD is challenging and tough, but first and foremost it is a great privilege. Despite difficulties and doubts, this PhD journey has involved joyful immersion and rewarding learning about a timely topic that I had only limited knowledge of prior to my research, but which has ended up involving me deeply, both academically and personally. I owe a great thanks to the many people who have helped, supported, and inspired me along the way.

First and foremost, I am grateful to all the research participants who made this research possible. Thanks to the technology professionals for speaking openly about their work and visions and giving me insight into the vast and intriguing industry behind the smart home. Thanks to the household participants for letting me into their homes, sharing experiences and anecdotes, and giving me insight into their everyday. Your time and openness have been invaluable.

I also thank my supervisor, Kirsten Gram-Hanssen, who has unceasingly provided inspiration, structure, care, and confidence. Thanks for helping me navigate the long and tricky PhD path that has ended up in an even more rewarding place than I hoped for. Thanks for being a feminist inspiration, although you are not always aware of it. Your genuine frankness and direct manner both inspire and amuse.

Thanks to my co-supervisor Line Valdorff Madsen for great collaboration and feedback during the final stage of the PhD. Also, a thousand thanks to all my colleagues (both previous and present) at the Department of the Built Environment, in particular the SCEP research group. I simply do not believe finding a more outstanding and engaged research community is possible. I am grateful for the non-hierarchical work environment and the great company (both in and outside the university's walls), enriching this journey from beginning to end.

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I would further like to thank the anonymous reviewers, journal editors, conference audiences, and everyone else who have provided feedback, read, listened to, and discussed my research with me, connecting me with other studies, concepts, and ideas. The last three years have, if anything, taught me the key value of peer exchange.

Last but not least, I would like to thank my wonderful friends for always being there and my loving family for unconditional support. Thanks to Jeppe for entering my life, broadening my world, and for sharing my techno-feminist enthusiasm and general joy of norm criticism. Thank you for immersion, transcendence, and everything else.

COLLECTION OF PAPERS

1. Aagaard, Line Kryger. 2021. 'The Meaning of Convenience in Smart Home Imaginaries: Tech Industry Insights'. *Buildings and Cities* 2 (1): 568–82. <https://doi.org/10.5334/bc.93>.
2. Aagaard, Line Kryger. 2022. 'When Smart Technologies Enter Household Practices: The Gendered Implications of Digital Housekeeping'. *Housing, Theory and Society* 0 (0): 1–18. <https://doi.org/10.1080/14036096.2022.2094460>.
3. Aagaard, Line Kryger, and Line Valdorff Madsen. 2022. 'Technological Fascination and Reluctance: Gendered Practices in the Smart Home'. *Buildings and Cities* 3 (1): 677–91. <https://doi.org/10.5334/bc.205>.
4. Aagaard, Line Kryger, Toke Haunstrup Christensen, and Kirsten Gram-Hanssen. 2022. 'My Smart Home: An Auto-Ethnography of Learning to Live with Smart Technologies'. Submitted to *Personal and Ubiquitous Computing*.

PREFACE

This PhD dissertation emerges as part of the ERC funded research project eCAPE (Advanced Grant agreement number 786643) which explores how current transitions in our energy system aimed at a low-carbon society relate to the increasing use of smart technologies in homes and everyday practices¹. eCAPE focuses on three areas:

1. The importance of gender and social structures
2. The role of the ethical consumer in developing new practices
3. The inclusion of non-humans as carriers and performers of practices

Initially, my PhD study targeted the third area, with an aim of exploring technological agency and how the smart home automates practices previously performed by humans. However, during my empirical encounters, home visits, and household interviews, it became clear that technological agency was still difficult to find in the everyday lives of my research participants and seemed more like a dream for the future than something they experienced in their daily interaction with smart technologies. An aspect I discovered to be essential on the other hand, was gender. The implementation and everyday use of smart technologies in the households I visited during my field studies had a clear gendered division, which became a critical lens for understanding the implications of the increasing ‘smartification’ of homes.

My focus thus shifted during the three years of my PhD, illustrative of how a research journey often starts in one place and ends up in another. Following the rich tradition of feminist technology studies that highlights the close relation between gender and technology, part of my research has come to follow this path, moving from the third of eCAPE’s research objectives to the first. This rearrangement has involved adjustments and reflections as will be described in the dissertation.

The PhD dissertation is paper-based and consists of two parts: a collections of research papers (paper 1-4, found at the end of this document) representing the analytic findings and results of my research; and an extended summary situating my study within existing research, elaborating on applied concepts and theories, and expounding the methods chosen for my empirical investigations. The summary ends with a discussion and conclusion reflecting upon the implications of my research (as presented in the papers) and the connection between the analytic findings. The papers comprise the core of the dissertation while the extended summary unites their findings

¹ eCAPE’s website: <https://www.ecape.aau.dk/>.

and provides elaborated background information and reflections on the theoretical, analytical, and methodological choices made along the way.

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CHAPTER 1. INTRODUCTION

”You step on the train [...], the app already knows you’re on your way home. So, the app turns on the heat when you come within range, the alarm is disabled, the doors open. You step in, the motion sensor detects that you’re in the living room, so lights go on that you have programmed to go on. [...] The more devices you have that are smart, the more valuable the solution is.”

(Interviewee in Aagaard 2021, 574).

This quote belongs to a smart home professional, a project manager whom I interviewed in the Spring of 2020 during my studies on the role of smart home technology in everyday life. Smart homes have within the last decades developed from visions, ideals, and utopias into real life contexts for many people and are “increasingly becoming a mundane reality” (Hine 2020, 23). In the Global North, smart home technologies have drastically grown in numbers. Denmark is a case in point as it has recently been ranked number one in Europe when it comes to smart home technology usage (23% compared to 10% in EU on average, Statistics Denmark 2020). Ever more people will house technologies like digital voice assistants and smart security systems in the future as the smart home market is expected to double in size in 2025 compared to 2020 (Statista 2020).

The scenario presented by the project manager in the quote above reflects widespread visions of the smart home industry: our future homes should be fully automated with heightened standards of comfort. Smart devices will accommodate our needs, work together, and create smooth solutions for our convenience. Our homes will be helpful, attentive, and *smart*. In the quote, the app “*knows*” that we are on our way home. Smart technology acts automatically and somewhat independently, however, in accordance with individual preferences and depending on how we have “*programmed*” it, as the quote reflects. Technological and human agency intersect in the smart home. When smart technologies provide services and automate household chores, we are relieved of irksome duties and everyday inconveniences. We will have more time to sit back and relax.

Although this narrative of smart home technology is prevalent within the industry and is reflected in areas of policy and technical research, a growing number of studies from the social sciences and humanities have begun to question these promises. Does the smart home always entail smooth convenience? What is it like to live in the smart home? Who is it designed for? By asking these critical questions, studies such as those in the sociological, anthropological, and critical media fields have brought the *human* side more into focus, highlighting not just technical challenges, but also the social consequences, frictions, and difficulties arising when homes become smart. For

instance, this branch of research shows that it takes *work* to live in a smart home. This includes installing, programming, and maintaining the technologies – what can be captured by the term ‘digital housekeeping’ (Tolmie et al. 2007). Digital housekeeping poses a new and growing field of household labour (although sometimes conflated with leisure) that exists in tandem with (and affects, sometimes even redistributes) manual housework and everyday practices. Thus, the smart home does not only involve changes in the material arrangements of our homes, but it also impacts on our everyday practices, social relations, and role dynamics. In this PhD dissertation, I explore how this unfolds, from both the professionals’ perspective and from the users’ side. My overall research question is:

How is smart home technology implemented in households and what implications does this have for everyday practices?

1.1. WHAT IS A SMART HOME?

Definitions of the smart home vary, but common to most of them is an emphasis on automation, interoperability, and remote control. In Gram-Hanssen and Darby's (2018) review of smart home research, they write:

“A smart home is one in which a communications network links sensors, appliances, controls and other devices to allow for remote monitoring and control by occupants and others, in order to provide frequent and regular services to occupants and to the electricity system” (Gram-Hanssen and Darby 2018, 96).

Among the most popular smart home technologies are digital voice assistants, smart speakers, and smart sensors, such as door locks and light switches (von See 2021). Smart homes are developed to meet certain household desires, as Chambers notes:

“Designed to respond to householders’ desires *for convenience, entertainment, security, and energy management*, ‘smart homes’ are households supported by individual smart gadgets or an interdependent home network enabled by internet-connected devices known as the Internet of Things (IoT).” (Chambers 2020, 304, emphasis added).

These common motivations for smart home technology (SHT) installation – convenience, entertainment, security, and energy management – are some of the typical themes and promises promoted in smart home narratives and development (Hazas and Strengers 2019; Strengers et al. 2020; Strengers and Nicholls 2017). Whether SHT delivers on these promises is a different story, and the present PhD dissertation aims to illuminate some of the tensions and contradictions that arise when

smart technologies move in. As homes become smart, not only are their material interiors reconfigured, but social relations, roles, and everyday practices are also affected. As Chambers further notes, “The smart home promise of comfort, efficiency and convenience infers the easing of housework and impacts on the moral economy of the household in ways we are only beginning to understand” (Chambers 2020, 305). To put it bluntly, SHT mediates new social realities. Quickly rising in number, they are rapidly transforming what many define as their most intimate space; namely, the home.

1.2. SMART HOMES THEN AND NOW

Although SHT has become widespread within recent years, visions relating to home automation and smart solutions can be dated to as early as the turn of the nineteenth century. With the electrification of wealthy households in the late nineteenth and early twentieth centuries, home appliances as enablers of convenience and luxury were promoted, heightening levels of automation and announcing modern progress (Gram-Hanssen and Darby 2018). The smart home as a specific concept can be dated to the 1930s, part of a vision of the ‘homes of tomorrow’ (Strengers 2013). More extensive forms of SHTs were developed for the mass market in the last decades of the twentieth century, introducing consumers to automation and remote control (Gram-Hanssen and Darby 2018).

With its automating capabilities, the smart home is promoted as enabling more comfort and convenience in people’s everyday lives while, at the same time, delivering more efficient energy management. However, rising standards of convenience also relate to certain lifestyle expectations that are likely to increase energy consumption rather than reduce it (Strengers and Nicholls 2017; Shove 2003a). With its big size and rapid growth, the smart home market is characterized by sizeable economic interests and investments. Google and Amazon are among the large commercial entities that dominate the field, in particular via their popular smart speakers and digital voice assistants (i.e., Google Home and Alexa) that serve as a gateway to the smart home while also being an important point of control within the smart home market (BCG 2018). Notable points of concern that critics and scholars voice involve risks of masked energy consumption together with privacy issues and increased consumer homogeneity (Sadowski, Strengers, and Kennedy 2021). Besides the big corporate players, thousands of smaller businesses operate within the market, and put together, the smart home industry forms a complex and powerful force that is shaping the homes of tomorrow.

The smart home development is thus comprised of a myriad of actors, relations, and practices; smart homes are imagined and designed as well as lived and experienced in real-life settings. To capture the implications of the smart home, we need to include

and understand both perspectives – of the professionals and of the users. In this PhD dissertation, I explore the visions and work behind the technology to investigate how our future homes are formed and assess how the smart home is lived: what professional practices are forming this field, and how they relate to the everyday practices of users.

1.3. A FEMINIST ENQUIRY

The relation between everyday practices and technology is shaped by, and is in turn shaping, gender. As feminist studies of housework have shown, the division of housework has been highly gendered in western households (Cowan 1985) – and continues to this day despite advocacy for more gender equality (Rulffes 2021). Feminist technology studies have documented the historical association between masculinity and technology on the one hand, and home and femininity on the other; a prevailing cultural dichotomy (Cockburn and Fürst-Dilić 1994; Faulkner 2001). However, feminist studies also show that these associations are not natural or inherited; rather gender can be understood as performative, as something that is produced and reproduced in our social interactions. Gender can thus be done and undone (Butler 2006). People constitute and negotiate their gendered identities through housework, reproducing *and* resisting gender norms (Pink 2004). Furthermore, the mutual constitutive relation between gender and technology is highlighted as the two continually shape each other, in processes of both design and use (Wajcman 2010).

In Perez' (2020) agenda-setting book *Invisible women: Exposing data bias in a world designed for men*, she presents critical evidence of gendered biases prevalent in various areas of science, technology, and society. The smart home does not escape the critical statistics; for instance, Google Home is 70% more likely to respond to male voices than female (Perez 2020). To understand gendered differences and biases in technology development and use, however, statistics are not sufficient (although they are important). To challenge and move beyond gendered norms and stereotypes, the mechanisms behind their daily (re)production need scrutinization. Studying everyday practices and domestic roles is one step in this direction.

1.4. STRUCTURE OF THE DISSERTATION AND RESEARCH QUESTIONS

The present dissertation consists of two parts: 1) a collection of journal papers capturing the research results, and 2) an extended summary. Apart from the present introduction, the extended summary includes chapters reviewing the existing

literature within the field and the concepts and theories that have inspired me throughout my studies and guided my analyses (Chapter 2: *The smart home designed and lived*, and Chapter 3: *Studying social practices*). Following this, I elaborate on the methods chosen, reflecting on their merits and their limitations (Chapter 4: *Methodologies*). The next chapter (Chapter 5: *Summary of papers and key insights*) summarises the papers and their key findings. The final chapter (Chapter 6: *Concluding discussion*) concludes and synthesises the findings across the papers, discussing their contributions and implications as a whole.

Each of the four papers explores the smart home universe from different angles. The first paper is based on interviews with professionals in various positions within the smart home industry. In this paper, I explore the meaning of convenience in technology development by considering both the ideas behind the technology, the professional practices, and the relation between the different actors that constitute the field. The second paper is based on household interviews and show-and-tell home tours. Here, I home in on the everyday practices and explore how the technology affects roles, relations, and the division of housework. The third paper is co-written with my co-supervisor, Line Valdorff Madsen. In the paper, we compare our two empirical studies on households living with smart technologies in relation to how different competences and meanings in the performance of practices have implications for technology use and gendered divisions within the home. The fourth paper is co-written with my principal supervisor, Kirsten Gram-Hanssen, and my colleague, Toke Haunstrup Christensen, and in this, we study how the implementation of SHT relates to processes of learning. This paper is based on an auto-ethnographic diary written by Gram-Hanssen over the course of 20 months. The paper investigates in detail how learning takes places chronologically while developing a theoretical framework for studying learning within theories of practice.

The following list of research questions framed the four papers:

1. *How is the notion of convenience tied into smart home technology development and how might this impact on user practices and sustainability?* (Paper 1)
2. *How does smart home installation and digital housekeeping impact on everyday practices and gender relations?* (Papers 2 and 3)
3. *What are the gendered implications of differences in competences, meanings, and forms of knowledge among variously tech-engaged smart home users?* (Paper 3)
4. *How does the implementation of smart technologies in the home interact with learning processes and the establishment of new everyday practices?* (Paper 4)

In the following chapters, I guide the reader through some of the existing literature upon which my research builds. I will elaborate on the concepts, theories, and methods that have shaped my study of this emerging technological field before presenting the findings of the papers and discussing their united contribution.

CHAPTER 2. THE SMART HOME DESIGNED AND LIVED

Given that the smart home is a relatively new phenomenon and in rapid development, research in the field has been scarce, characterized primarily by technical studies. As reviews indicate (e.g., Wilson et al. 2014; Hargreaves and Wilson 2017; Gram-Hanssen & Darby 2018), most smart home studies have focused on the technical challenges of establishing smart solutions in home environments. These technically oriented studies, found within disciplines such as computer science, electrical engineering, design, and behavioural and social psychology, can be characterized by what Hargreaves and Wilson term “functional” and “instrumental” views of the technology (Hargreaves and Wilson 2017, 28). In these views, the focus is on optimizing and spreading the adoption of technology, aiming to smooth daily living or improve energy efficiency. These views or “grand narratives” (Hargreaves and Wilson 2017, 18) generally omit consideration of the user of the technology.

Within recent years, smart home studies within the social sciences have begun to rise in number. In this chapter, I will discuss some of these studies on which my own research builds and with which it engages in dialogue. First, I will elaborate on the professional perspective, the smart home industry and its visions, and present concepts useful for exploring the field. Further, I will assess research on smart home users that shows how the implementation of smart home technology (SHT) involves both tensions and processes of learning, affecting everyday practices and the organization of households. I will show how gender plays a role across the SHT field, within technology development, and in the everyday lives of users.

2.1. DESIGN, VISIONS, AND USER IMAGINARIES

Technology and the social are interlinked, as technology carries ideas, norms, and values, shaping social relations and practices. Thus, as science and technology studies (STS) point out, technology should not merely be regarded as neutral hardware but rather comprehended via the knowledge and processes that give it meaning (Bijker, Hughes, and Pinch 2012; MacKenzie and Wajcman 1999; Suchman et al. 1999). To understand the technology and its implications, we need to scrutinize its development and design. As STS scholar Akrich (1992) writes, “Like a film script, technical objects define a framework of action together with the actors and the space in which they are supposed to act” (p. 208). The way technologies are designed influences how they eventually play a role in everyday life. Akrich (1992) argues in favour of moving back and forth between the perspectives of professionals and users, “between the world

inscribed in the object and the world described by its displacement” (p. 209). By inscription she refers to the work of professionals and their ideas of the projected user, while description refers to the object coming into being in a real environment through the user’s reactions. Thus, the practices of designers and developers relate to and connect with the practices and reactions of users. To understand the implications of technology, both the design *of* and everyday living *with* the technologies must be considered.

2.1.1. CONVENIENCE AND ENERGY EFFICIENCY – A PARADOX?

Four aspects of SHTs are especially highlighted in studies of the industry: 1) convenience; 2) energy savings; 3) entertainment; and 4) security (e.g., Wilhite and Diamond 2017; Furszyfer Del Rio et al. 2020; Strengers 2016; Wilson, Hargreaves, and Hauxwell-Baldwin 2017). In terms of points three and four, smart technologies enable and integrate various forms of media use via appliances, such as smart TVs and wireless music systems, and deliver smart security systems via sensors, cameras, and connected door locks, both in DIY (*do-it-yourself*) versions and in all-in-one solutions. Although changing forms of entertainment and security systems within homes have important implications for sociality, the two first aspects especially, convenience and energy savings, have received attention within the literature on smart homes and everyday practices. In this section, I will focus on these two aspects which have been the most relevant in my own studies of SHT.

Throughout their development, smart homes have been framed within the industry and in much technical-applied research as enablers of energy savings, efficiency, and decarbonization. For instance, the Buildings Performance Institute Europe defines a smart building as one that “stabilises and drives a faster decarbonisation of the energy system through energy storage and demand-side flexibility” (BPIE in Gram-Hanssen and Darby 2018, 96). As Gram-Hanssen and Darby note, such definitions represent a view of smart buildings that are “ascribing great agency to the building itself” (Gram-Hanssen and Darby 2018, 96) which does not indicate consideration for the impact of users and their practices. Reviewing technical studies and grey literature within the field, Gram-Hanssen and Darby detect two general discourses on how the smart home is related to energy efficiency. Within these discourses, energy efficiency is expected to be delivered at: 1) the household level, as SHTs can integrate and optimize e.g., heating, lighting, and the charging of electric vehicles; and 2) at the electricity system level, as the smart home can assist in network and grid management, for instance, via demand-response needed for integrating more renewables into the grid or resolving issues of fluctuating energy supplies (Gram-Hanssen and Darby 2018, 96).

The automation of energy consumption and domestic tasks is simultaneously related to the enabling of comfort and convenience. In the Britannica Dictionary, convenience is defined as:

“a quality or situation that makes something easy or useful for someone by reducing the amount of work or time required to do something”, and as:

“something (such as a device) that makes you more comfortable or allows you to do things more easily”.²

From an everyday-life perspective, convenience can be related to things and devices and to more abstract notions, visions, and ideals. Shove has researched the field of convenience related to consumption and has contributed with useful perspectives. For instance, she conceptualizes convenience as a domain of everyday life (Shove 2003a, 395), a standard of normality (Shove 2003b, 194), but also as a service and “a complex concept [...] used to sell any number of appliances and devices.” (Shove 2003b, 195). Furthermore, convenience can be described as a promise held by and ascribed to technology (Shove and Southerton 2000, 305), a dominant convention or ideal (Hand and Shove 2007, 94), an ideology (Hand and Shove 2007, 98), and a regime to be pursued (Hand and Shove 2007, 83). Thus, convenience appears as a powerful concept, guiding and shaping consumption.

In Strengers and Nicholls' (2017) analysis of smart home industry visions, convenience is not only related to making tasks simpler and easier, but also to notions of luxury, relaxation, and aesthetics. The smart home delivers what the authors term ‘pleasance’ by “creating ambiance, fun, comfort, atmosphere, elegance and new aesthetic experiences, all of which involve connected devices and associated apps and control centres” (Strengers and Nicholls 2017, 89). While ‘pleasance’ has perhaps always been an ideal of homes, smart technology enhances its meaning by shifting the home atmosphere via automation and ready-made convenience solutions. However, in the pursuit of pleasance and convenience, automation can quickly and unnoticeably lead to increased energy consumption and resource use. Thus, as an enabler of convenience, it is questionable whether the smart home does lead to energy savings (Strengers and Nicholls 2017; Strengers et al. 2016; Furszyfer Del Rio et al. 2020; Darby 2018).

² <https://www.britannica.com/dictionary/convenience>, brackets in original. Accessed on March 30, 2022.

2.1.2. THE POWER OF THE INDUSTRY

Ideas of convenience and technology visions within the industry, what can be termed ‘sociotechnical imaginaries’ (Jasanoff and Kim 2009), also relate to certain ideas and views of the users: who these are and how they use the technologies (Rygghaug and Toftaker 2016; Skjølsvold and Lindkvist 2015). Both sociotechnical and user imaginaries are often shown to be one-sided, representing the technologies as objective and neutral and the users as autonomous, rational, and technologically capable subjects who respond to the technology’s functions in a predictable manner (Strengers 2013; 2014; Chambers 2020).

Sociotechnical imaginaries and industry visions are important to understand as they express influential norms and ideals, shaping our technological futures. In the smart home market, the large commercial actors make these imaginaries even more powerful. Amazon, Apple, Facebook, Google, and Microsoft, companies that can be termed “the Big Five” or the “genuine heroes of the Internet of Things”, as sci-fi writer Bruce Sterling calls them, are not just characterized by selling people stuff, but are in Sterling’s formulation aiming at becoming a new “social reality” (Sterling in Strengers and Kennedy 2020, 85). These businesses influence and form our social lives and everyday practices, filling up our homes with devices and services.

In the paper, ‘More Work for Big Mother’, Sadowski, Strengers, and Kennedy (2021) describe how SHT, for instance, conflates aspects of care and control, enacting a form of “commodifiable digital surveillance of the home under the guise of maternal care” (p. 3). While delivering convenience and care, e.g., by ensuring safety and comfort, technologies, like smart door locks, sensors, and cameras, simultaneously enable surveillance and supervision, both internally in the home and externally to companies. The same can be seen with seemingly ‘innocent’ devices, such as automated lights or smart white goods, that map our behaviour with consumption data. Referring to Zuboff’s (2019) influential book, *Surveillance Capitalism*, Sadowski, Strengers, and Kennedy (2021) problematize how human data are capitalized by big tech companies, enabling them to sell more products while simultaneously homogenizing consumption and behaviour. These mechanisms often appear seamless and invisible in people’s homes as the technologies are adapted for supporting (certain forms of) family life. As Hui and Leong (2017) write:

“The seamless assimilation of the home assistant to the lives of its owner is an aspect that is also actively encouraged by the technology companies themselves, who advertise the devices as being a ‘natural’ part of the family” (Hui and Leong in Strengers and Kennedy 2020, 104).

The effects and mechanisms of SHT has a gendered dimension, as mentioned in the introduction. In the next section, I present some of the influential ideas, visions, and

imaginaries at play in the industry which researchers have shown to be highly gendered.

2.1.3. RESOURCE MAN, FLEXIBILITY WOMAN, AND THE SMART WIFE

In the book, *The Smart Wife*, Strengers and Kennedy (2020) examine the gendered aspects and biases in the smart home field. With the subtitle, *Why Siri, Alexa and Other Smart Home Devices Need a Feminist Reboot*, the book represents a “critique and intervention into conversations about the future of domestic life, human relationships with AI, and contemporary feminism” (p. 5). Strengers and Kennedy present their analysis by characterizing the smart home as a “smart wife”. They show how current smart home visions, promotions, and narratives tap into images of the 50s housewife – impersonating the nurturing, caring creature who manages the daily chores while serving and attending to the needs of other household members. SHT is in many ways developed to carry out what can be termed ‘wife-work’, referring to the domestic chores and activities that housewives traditionally carry out. Smart technologies are often developed with a feminine expression, for instance, most digital voice assistants have female names and voices (p. 2).

Research on the design of smart homes indicates that this is predominantly a male professional domain with men as the primary target group (Strengers and Kennedy 2020; Chambers 2020). Gender imbalances within the industry are reflected in the development of technologies: how they are tested and created and for what purposes. An issue about designing in gendered ways is that gender stereotypes are continually re-inscribed and reinforced in the process (Strengers and Kennedy 2020, 17). In relation to the smart home, this can find expression in a reproduction of the ‘housewife’ (via the ‘smart wife’) responsible for housework while the ‘man of the house’ is in charge of controlling the technology by possessing technological skill and power.

One of the gendered stereotypes found within the smart technology industry and energy sector is what Strengers (2013; 2014) has termed the ‘Resource Man’. This term captures how the ideal consumer is imagined as a (male) tech-savvy, economically rational, energy-optimizing individual, in many ways appearing as a kind of micro-engineer reflecting the sector’s own image. The concept of the Resource Man has gained recognition within smart home research, depicting how the technology is designed in line with heterosexual norms, reinforcing masculine technological hegemony (Mechlenborg and Gram-Hanssen 2020).

Johnson (2020) introduced the concept of ‘Flexibility Woman’ as a response to Resource Man. Flexibility Woman, in contrast to Resource Man which reflects the industry’s ideal consumer, is often found in low-income households in which smart technologies are not affordable or are less-smoothly integrated: households lacking a

‘smart wife’. Instead of technologies enabling energy flexibility and automation, it is Flexibility Woman who is responsible for adapting to the smart energy future, as she manages manually to care for the family, be thrifty, and do chores. The concept of Flexibility Woman underlines the importance of acknowledging (female) domestic labour and (often unnoticed) chore-doing when imagining a smart future. Both the concepts of Flexibility Woman and Resource Man are examples of how gender and household practices need ongoing attention in the development of smart technologies to ensure an equal and just future within smart homes.

2.2. A FEMINIST APPROACH TO TECHNOLOGY AND (DIGITAL) HOUSEKEEPING

Rather than being an inherent quality of the sex we are ascribed by birth, the fluidity and performativity of gender have generally been highlighted within gender studies, indicating that gender is something we *do* in our social interactions rather than something we *are* (West and Zimmerman 1987). Because dominant gendered categories can be questioned and resisted in various ways, gender can be *undone* (Butler 2006). Gender is produced and reproduced via social practices and is thereby grounded in everyday life (Mechlenborg and Gram-Hanssen 2020; Pink 2004). Household practices and the organization and distribution of these are gendered in different ways. Feminist studies have for decades pointed to the unequal division of housework and how women’s higher workload is in many ways invisible. Hence, studying SHT in everyday life entails a focus on households’ social practices, their organization, and distribution.

In feminist technology studies, the relation between gender and technology is seen as one of mutual constitution. Not only are cultures *around* technologies gendered, gender is understood as “embedded in technology itself” (Wajcman 2010, 146). Techno-feminist approaches, such as Wajcman’s (2004; 2010), regard technology as both a source and consequence of gender relations. Although many exceptions and nuances exist, hegemonic masculinity is still associated with technological skill and power in Western societies (Wajcman 2010; 1991). To understand the relation between gender and technology from a feminist perspective, we must look to cultures and practices. As Wajcman notes: “A feminist perspective shifts our understanding of what technology is, broadening the concept to include not only artefacts but also the cultures and practices associated with technology” (Wajcman 2010, 143).

By looking at household practices and technologies in tandem, feminist studies have detected a ‘housework-technology paradox’ when it comes to the division of and time spent on housework in relation to the introduction of new technologies. It is regarded as a paradox because: “so much time continues to be spent on housework in modern households, despite the massive introduction of technology to the home” (Berg 1994,

166). This paradox has also been described in Cowan's (1985) seminal work, *More Work for Mother*. In the book, she traces the development of technology and housework and shows how the rise of new appliances and technologies in the home, promoted for delivering comfort and easing the burden of the housewife, in fact intensified this burden. Adding new appliances meant that work previously done by other household members (e.g., men, children, and outside workers, such as laundresses), now became the sole responsibility of the housewife. More recent research on the role of the housewife indicates that she has only been more burdened with responsibilities throughout history continuing to this day (Rulffes 2021).

The continuing gendered divisions and inequalities in households can be related to the historical connotations of technology as a masculine domain on the one hand, and the home as a feminine domain on the other (Berg 1994; 1989). In an analysis of SHT, this point is indeed relevant. Do the smart technologies assist in the daily housework, or do they rather appear as gadgets underscoring leisure? Who are the technologies for and how do they affect and potentially reconfigure household practices?

2.3. SMART HOME USERS

Gendered biases and simplified views of users can collide with real-life settings when technologies are implemented in homes that are characterized by differentiated social roles, interrelated practices, and complexity. A research interest in nuancing the understanding of the users and exploring relational and contextual aspects of SHT has therefore grown during recent years (Mennicken, Vermeulen, and Huang 2014; Wilson, Hargreaves, and Hauxwell-Baldwin 2014; 2017). As mentioned in the beginning of this chapter, Wilson, Hargreaves, and Hauxwell-Baldwin (2014) find that, even though smart home research has been dominated by 'functional' and 'instrumental' views, there is a minor but growing branch of research representing socio-technical perspectives, e.g., within sociology, anthropology, and STS studies. What especially distinguishes socio-technical perspectives from functional and instrumental ones is a focus on *relations* in the former, both the technologies' relation to the broader society and to the users and social practices:

"The socio-technical view of smart homes is distinctive in arguing that such [i.e., smart] technological developments always, and necessarily, co-evolve with broader and longer-term societal changes that may include indirect and unintended consequences. Smart homes are important and interesting precisely because of these potentially transformative but as yet unknown effects. Social practices within everyday life at home may be combined or scheduled in new ways" (Wilson, Hargreaves, and Hauxwell-Baldwin 2014, 467, brackets added).

As these authors point out, the socio-technical view is concerned about how technology relates to social practices and how the smart home might be transformative. Several scholars have made significant contributions to addressing these questions (Röpke, Christensen, and Jensen 2010; Takayama et al. 2012; Paetz, Dütschke, and Fichtner 2012; Strengers 2013), highlighting that SHTs are socially disruptive (Hargreaves and Wilson 2017; Hine 2020). Thus, evaluations of smart homes suggest that the technology is rarely domesticated smoothly and it influences social roles and practices as well as already-existing technological solutions. As Hargreaves, Wilson, and Hauxwell-Baldwin (2018) formulate it, one has to ‘learn to live’ in a smart home. People use different strategies to adapt to the disruptions to which SHTs may lead, for instance, by using only some of the technologies’ functions or creating work-arounds (Hargreaves, Wilson, and Hauxwell-Baldwin 2018; Larsen and Gram-Hanssen 2020). Based on an in-depth qualitative study, Hargreaves, Wilson, and Hauxwell-Baldwin detect four themes that are central in households’ domestication of SHTs: 1) the technologies are both technically and socially disruptive; 2) they require forms of adaptation and familiarization from householders that can limit their use; 3) learning to use the technologies is demanding and time-consuming with little support available; and 4) there is no significant evidence that the technologies will generate substantial energy savings (Hargreaves, Wilson, and Hauxwell-Baldwin 2018, 136). On the contrary, there is a risk that they may generate further intensification of energy consumption, as also noted in the other studies referred to above.

People have different starting points and qualifications when it comes to engaging with smart homes and use the technologies in different ways. This is both influenced by variations in interests, existing knowledge, and competences as well as by prior technological experiences. Thus, different forms of user engagement exist from the more tech-savvy to the sceptical or reluctant, which impacts on how the technologies are used (Larsen and Gram-Hanssen 2020). One form of user engagement can be characterized by a DIY approach, which often relates to users with an interest in and perhaps prior experience with programming, relating to the technology as a hobby, and working on making it ‘homey’ (Takayama et al. 2012).

There are not only differences in how households engage with the technology, but also within the household itself. Thus, some household members may engage more or less with technology, and there tends to be one person who is primarily in charge of managing the technologies (Takayama et al. 2012; Nicholls, Strengers, and Tirado 2017). This finds expression in gendered imbalances relating to domestic roles and the daily organization of housework (Kennedy et al. 2015; Strengers et al. 2019) as described in the previous section, with important implications for power and control in the home.

2.3.1. A NOTE ON THE HOME

Since SHT is implemented in homes, the way we understand ‘home’ as a concept influences our understanding of the technologies in general. As has been increasingly recognized across various disciplines engaged with the home, e.g., architecture, history, geography, psychology, and sociology, a home is not only a physical structure (an apartment or a house), and householders are not just passive inhabitants using the house in an ‘intended’ or predictable way. Rather, both physical and social aspects need to be acknowledged in the concept of home (Ellsworth-Krebs, Reid, and Hunter 2015; Mallett 2004; Blunt and Dowling 2006). Home can be understood as a unit of social organization in which social categories, roles, and relations are (re)produced (Ellsworth-Krebs, Reid, and Hunter 2019). Technologies play a central role in this process, as they also shape the home as a social organization. In Sadowski, Strengers, and Kennedy’s (2021) formulation, the home can be seen as “an ever-changing assemblage of technologies that shapes the organisation and division of housework and supports certain models of what that work entails, who does it and for what purposes” (p. 2). As such, studying domestic technologies is a lens for understanding the meaning of home as a unit of social organization.

2.3.2. DIGITAL HOUSEKEEPING

As mentioned in the introduction, ‘digital housekeeping’ has proved to be a useful concept in studies of homes and technologies. Digital housekeeping relates to the activities involved in the installation and maintenance of SHTs, such as selecting, purchasing, programming, testing, repairing, replacing, adjusting, and troubleshooting. Introduced by Tolmie et al. (2007), digital housekeeping was not initially applied with a focus on gender. However, in later smart home studies, gender has emerged as a key theme. For instance, studies have shown that it is often men who perform digital housekeeping, and some scholars conceptualize it as a kind of gendered (Strengers and Nicholls 2018) or masculinized tech-work (Chambers 2020).

Relating to gender, Chambers (2020) problematizes the gendered power imbalances that arise with the unequal distribution of digital housekeeping: “Reluctant or powerless to relate to this masculinised smart agency, women encounter the smart home as an alien and precarious space” (Chambers 2020, 313). When men spend an increasing amount of time on digital housekeeping, from which women are often excluded, women are likely to become even more responsible for the traditional housework and daily chores. In other words, the gendered digital housekeeping risks reinforcing the division between digital and traditional housekeeping (Strengers and Nicholls 2018; Kennedy et al. 2015; Chambers 2020). As mentioned previously, domestic technologies risk reinforcing the role of women as responsible for ‘traditional’ housekeeping and the role of men as primarily responsible for technology

and technical chores. The uneven use of SHTs and gendered forms of digital housekeeping therefore need ongoing attention and critical investigation, not only in relation to overcoming digital inequality and uneven access to technologies, but also in relation to challenging normative gender divisions. To understand how these gender roles and divisions are produced, reproduced, and possibly resisted, homing in on everyday practices has proved valuable. Theories of social practices, for example, enable such an enquiry which will be elaborated in the next chapter. There, I will delve further into the theoretical framework that has guided my research throughout the PhD. In the four journal papers, I draw on this framework in different ways, although core concepts and ideas are shared across the papers.

CHAPTER 3. STUDYING SOCIAL PRACTICES

Being located within the home, SHT simultaneously shapes, and is shaped by the daily activities, routines, and social organization of the home. In other words, the smart technologies become a part of everyday life. Theories of practice explicitly focus on the activities, routines, and organization of everyday life, and therefore make a useful framework for the study of SHT. In this chapter, I will point to some of the major characteristics of theories of practice which provide the theoretical ground of the dissertation.

3.1. THE ORIGIN OF THEORIES OF PRACTICE

At the turn of the millennium, Schatzki, Knorr-Cetina, and Savigny (2001) identified a shift in contemporary theory calling this the *practice turn*. The authors describe how throughout the twentieth century, contemporary theory has generally been characterized by a culturalist understanding of the social as something rooted in symbolic structures, enabling and constraining agents to interpret the world. However, more recently, theories of practice have paved the way for an analytical focus on practices as the key to understanding the social (Schatzki, Knorr-Cetina, and Savigny 2001; Reckwitz 2002b). This implies analytical attention to the routinized and collective forms of behaviour and attention to the ordinary and perhaps less-visible aspects of everyday life and to the *material structures* surrounding it (e.g., technologies). Furthermore, shared understandings, habits, collective routines, embodied knowhow, and practical competences are of particular interest in this regard (Warde 2005; 2015).

Rather than a demarcated and unequivocal body of theory, theories of practice (also referred to as (social) practice theory) comprise a heterogeneous framework of approaches and concepts, all with social practices at the centre of analysis. A number of scholars have attempted to identify the main characteristics of a practice theory to distinguish it from other social science theories, with one of the main characteristics being the objective to bridge the structure-actor-duality that has dominated much classical sociological thinking (Schatzki, Knorr-Cetina, and Savigny 2001; Reckwitz 2002b). Practice theory draws on ideas of Bourdieu (1977, 1990), including his concepts of habitus and praxeology, and Giddens (1979, 1984), including elements from his structuration theory. Both Bourdieu and Giddens emphasize dynamic, flexible, and emerging aspects of practice and agency, where the structural context is not seen as fixed or external to social actors but as interrelated, acting as both a medium and outcome of practices.

3.2. WHAT IS MEANT BY SOCIAL PRACTICE?

Practices can be defined in various ways. Schatzki (1996; 2002) defines practices as sayings and doings situated in specific times and places. Another often-cited definition is that of Reckwitz (2002b) describing practice as:

“[A] routinized type of behaviour which consists of several elements, interconnected to one other: forms of bodily activities, forms of mental activities, ‘things’ and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge” (Reckwitz 2002b, 249).

Although different perspectives and formulations exist, common to these newer definitions of social practice is the inclusion of elements as constitutive of practice, and the interconnection between these elements (see Gram-Hanssen 2011 for an overview and comparison between different definitions and conceptualizations of elements). As an attempt to simplify and clarify the constitution of practices, Shove, Pantzar, and Watson (2012) developed a model based on three elements only that bring together and overlap with elements from other definitions. In Shove, Pantzar, and Watson’s synthesizing model, the elements are: 1) material; 2) competence; and 3) meaning. The first element, material, comprises, e.g., technologies, objects, things, resources, and infrastructures. The second element, competence, covers different forms of practical and embodied knowledge, understandings, and skills. The third element, what the authors regard as the ‘trickiest’, is meaning: tricky, because there has been less agreement within theories of practice about what meaning entails. Shove, Pantzar, and Watson define meaning as relating to emotion, motivation, and mental activities (Shove, Pantzar, and Watson 2012, 23). Comprised of these elements, practices are further defined by the interdependent relations between the elements and can be understood as outcomes of the elements’ ongoing integration.

3.3. CONTINUITY AND CHANGE

In theories of practice, one can distinguish between two different notions of practice: practice as ‘entity’ (a result of collective achievement and historical formation) and practice as ‘performance’ (the individual’s reproduction and transformation of the practice entities). In this, individuals are seen as both ‘carriers’ and ‘performers’ of practice (Schatzki 1996). For practices to be effective (that is, to remain as an entity over time) the links between the elements must be renewed continually (via practice performance). Understanding change and continuity in practices, i.e., understanding change and continuity in everyday life, entails studying the elements that constitute practices and how these elements are interlinked. Thus, a change in one or more of the elements leads to a change in the given practice, as the relations between the elements are reconfigured (Gram-Hanssen 2011). Relating to SHT, an example could be replacing a manual radiator valve with a smart thermostat. This involves a change

in the material element, and, at the same time, the very practice of heating is changed. Thus, with a smart thermostat, heating no longer involves adjusting a valve manually as the thermostat does this automatically. Not only does the materiality change in this process, the competences needed for heating also change, for instance, competences for operating an app become necessary. Thus, a change in the material element of a practice reconfigures its other elements, changing the practice itself.

Change is generally a central theme within theories of practice. As Schatzki formulates it, social life is a “complex and developing mosaic of continuity and change” (Schatzki 2016, 40), and practice theory is concerned with both: social stability and social change. Materiality plays a central role in this as the introduction of new appliances and technologies, for instance in the home, can be the occasion for such change. Change does not occur from one day to the next, but usually takes place over a longer period in which a new appliance becomes ‘normalized’. Normalization should not be understood as a final state of domestication, but rather as an ongoing process in which the role of the material objects is dynamic and constitutive of social order (Hand and Shove 2007; Shove, Pantzar, and Watson 2012). Thus, both continuity and change are involved in practices, and material objects are part of this change.

Change in materials and practices will often involve processes of learning. Particularly relevant to learning is the concept of practical intelligibility, referring to what makes sense for a person to do in a given situation, i.e., an intuitive feeling or direction for what to do next when performing a practice. In Schatzki's (2002) terminology, the practice nexus is linked together through practical understandings (the knowledge of how to do something), rules (e.g., principles or instructions), telos or teleo-affective structures (the goal of a practice), and general understandings (overall shared beliefs, e.g., religious). While practical intelligibility provides impetus and directionality to actions of the individual performer of practices, it is through practical understandings – the knowledge of how to go on in something – that the actions are carried out. When learning takes place, practical intelligibility is extended, and the result of this is augmented operability, referring to how one becomes more skilled in performing a practice (Schatzki 2017).

Augmented operability links and mediates between shared collective practices on the one hand and learning biographies of individual practitioners on the other. Thus, a focus on learning paths and different learning biographies is needed in studying how learning takes place. Schatzki's development of a practice theoretical framework for studying learning among other things builds upon the influential work of Lave and Wenger (1991) and their notion of ‘situated learning’. As Schatzki writes, the practice theoretical approach to learning should not be seen as a break with the ideas of these scholars but rather as an extension:

“Upholding practice theory does not require jettisoning the traditional conception of learning and adopting a new conception that defines learning as coming to participate in practices. [...] What the ontology

of practice theory provides to students of learning is what it provides to students of any aspect of social life, namely, a conception of the site where their topics of concern play out: learning, like life itself, transpires in the plenum of practices” (Schatzki 2017, 41).

Thus, the practice theoretical framework for studying learning does not contrast with, e.g., Lave and Wenger’s conceptions, but rather the framework involves a certain focus in terms of the *site* of analysis, namely, as situated within social practices.

3.4. MATERIALITY IN AND AROUND PRACTICES

One of the elements that distinguishes the newer branch of practice theory from the ideas of, e.g., Bourdieu and Giddens, is an interest in the role of the material (Reckwitz 2002a; Røpke 2009; Shove, Pantzar, and Watson 2012). This focus marks a general reorientation within social theory that Reckwitz (2002a) detects in his account of practice theory compared to classical social and cultural theories. Thus, most practice theory scholars regard the material as integral to social practices, rather than reflecting underlying structures of society as it is conceptualized in classical sociological accounts, or as cultural theories that focus on the material as symbolic objects or objects of knowledge. Thus, theories of practice do not operate with underlying structures as within classical sociology, nor with symbolic meanings as in cultural theories of the late twentieth century. Rather, there is one flat level of reality and that is social practices (Reckwitz 2002a). As such, theories of practice represent a ‘flat ontology’ (Schatzki 2016).

As described above, Shove, Pantzar, and Watson’s (2012) ‘three elements’ model represents materiality as an element constituting practices through an ongoing integration with competence and meaning in social practices. This view of materiality as an integral component of practices is also present in Reckwitz writings:

“(…) certain things or artefacts provide more than just objects of knowledge, but necessary, irreplaceable components of certain social practices, that their social significance does not only consist in their being ‘interpreted’ in certain ways, but also in their being ‘handled’ in certain ways and in being *constitutive, effective elements of social practices*” (Reckwitz 2002a, 210, emphasis added).

With a slightly different approach, Schatzki regards materiality not as a constituting element *in*, but rather as a central arrangement *for* practices. With his notion of ‘material arrangements’ he describes materiality as “a set of interconnected material entities” (Schatzki 2010, 129) which he divides into four categories: “humans, artefacts, organisms, and things of nature” (p. 129). The material is to be understood as a dimension of social life, a dimension of society. Although Schatzki regards materiality as “part of, a constituent of, social phenomena” (p. 141), the material is

thus not part of practices as in Shove et al. or Reckwitz's account, but interrelated with practices:

"Human coexistence is inherently tied, not just to practices, but also to material arrangements. Indeed, social life, as indicated, always transpires as part of a mesh of practices and arrangements: practices are carried on amid and determinative of, while also dependent on and altered by, material arrangements." (Schatzki 2010, 130)

From these two perspectives, 'material elements' and 'material arrangements' can be seen as conceptualizations reflecting "basic ontological difference" (Shove, Watson, and Spurling 2015, 279). However, there are similarities in that both deem the role of materiality as central to the performance of practice.

In the 'three elements' model (which has shaped the theoretical framework for the papers in this dissertation, among others, chosen for its straightforward analytical applicability), various forms of materiality are not differentiated. However, in later writings, Shove develops a way to distinguish between different material roles, which she argues can be useful in the analysis of forms of materiality that are more in the 'background' of practices, e.g., infrastructures (Shove 2016). In this, she distinguishes between devices, infrastructures, and resources. Since devices are often interacted with directly (e.g., smart home devices), analysing practices in which these are a part is relatively straightforward. However, when, for instance, analysing "flows of goods and transformation of energy" (Shove 2016, 167), the differentiation between material roles can provide insight into the interlinking of practices and materialities on various levels. Furthermore, "recognising the fluid status of things and their role in the foreground, in the background, and in spanning between different practices" (p. 166) can be useful since "the 'line' between device and infrastructure is sometimes subtly, sometimes dramatically repositioned through processes of automation and delegation" (p. 166-67). Although attention to these forms of repositioning has not been an explicit part of analysis in the journal papers, it is relevant to include in understanding the consequences of SHT implementation and points to future possible lines of research (an elaborated discussion of future research directions will be presented in the final chapter, Chapter 6, Section 6.4: *Smart home materialities*).

3.5. A NETWORK OF PRACTICES?

By focusing on materiality, theories of practice diverge from earlier eras of social theory. As Schatzki (2010, 127) notes: "the most prominent social ontologies have ignored materiality". Schatzki's explanation for this 'ignorance' is the historical separation between, on the one hand, society and the human and cultural realm, and on the other hand, the natural and the physical surroundings. Although theories of practice have played an important role in bringing materiality to the fore in the analysis of social life, it is important to note that this is not the only, nor the first

theoretical perspective that has shown an interest in physical matters. STS studies and actor-network theory (ANT) have been important in establishing the socially constitutive role of the material world by drawing attention to artefacts, objects, and all the ‘missing masses’ (Latour 1992) that have been absent in much earlier social theory.

While several similarities between theories of practice and STS perspectives and actor-network theory are evident, there are notable differences. As Schatzki (2010) writes:

“The networks of actor-network theory closely resemble what I call “arrangements”. Both are composed of interrelated material entities. Arrangements, however, are only one of the two principle sorts of phenomena that make up social phenomena. The second is practices, which have no pendent in actor-network theory.” (p. 134).

Gram-Hanssen (2019) makes a similar point when she writes:

“The focus on the activities, rather than only the things and intermediaries, together with the inclusion of a teleo-affective element in holding practices (sayings and doings) together, gives more direction in an empirical investigation compared with ANT and its more limited focus on the linkages between all things. The practice theoretical perspective, by contrast, also conceptualises how practices are interlinked with each other and are routinised in temporal rhythms. In this way, the practice theoretical perspective better matches with an everyday life perspective in terms of what makes sense to people in their doings.” (p. 245-46).

Although both Schatzki and Gram-Hanssen underline the focus on and conceptualisation of practices as distinguishable in practice theory, it can be said that actor-network theory *does* take an interest in practices and the connections between them. For instance, the notion of the script (Akrich 1992) mentioned in the previous chapter brings attention to the ways that practices of designers and those of users are connected. Thus, what the actor-network perspective, among others, has in common with practice theory is the focus on how things and people are in flux and are connected through activities. In Shove’s (2016) comparison between the theoretical traditions, she writes:

“The common point is that things which are mobilised in practice are not merely ‘used’. Rather, such things are implicated in defining the practice itself. In this role, things-in-action matter for the division of labour in society” (p. 159).

One aspect in which theories of practice and actor-network theory do differ substantially is regarding the relationship between humans and non-humans. While

theories of practice have tended to maintain a clear distinction between the two, humans and non-humans are often granted equal status within STS studies, for instance, in Latour's (1993) 'symmetric anthropology'. In this, materiality is "understood as 'artefacts' or 'things' that necessarily participate in social practices just as human beings do" (Reckwitz 2002a, 208).

Practice theory, on the contrary, has been primarily concerned with humans as performers and carriers of practice, especially in the influential work of Schatzki (1996; 2002; 2010). However, some practice theory scholars have raised the question of whether practice theory should rethink the role of the material, and in line with actor-network theory and ideas from Latour, grant materiality the same status as humans in the performance of practice (Reckwitz 2002a; Gram-Hanssen 2019). This discussion has been pushed further by the rapid advance in technological development and processes of automation within recent years. In the book, *Social Practices and Dynamic Non-Humans* (eds. Maller and Strengers 2019), different authors discuss the ambivalent status of dynamic materialities (e.g. social robots, smart technologies, and 'invasive' species) in practices and present ideas on whether and how to incorporate these non-humans as a kind of practice performers. Despite the many different and sometimes contradicting ideas on human and non-human agencies and practice performances in practice theory, these questions on materiality and emerging technologies (e.g., SHT, which is advancing in levels of automation and artificial intelligence) are likely to continue to take inspiration from and exchange ideas with the field of STS studies and actor-network theory.

While the STS and actor-network frameworks have not been explicitly used in this dissertation, they are appropriate to mention here as shaping and establishing influential understandings within the social sciences and humanities of the socially constitutive role of technology. Although not engaging with the concept of non-human agency in my analyses, this could be a relevant path to pursue in future studies of SHT, not least in the wake of automation levels advancing, changing human-technology interactions, and shifting the role of human agency. I will discuss this in the final chapter, Section 6.4: *Smart home materialities*.

CHAPTER 4. METHODOLOGIES

To investigate the smart home from both a professional and an everyday life perspective, several different methodologies have been deployed throughout this dissertation. While these have been briefly presented in the papers, this chapter will elaborate on the methodologies in more detail. First, I will describe how my point of departure in theories of practice has shaped my methodological approach. Second, I will reflect on the implications of conducting empirical studies during a pandemic, elaborating on the advantages and disadvantages of applying online methods. I will reflect on my own position as a social scientist with limited prior knowledge about the smart home field, requiring me to “learn the technical language” (Bruun, Krause-Jensen, and Saltofte 2015) of my research participants. The chapter provides an overview of my methodological journey that involves interviewing smart home professionals, conducting show-and-tell home tours and household interviews, and deploying ‘in- and outsider’ auto-ethnography.

4.1. STUDYING SMART HOME PRACTICES

As mentioned in the previous chapter, theories of practice have served as a guiding framework for the structure, analysis, and methods chosen for this research. The social practice approach focuses on the taken-for-granted, mundane aspects of everyday life, useful for illuminating the different elements that comprise practices in which SHT plays a role.

In my empirical studies, which include home visits and qualitative interviews, I explored how SHT is involved in everyday household practices and how the technology is developed in professional practices within the industry. User and professional practices exemplify how practices are interconnected across different sites and together form social order (Nicolini 2009). As mentioned in Chapter 2 (*The smart home designed and lived*), the practices of technology users and professionals relate to each other via norms and ideas inscribed in the technologies (Akrich 1992). Change in one practice may result in changes in other practices, not only across different sites but also internally within households. For instance, automating the practice of laundering can influence standby-consumption practices (Gram-Hanssen 2011). Applying practice theory entails an analytical focus on the tangible everyday rather than on people’s self-reflections, interpretations, and evaluations. In relation to SHT, I have sought to uncover aspects of stability and change, learning, routines, roles, relations, meanings, and competences within practices (Shove et al. 2012).

Practice theory is not tied to a specific set of methods. Rather, by placing practices at the centre of analysis, the theoretical framework generates certain types of questions

which are in turn defining for the choice of methods (Shove 2017). Applying practice theory in research entails a focus on the ‘doings and sayings’ of everyday life (Schatzki 1996; 2002). In Hitchings’ (2012) paper, ‘People Can Talk about Their Practices’, he advocates for the value of interviews in studies of social practices. As a response to the opposing assumption that because practices are embodied, they cannot be understood solely through words, Hitching argues that people can, in fact, recount their practices by describing mundane actions and, together with the researcher, reflect on how they perform their routines.

Practice theory is concerned with understanding the ‘mundane performativity’ of social life which Halkier and Jensen (2011) point out relates to a methodological blurring between data from interviews and data from participant observation. Drawing on Atkinson and Coffey’s (2003) constructivist approach to methodology, Halkier and Jensen argue that social interpretation and performativity is not only at play in interview settings (e.g., when people talk about their practices), but also in participant observation and other forms of qualitative data-generative settings. Thus, performativity appears as a central concept in studies of practices, relating to the move beyond a strict division between what people do and what people say; both events and accounts can be seen as ‘enactments’ (Atkinson and Coffey 2003).

Although this dissertation is comprised of relatively small-scale qualitative studies, this does not mean that analytical generalization is unachievable. In the paper ‘Methodological Practicalities in Analytical Generalization’, Halkier (2011) points to the ambivalent and contested status of analytic generalization within the social sciences and humanities. While some scholars believe that generalizations made from qualitative research is neither possible nor desirable, others take the opposite stance – including Halkier, who argues that analytical generalization is achievable when applying qualitative methodological strategies.

With reference to Søndergaard (2002), Halkier notes that: “Just as generalizing should not be universalizing, generalizing should also not produce stable representations but rather representations characterized by contingency and instability” (Halkier 2011, 788). The findings of this dissertation should be seen in this light: as not reflecting universality but rather instability, with analytical significance and generalizability understood as a “contextbound typicality” (p. 788). This term denotes how “social relationships, categories, and processes are *both uniquely and recognizably* performed at the same time” (p. 788, emphasis added). Furthermore, analytical generalizability in qualitative research should aim at recognizing and describing “dynamisms, ambivalences, conflicts, and complexities that constitute various overlapping contexts” (p. 788). In my research endeavour, analytical awareness has been given to such dynamisms and ambivalences, not with an aim of producing universalizing results but rather of showing the complexities, contradictions, and mechanisms of SHT implementation and its implications for household practices.

4.2. DATA COLLECTION IN A PANDEMIC

From the beginning of my PhD, I had planned to conduct in-depth qualitative interviews with both households and smart home professionals in participants' homes and workplaces respectively. The home visits were aimed at enabling insights into how the technologies are placed and used in the households, while the purpose of workplace visits was to obtain an understanding of the professional environments that form the SHT field. Furthermore, conducting interviews in person is a widely acknowledged method for building rapport and creating a confidential and informal atmosphere while also enabling informal observations on site simultaneously (Bernard 2006). In addition, the gesture of meeting people in their homes or workplaces at a time suiting them expresses obligingness and enables research participants to stay comfortable, on their own ground.

I had initially planned to begin my data collection with household interviews and home visits as the everyday-life perspective constitutes the core focus of my study. However, a few months after initiating the PhD research, Covid-19 struck. Like the rest of the world, Denmark entered a lock-down period in March 2020 and the prospects of physical meetings were poor. As the home visits were central to my empirical studies, I decided to postpone these (which I did manage to conduct in-person, as described later in this chapter) and, instead, to proceed with the interviews of professionals, which could more easily be adapted to an online format. Although I had hoped to conduct these in person and meet the professionals in their workplaces, seeing their offices and organizations, the online format had its advantages.

Within the last decade, various studies have pointed to the new possibilities that online interviews enable in qualitative research (e.g., Deakin and Wakefield 2014; Lo Iacono, Symonds, and Brown 2016). Different opinions on the pros and cons of remote interviews versus in-person meetings exist, for instance, relating to interview length and degree of detail (Irvine 2011; Johnson, Scheitle, and Ecklund 2021). Although there are limitations to the online interview, during the pandemic, online methods proved not only valuable but also crucial to proceeding with the qualitative research format (Lobe, Morgan, and Hoffman 2020; Lupton 2020).

On the positive side, remote interviews are often an easy way to provide a calm, quiet setting (Johnson, Scheitle, and Ecklund 2021). Furthermore, the online format is flexible in time and space; for instance, it does not require transportation. As I interviewed professionals across all parts of Denmark and a few located abroad, this flexibility was a clear advantage. The online interview can either take a synchronous (real-time) or asynchronous (non-real-time) form (Janghorban, Roudsari, and Taghipour 2014). As with the in-person interview, synchronous online interviewing enables instant interaction, which I chose to do. The synchronous online interview is usually planned for a specific time when it is expected to begin, e.g., in a scheduled Skype meeting, which can be less time-demanding for the research participant than a

physical meeting. When interviewing busy professionals in their working lives, this aspect was a clear advantage, both in terms of planning and conducting the interviews.

As the flexibility of the online interview provide convenient conditions (Janghorban, Roudsari, and Taghipour 2014), the online format may have resulted in more research participants being willing to participate. In addition, the lockdown necessitated online interactions as ‘a new normal’ in many people’s working lives, and consequently, my research participants had quickly familiarized themselves with video calls and electronic meetings. Moreover, some researchers have found the online format able to give a sense of anonymity that may increase confidentiality and authenticity in some cases (Bargh et al. in Janghorban, Roudsari, and Taghipour 2014).

The flexibility and swiftness of online interviewing can also be seen as a weakness. Online interviews do not allow for informal observations and the chances of initiating further topics related to, e.g., physical props or the chance of meeting other potential research participants are clearly limited. Online interviews are in this way more narrowly staged. However, as noted in the previous section, human experience is generally narrated and both observation and narration are forms of social action (Atkinson and Coffey 2003). Online interviews can be seen as one form of social action that is often more formal, requires that the researcher manages to build rapport with the participants, and, as Lobe, Morgan, and Hoffman (2020) note, pays special attention to ethical issues and consent processes. In this regard, I had prior phone conversations with research participants informing them of the research project, answering any of their potential questions, and sending them project information letters and consent forms to sign prior to the interview. These documents described the research objectives and explained how the research data from participants would be stored and protected in line with the General Data Protection Regulation (GDPR) and general research ethics. The consent form was produced with guidance from the university’s legal department (Kontraktenheden, Aalborg University) who approved its wording (see information letter and consent form in Appendix B).

I conducted the online interviews in Spring 2020 using Skype. Skype enables audio and video recording and is a software that qualitative researchers widely use (Lobe, Morgan, and Hoffman 2020). Furthermore, the university recommended Skype as it has a subscription that ensures a safe connection and secure data storage. Most of the interviews were conducted without camera, because of the varying quality of my home internet connection where the call quality was better without video, and because many participants preferred this mode. The ‘zoom’ fatigue is a well-known concept to most people working from home during the pandemic, referring to the fatigue experienced from looking into a screen during video calls while remaining presentable and performing professionally. Furthermore, the voice-only Skype interview can create a more confidential space (Sipes, Roberts, and Mullan 2022). Overall, online methods proved valuable in overcoming the challenge of qualitative data collection in an era of social distancing (Lobe, Morgan, and Hoffman 2020). In the next session, I

elaborate on the content and recruitment process for the interviews undertaken with smart home professionals.

4.3. RECRUITING AND INTERVIEWING PROFESSIONALS

The interviews with smart home professionals form the basis of my first paper. To understand how SHTs are being created and by whom, I wished to explore the ideas behind, and also the practices involved in, technology development, mapping the different professional actors and the connections between them. However, with a background in anthropology and no prior experience with SHT (either professionally or personally), I had first to form an idea of *who* I wished to talk to. Thus, I began a process of mapping the different products in the smart home field and getting an overview of the businesses behind it by mapping the smart home industry and understanding who the most important actors were in Denmark where my study was located.

4.3.1. RECRUITMENT

With my initially limited smart home knowledge, entering the field required that I educated myself by learning the ‘technical language’ of the potential research participants (Bruun, Krause-Jensen, and Saltofte 2015, 75). Apart from reading commercial ads, grey literature, and research papers, I contacted two researchers from engineering with knowledge, experience, and connections in the smart home field (anonymized here for confidentiality of participants). These two researchers helped me to map the field in Denmark and provided me with the contact information of several smart home professionals, among others, key actors in management positions. With the references from these researchers, I contacted several professionals via email and follow-up phone calls. In a few instances, the contacts were not relevant, but referred me to other participants. Aiming for a broad range of smart home businesses, I gathered a participant sample that included representatives of large companies working with, e.g., heating, energy, and telecom technologies and smaller businesses working with apps and software development. I included participants from both research and development (R&D) and management positions in the study as representing different steps in the production chain to help map the smart home ecosystem. As described in paper 1, the total sample comprised 11 participants from various positions within the field (see Appendix C for descriptions).

4.3.2. WALK-ALONG INTERVIEW

Apart from online interviews, I arranged an on-site interview with a participant working as an electrician establishing SHT in people's homes. This on-site visit was possible some months after the online interviews since Denmark allowed an intermittent reopening in the summer and fall of 2020. I wished to interview this participant in-person to supplement my knowledge on SHT development with insights into professional installations and the smart home as a construction site – an area that reflects a different aspect of the SHT professional field. Due to space limit in paper 1, I only briefly mention the use of this method. However, I wish to note here that the walk-along interview gave important insights both for the paper and for this research process.

When visiting this participant at the construction site, I conducted a walk-along interview to explore the participant's workday and the various processes that are part of a professional SHT installation. As Kusenbach (2003) notes, 'going along' with the participant while interviewing constitutes a hybrid between participant observation and interviewing, providing a window into the participant's interactions with their physical and social environment, in this case, the luxury villa construction site and the large team of professionals building an extension to the house, including electrical installations with various forms of automation. This participant was the head of the electricians' team and owner of the SHT electrical business. The interview differed from the other interviews with professionals by incorporating on-the-ground considerations and concrete challenges related to SHT implementation while also allowing a more direct dialogue with the user.

4.3.3. APPROACH AND THEMES

In paper 1, I approach the development of SHT as a practice field (Nicolini 2009), focusing on concrete activities, tasks, forms of collaborations, skills, and knowledge (see Appendix E for the interview guide). Before entering the field, my original research question was broad: *How is SHT developed and envisioned by smart home professionals?* During the iterative process of engaging with my empirical material and in the analytical process inspired by Nicolini (2009) among others, I revised the research questions to: *How is the notion of convenience tied into SHT development and how might this impact on user practices and sustainability?*

Being interested in both the ideas and the practices of technology development, an objective of the interviews was to map the mundane activities of professionals' everyday work lives. To enhance concreteness, I asked about examples, situations, and scenarios; for instance, asking professionals to describe a typical workday from beginning to end and including as many details as possible. To understand the

organization of the companies represented, I asked whom participants worked with, both internally and externally. To explore user-imaginaries (see Section 2.1: *Design, visions, and user imaginaries*) I asked participants whether they conceptualised specific user types and if (and how) they involved users.

As the participants represented different fields and positions within the smart home industry, interviewing helped me understand the heterogeneity of the industry and the connection between the various actors. However, despite this heterogeneity, there were shared themes and general trends observable from the interview material, and although the number of participants was limited, I found saturation throughout the interviews as also noted in paper 1. One theme I had not yet begun to approach was gender. However, it became clear at this point that the smart home field is highly male dominated.

4.4. RECRUITING AND INTERVIEWING HOUSEHOLDS

In exploring the role of SHT in everyday life, household interviews combined with home visits constituted a central part of my empirical investigations. Although Covid-19 limited physical meetings in 2020, Denmark intermittently reopened in the fall. Luckily, I was able to conduct household interviews in person³, visiting people with installed smart technologies all over the country during the months of September and October 2020.

4.4.1. RECRUITMENT

Initially, I was interested in how advanced forms of automation change aspects of agency within homes. For that reason, I aimed to recruit participants with the most comprehensive smart homes, having the ‘smartest’ technologies available rather than aiming at socio-economic representation (which other parts of the eCAPE project would cover). Thus, in recruiting participants, I targeted smart home ‘frontrunners’. As a way of approaching them, online forums provided a good source, representing proactive communities with shared interests (Rahm-Skågeby 2011). In five Danish smart home Facebook groups, I found people with an outspoken interest in the technology, most of whom had comprehensive smart homes with different devices. Following these Facebook groups enabled recruitment and aided small-scale online ethnography. By browsing through the groups and studying posts and debates within these virtual communities, I formed an idea of the current state of affairs, challenges,

³ However, one out of the 15 interviews was conducted online because of a concern for Covid-symptoms. This interview included a video home tour.

and debates (Dalsgaard 2016). Finally, I posted a call for research participants in the five groups, briefly describing the project and containing my contact information (see the posted research call in Appendix G).

Since the number of people who responded to the research call was limited, I accepted everyone who responded ($n=9$) as all appeared relevant, having a combination of several SHTs, such as digital voice assistants and connected lights, and in many cases also having smart heating control, smart alarm systems, and robotic vacuum cleaners. During the recruitment process, another lockdown seemed to be approaching (Denmark entered its second lockdown a few months later, in December 2020). Wishing to include more participants in the sample, I sped up the recruitment process, supplementing the sampling strategy with snowball sampling. Thus, two additional households were added via referral from the participants from the Facebook groups. Furthermore, I inquired within my personal network. The male partner of a female acquaintance had smart technologies installed and this couple was recruited and interviewed. Since SHT is not a sensitive topic, I found that our personal acquaintance did not affect the interview situation. Referral from this couple enabled three more households to participate, with whom I had no prior personal acquaintance. Although geographical spread was not a requirement in my study, the 15 participating households were drawn from all over Denmark: from Zealand, Jutland, and Funen, including both rural and urban areas (see Appendix D for specifications on the research participants⁴), thus representing a wide geographical scope.

As noted in papers 2 and 3, people living in smart homes represent different levels of technology engagement, e.g. some identify as ‘tech-savvy’ while others are more reluctant (Larsen and Gram-Hanssen 2020). While the male participants in my sample belonged to the tech-savvy category, the female participants were often more reluctant to interact with the technologies. Thus, the households were characterized by internal differences in user engagement, which affected the course of the interview and which I elaborate further below.

As stated in papers 2 and 3, I encouraged respondents to bring their partner for the interview which 12 out of the 14 did. Furthermore, in one interview, a teenage daughter participated. In total, I conducted 15 household interviews, comprising 26 participants of which 14 were men and 12 were women. All participants received a document with information about the research project and a letter of consent explaining their rights as research participants and how their personal data would be stored and protected (see Appendix A). Apart from agreeing to have their data collected for the research project, the participants could choose to tick an additional box in the consent form that allowed me to take photos in their homes for visual

⁴ Appendix D also lists the smart heating households that participated in the study by Line Valdorff Madsen that is part of paper 3 (further described in Section 4.5: *The smart heating study*).

fieldnotes and potential use in research dissemination. All participants gave their written consent to a recorded interview and photo recording respectively. In the case of children under 18, parents gave their written consent on behalf of their child, in addition to the latter's oral consent to participate (only relevant in one case).

4.4.2. APPROACH AND THEMES

The practice focus has guided my interviews in which I asked about concrete use of and activities with SHT, aimed at uncovering routines, roles, and relations in and between practices. In the households, I explored not only the practices in which smart technologies were directly involved, e.g., digital housekeeping, smart heating, or lighting practices, but also general routines and other household practices that did not include the direct use of smart technologies. I asked participants to describe the technologies and their use, exploring competences, meanings, and forms of knowledge related to them (see interview guide in Appendix F).

As gender was not initially a focus in my study, I did not specifically ask about this aspect. However, gender automatically arose as a key theme. Gendered differences were apparent in all interviews conducted, noticeable in the recruiting process (where only men responded to the Facebook posts), and during interviews and home tours where male participants most often took the leading role in talking about the technologies and showing their properties. Female participant also spoke and participated, although with different perspectives (as noted in papers 2 and 3). The reluctant attitude of many female participants sometimes found expression in silences during the interviews, which also served as meaningful empirical data.

Before switching on the audio recorder, I met with the research participants, often over a cup of coffee, informing them about the research project, introducing myself, my background, and the research project, and letting them read and sign the consent declarations. Following this initial introduction, with the participants' consent, I switched on the recorder, beginning the interview by asking participants to introduce themselves and then asking initial questions about the number of technologies they had and for how long they had had them, as a way to break the ice and to achieve an overall picture of their smart home engagement. Beginning the visit with telling them about myself and asking them to do the same helped to create an informal and confidential setting and to build rapport between the research participants and myself as a researcher (Bernard 2006).

4.4.3. HOME TOURS

As part of the interviews, I asked participants to take me on a home tour to show and tell about the different technologies, their use, and their role in the routines of the household, for instance, in relation to frequency, timing, and temporality. Usually, the home tours were conducted early in the interview after initial questions and introductions. The ‘show-and-tell’ home tours provided an opportunity to conduct observations and take photos while interviewing. During the home tours, we went through the different rooms in which I took photos of the different technologies with a digital camera. This served the purpose of creating visual field notes, capturing the atmosphere and details from the interview situation (Rose 2006).

Furthermore, the tours helped spark participants’ memories while enabling a more dynamic and informal conversation. When both partners in a couple participated in the tour, they would often focus on different things, sometimes displaying frictions or disagreements which gave me insight into their roles and dynamics. Talking about the specific technologies led to a conversation about concrete scenarios, examples, and anecdotes. Beginning the interview with a tour seemed to loosen the atmosphere, creating a more confidential, informal space for the remaining interview which took place sitting down, usually at the dining table. Home tours have been used in other studies of home technologies (e.g., Strengers 2010; Hargreaves and Wilson 2017; Larsen and Gram-Hanssen 2020) and is an acknowledged method for building rapport and studying everyday practices without disturbing the intimate space of the home (Serjeant, Kearns, and Coleman 2021).

4.5. THE SMART HEATING STUDY

In the third paper of the dissertation, co-authored with Line Valdorff Madsen, a study conducted by Madsen of households with smart heating installed by outside operators is included. Thus, although I did not conduct this study, I mention it here as it appears in the third paper of the dissertation. This study, like my own PhD, was also part of the eCAPE project and shares the focus on technology use and everyday practices, however in particular on heating practices, comfort, and energy consumption.

The participant sample of the smart heating households represents more mixed users than the ‘frontrunner’ participants in terms of technology interest and engagement. Participants were recruited from two different parts of Denmark: an island including various housing types and locations, and a wealthy area of a big city with newly built apartments. The apartments were part of a smart energy demonstration project in which smart heating and IHDs (In-Home Displays) were installed prior to occupants moving in as part of the building process. On the island, households participated in a smart heating demonstration project where electrical space heating was controlled

remotely by the energy utilities leading the project. In total, seven people from the island and five from the apartments participated (see Appendix D for a summary of the research participants).

As part of the interviews, Madsen conducted ‘show-and-tell’ home tours similar to the ones I conducted in the ‘frontrunner’ study, mapping routines, everyday practices, and technology use. The idea to combine the two studies into a paper emerged from the co-authors discussing the similarities and differences detected between them.

4.6. TRANSCRIPTION, CODING, AND ANALYSIS

The interviews with professionals were transcribed by myself while the ‘frontrunner’ household interviews were transcribed partly by myself and partly by a student assistant. I analysed the interviews in the software tool NVivo by coding the transcripts for themes related to everyday practices, materials, competences, and meanings. While my research interest was broad in the beginning and my approach explorative, many of the questions asked during the interviews were open-ended. In reading and rereading the transcripts, the analytic process was also characterized by an open, iterative coding process in which I discovered prevalent themes central to the findings. For instance, gender quickly emerged as a key theme in the household interviews, although it was not what I had initially set out to study. Later, I undertook a second round of coding of the ‘frontrunner’ household interviews and the smart heating household interviews together with Madsen as part of writing paper 3. In this process, we applied a narrower focus on gender, competences, meanings, and divisions of housework. In the analysis of the interviews with professionals, the themes of convenience, interoperability, and user passivity arose as central themes.

The analytic processes thus established general patterns and similarities in the empirical data which are reflected in the analytic findings presented in the four journal papers. Quotes used in the papers are both illustrative of these general analytic patterns while at the same time exemplifying the differences and nuances in the empirical material. Coding and analysis are part of making categories from, and in dialogue with the material, while also being shaped by the parallel inspiration that the researcher is continually immersed in when interacting with and building upon the work of fellow scholars (Golden-Biddle and Locke 2006).

In general, analytic processes during research can be difficult to demarcate in space and time, and the analyses have been in a state of continually becoming, not only through processes of coding in the NVivo software, but also through discussions with

colleagues in the SCEP research group⁵, via conference presentations, in the writing of papers (with and without co-authors), and in rewriting processes shaped by peer-reviewers' comments. To pin down the analytic steps taken during this journey cannot be done in any straightforward chronological manner, but should rather be seen as a process and dynamic interplay between reading and revisiting, taking steps back and forth. While the analytical strategies deployed in the first two papers took a more open-ended form, with a bottom-up approach to the analytical themes (reflecting an early stage of the research), the analytical strategies in papers 3 and 4 had a narrower practice theoretical focus, particularly on competences and meanings (paper 3) and on learning (paper 4).

4.7. WHY NOT LONG-TERM FIELDWORK?

As noted previously in the chapter, there are no predetermined right or wrong methods in a study of social practices (Shove 2017). However, there will be advantages and disadvantages when choosing one set of methods over another. Although the household interviews and home visits enabled valuable insights into people's everyday life with SHT, including social practices and gender dynamics, the household studies did not allow, for instance, long-term observation. SHTs are able to disrupt social relations in various ways, e.g., they can be seen as enablers of conflict (Furszyfer Del Rio 2022), and long-term fieldwork involving participant observation could potentially have enabled a deeper insight into the different ways that technologies influence social relations, practices, and everyday life. However, long-term fieldwork requires considerable time, and as I decided to include the professional perspective in my research, I needed to prioritize this aspect as well. As Pink (2009) notes, the intimate space of the home can pose challenges to more extensive forms of participant observation and can be an impractical and even inappropriate site for research interference in the form of long-term fieldwork (p. 9).

As a way of overcoming the challenge of long-term access, the show-and-tell home tours served as a useful alternative, as described in the previous section, providing 'in-situ' insights on the performance of everyday practices. As Serjeant, Kearns, and Coleman (2021) note, "a mobile method such as Home Tours which considers the place of the research encounter, enables 'being there' and serves to stimulate deeper considerations by participants when talking about their practices" (p. 5). In this way, the home tour partially compensated for the lack of long-term presence.

⁵ SCEP (Sustainable Cities and Everyday Practices) is located at the Department at the Built Environment, Aalborg University Copenhagen. Website: <https://vbn.aau.dk/en/organisations/forskningsgrupper-for-baeredygtige-byer-og-hverdagspraksis>

A way of providing long-term insights was alternatively enabled by incorporating auto-ethnographic material. My supervisor, Kirsten Gram-Hanssen, had kept an auto-ethnographic diary about her life with smart technologies over the course of 20 months, and being able to work with this empirical material provided a way of including longitudinal perspectives and chronological insights as will be elaborated below.

4.8. IN- AND OUTSIDER'S AUTO-ETHNOGRAPHY

The fourth paper of the dissertation, co-written with Toke Haunstrup Christensen and Kirsten Gram-Hanssen, concerns learning to live with smart technologies. Based on Gram-Hanssen's auto-ethnographic smart home diary, the paper provides a chronological account of failures and successes that she and other members of her household experienced. Gram-Hanssen began her auto-ethnographic writings in November 2018 as part of the eCAPE research project. At that time, she already owned a smart alarm system, and she and her husband installed a smart heating system. Later, they purchased an electric car (EV). The diary depicts Gram-Hanssen's experiences with these three technologies (the car was included as a technology in the diary as it has various smart properties and is connected to their home via Wi-Fi and Bluetooth). Paper 4 provides a table illustrating the process of the diary writing chronologically.

There exist different versions of the auto-ethnographic 'self-narrative', from indigenous insider accounts to academic self-reflections (Butz and Besio 2009). Gram-Hanssen's diary belongs to the latter category, as "academics' systematic efforts to analyse their own biographies as resources for illuminating larger social or cultural phenomena" (Butz and Besio 2009, 1660). To date, very few auto-ethnographic studies of smart homes exist, and applying this method to the smart home enables valuable insights, among others, on emotional and relational aspects. As Hine (2020) notes:

"The auto-ethnographer is well placed to reflect on the affective dimensions of the lived experience of smart technologies, exploring the emotional response to the technologies themselves and of the relationships that they mediate with other household members present and absent" (Hine 2020, 33).

The relationships with other household members were a relevant lens for studying learning as it enabled a juxtaposition between different competences and learning biographies, showing how learning is shared across collective practices, and how one learns to go on *in*, or sometimes *without*, interaction with others, either present or absent. Since Christensen and I are not authors of the diary, it is relevant to discuss whether there is sense in using the term 'auto-ethnography' here, or if 'in- and

outsider' should be added to the term. The analytic process and writing the research paper has been a close collaborative process between the three authors in which discussions and interpretations of the diary went back and forth. The auto-ethnographic approach puts the researcher as a subject of critical analysis. As outsiders to the diary, Christensen and I had a different perspective from Gram-Hanssen, and fruitful discussions resulted from the joint analytic process in which we coded themes, such as 'individual learning biographies', 'social relations and learning', and 'learning through material interactions'. By combining the 'outsider' perspective of Christensen and myself with Gram-Hanssen's own perspective, the term 'in- and outsider's auto-ethnography' seems appropriate.

As mentioned previously, the household interviews were conducted during a one-time visit. As a supplement to this, the inclusion of the auto-ethnographic diary into my dissertation has enabled an in-depth insight into the long-term workings, frictions, barriers, and learning processes that living with smart technologies involve. The opportunity for working with this material has provided a ground for a more detailed account of what goes on in the smart home on an individual level, homing in on the daily experiences and frustrations. The collaborative reading of the diary has enabled Gram-Hanssen to see her own experiences from the outside, adding an extra layer to her auto-ethnographic endeavour.

The four research papers of the dissertation comprise the empirical findings and analytic results that the different methodologies described in this chapter have facilitated. In the next chapter, I present the papers and their key findings before reflecting on their connections and contribution as whole in the concluding discussion (Chapter 6).

CHAPTER 5. SUMMARY OF PAPERS AND KEY INSIGHTS

Each of the four journal papers of the dissertation cover different empirical and analytical aspects of my research, and together they represent the research findings. The papers build on four different empirical studies (see Figure 1): interviews with SHT professionals, conducted by myself (paper 1); interviews and home tours with households living with SHT, conducted by myself (papers 2 and 3); interviews and home tours with households with smart heating installed by outside operators, conducted by my co-author and secondary supervisor, Line Valdorff Madsen (paper 3); and an auto-ethnographic diary written by my co-author and principal supervisor Kirsten Gram-Hanssen (paper 4). This chapter will provide an overview of each of the papers and summarise their key insights covering smart home development and household practices related to various themes, including gender and learning.

Figure 1: Empirical studies and journal papers produced for the dissertation

	Paper 1	Paper 2	Paper 3 Co-author: LVM*	Paper 4 Co-authors: THC* and KGH*
Interviews with SHT professionals by LKA*	X			
'Frontrunner' household study by LKA*		X	X	
Smart heating study by LVM*			X	
Auto-ethnographic diary by KGH*				X

*LKA: Line Kryger Aagaard. LVM: Line Valdorff Madsen. KGH: Kirsten Gram-Hanssen. THC: Toke Haunstrup Christensen

5.1. PAPER 1. THE MEANING OF CONVENIENCE IN SMART HOME IMAGINARIES: TECH INDUSTRY INSIGHTS

The first paper explores how SHT is developed in the smart home industry by mapping different actors, practices, and ideas behind the technology. Qualitative interviews with 11 SHT professionals working with different kinds of technologies (e.g., smart heating, smart home apps, and smart energy management) and representing different positions and levels of the production chain (e.g., sales, development, and management) provides an empirical insight into the composition and complexity of the industry. Despite the many different actors and processes involved, the participants shared visions of the technology and prevailing ideas about the users. The paper analyses these sociotechnical imaginaries and how they link to certain user imaginaries.

Convenience is known to be a widespread ideal and vision of the smart home industry. However, rather than taking this notion for granted, the paper seeks to deconstruct its meaning by looking at how it is brought into being within practices of the industry. Thus, the paper examines the concept of convenience by looking at its entanglement in technology development practices and its implications for user practices. The research question is: How is the notion of convenience tied into SHT development and how might this impact on user practices and sustainability?

The paper found that a prevalent vision among the SHT professionals was that the technology should not require too much interaction or skill on the users' behalf. Preferably, SHT should run smoothly in the background, leaving users' everyday practices unchallenged while relieving them of mundane tasks and making daily life more comfortable and convenient. Thus, convenience was connected to a user imaginary characterized by passivity. This connection can be problematic, however, as passivity means that users are disengaged from their own energy consumption and resource use, potentially leading to an increase in these resources with arguably unsustainable consequences.

Secondly, the paper illustrated how the meaning of convenience is closely connected to the notion of interoperability, meaning that different SHTs should be easy to integrate into the same system and thereby ensuring a convenient and flexible smart home. This close relationship between interoperability and convenience has important implications for sustainability as higher levels of interoperability promotes and potentially contributes to an acceleration of SHT purchases and use with consequences for energy consumption, resource use, and e-waste. Thus, a consideration of these matters should follow when promoting interoperability in the name of convenience.

Finally, by considering the SHT industry as a practice field, the paper demonstrated how the meaning of convenience is brought into being through various practices of

design, sales, and management, among others, located within a complex landscape of actors ranging from small independent businesses to large tech ‘titans’, such as Google and Amazon, that are highly influential in setting the agenda for SHT development. Acknowledging and understanding this SHT ‘ecosystem’ is important to comprehend and challenge the visions and ideas embedded in the technologies that the industry promotes, and to critically engage with a concept like convenience that is an outcome of this powerful commercial field.

5.2. PAPER 2: WHEN SMART TECHNOLOGIES ENTER HOUSEHOLD PRACTICES: THE GENDERED IMPLICATIONS OF DIGITAL HOUSEKEEPING

The second paper explores how SHT plays a role in daily life and how social practices are reconfigured with SHT implementation. Based on 15 ‘frontrunner’ household interviews (26 participants in total) including show-and-tell home tours, the paper presents empirical findings on the way SHT becomes part of new and existing household practices and how these practices are highly gendered. Thus, the paper investigates the gendered implications of SHT installation on everyday practices and domestic relations in the home.

It takes work to install and manage the many technologies in a smart home, and ‘digital housekeeping’ is a concept that has gained resonance in the literature to capture this work and the new practices that emerge with SHT implementation. In the paper, the gendered implications of digital housekeeping are explored and how it relates to the performance of traditional housework. While existing research shows that digital housekeeping is often a male domain, the paper also found this to be the case. However, in unfolding digital housekeeping and its relation to other household practices, the analysis showed that male participants’ performance of digital housekeeping was not only related to traditionally male-coded categories of technology control and calculation, but also to practices traditionally coded as feminine, namely practices of home decoration and cognitive labour. This shows how gendered categories and practices are not fixed, but are rather fluid, being continually (re)produced and potentially changed.

Another finding of the study was that being the primary digital housekeeper also implies a central position of control. Since many female participants were sceptical of the SHT and often reluctant to interact with it (e.g., with digital voice assistants), they would, to a lesser degree, integrate the technologies into their everyday practices, refrain from using them, or use them through their male partners in some cases. Male participants held the necessary competences to a greater degree, and were generally more interested in interacting with the technologies. This tendency is likely to reinforce the technical as a male domain, leading to gendered forms of digital

inequality. Furthermore, when male members of the household are more engaged in the digital housekeeping, they are likely to participate less in traditional housekeeping, such as cooking and manual cleaning practices, which reinforces the gendered divide between digital and traditional housekeeping.

Another finding of the paper was that male participants tried to be inclusive towards their female partners in their SHT implementation, encouraging them to accept and appreciate the technology by creating technological solutions to accommodate female partners' needs. Nevertheless, there seemed to be a gendered difference in terms of what SHT solutions were considered 'need to have' and 'nice to have', relating to the question of whether digital housekeeping should be seen as housework or leisure. Such a dilemma points to a need for more research on time use in relation to housework and SHT to understand SHT's gendered consequences in the long run.

5.3. PAPER 3: TECHNOLOGICAL FASCINATION AND RELUCTANCE: GENDERED PRACTICES IN THE SMART HOME

The third paper, co-authored with Line Valdorff Madsen, further explores the gendered expressions of digital housekeeping by comparing the study of 'frontrunner' households with a study conducted by Madsen of households with smart heating installed by outside operators. While a significant divide was found in the 'frontrunner' households between digital and traditional housekeeping, including clear gendered differences in terms of technology use and engagement, divisions between digital and traditional housekeeping were less apparent in the smart heating households. This difference between the two studies led to a question of what triggers gendered divisions in SHT implementation and to an exploration of the implications of these differences. With a focus on social practices, the paper delves into not only the material properties of the different technologies, but also into a deeper analysis of the practices performed in the two studies and their other constituting practice elements, namely, competence and meaning.

The analysis homes in on four cases, two from each study, that were generally illustrative of the division of practices and gender dynamics in the two studies respectively. The detailed descriptions of these four cases provided illustration of the households' compositions, values, competences, roles, and everyday practices. In the 'frontrunner' households digital housekeeping was associated with meaningful technological engagement, fun, and enjoyment by the male participants, while the female participants were more reluctant, expressing less engagement and fewer competences for integrating the technologies into their everyday practices. In the smart heating households, the digital housekeeping was more evenly distributed between male and female household members and, contrary to the male

‘frontrunners’, these participants associated digital housekeeping with necessary chore-doing and mostly valued the technologies when they did not require too much interaction.

In the smart heating households, housework was generally sought to be minimized, both the traditional and the digital. Participants in these households shared the responsibility for learning to operate the technology, appearing more equally competent, and the meanings associated with the digital housekeeping were, among others, time and money savings combined with consuming less energy and living more sustainably. In the ‘frontrunner’ households, on the other hand, the SHT did not always save time, on the contrary, male participants would spend much time on the digital housekeeping and did not express any environmental concerns as part of their SHT engagement and motivation.

The comparison between the two types of households illustrates the importance of competences and meanings in the division and performance of (digital) housekeeping. Relating the findings to existing literature on energy technologies, the paper concludes that knowledge on chore-doing and gendered responsibilities and household practices are crucial to include in the development of future smart homes and emerging energy technologies, both from a gender equality and a sustainability perspective.

5.4. PAPER 4: MY SMART HOME: AN AUTO-ETHNOGRAPHY OF LEARNING TO LIVE WITH SMART TECHNOLOGIES

The fourth paper of the dissertation, co-authored with Toke Haunstrup Christensen and Kirsten Gram-Hanssen, builds on an auto-ethnographic diary kept by Gram-Hanssen over the course of 20 months. Drawing on concepts from theories of practice and learning theory, the paper investigates how learning within the smart home takes place. In engaging with empirical findings from the diary, the paper seeks to develop a theoretical framework for analysing learning in interaction with smart technologies and simultaneously calls for further research in this field.

Drawing on the work of Schatzki, the paper uses the concept of practical intelligibility, which implies knowing ‘how to go on’ in the performance of practices, thus attaining what Schatzki terms ‘augmented operability’ (Schatzki 2002). Augmented operability implies an extension of the practical intelligibility which is enabled through acts of learning. The paper explores learning with SHT by focusing on three technological systems: a smart alarm connected to lights, a smart heating system, and a smart electric vehicle (EV).

While auto-ethnographic studies can provide detailed empirical insights and dynamic meta-reflections, the use of the method within SHT research has been scarce.

However, with an emerging technology like SHT, the method proved useful for understanding its implementation in daily interactions, including the subtle and sometimes steep learning curves that could be seen in the smart home. The diary thus provided an insight into both the challenges and frustrations of learning with SHT, the successes, and experiences of empowerment. Furthermore, the auto-ethnographer's household composition (living together with her husband and their two grown sons regularly visiting and sometimes engaging with the new technologies) showed the importance of different learning biographies intersecting and diverging, and to the collectivity of learning.

Learning in the smart home was related to programming, digital rulemaking, finding and correcting errors in the installations, and charging the EV. What initiated acts of learning were situations in which the auto-ethnographer was confronted with not knowing how to go on within a practice. The analysis showed how learning did not represent a linear curve but unfolded in dynamic processes. Thus, the analysis demonstrated learning in three ways: learning in interaction with materiality (e.g., trying out new settings); learning via remote assistance support; and learning through social relations. When augmented operability arose after learning, this could result in having new ideas, e.g., for additional SHT installations and settings. Interactions with others and the intersection of learning biographies also resulted in the development of new learning goals.

CHAPTER 6. CONCLUDING DISCUSSION

In this final chapter, I will synthesise the findings of the journal papers by discussing and elaborating on the most important themes that have emerged across them. In this, I will reflect upon the implications of the dissertation's united contribution to research on smart homes. Thus, the following discussion facilitates an integrated narrative shaped by the research findings as they thematically cross cut the papers.

The exploration of the smart home from both a user and a professional perspective have demonstrated how SHT is not merely 'used' as intended by developers; rather, the technology is integrated into everyday practices, reconfiguring them, and introducing new practices, changing and reinforcing domestic roles and housework, causing conflict, workarounds, and more.

While paper 1 illustrated smart home professionals' visions of the SHT as a smoothly integrated enabler of convenience, papers 2 and 3 showed how SHT is enacted in numerous ways and with different gendered implications. Paper 4 showed how new and changed practices related to SHT implementation require processes of learning. In other words, smart home professionals' visions of the SHT far from reflect people's daily interactions with the technology. The *first section* of this concluding discussion will elaborate on this complex relationship between professionals' imaginaries and the lived experiences of households.

As papers 2 and 3 showed, SHT implementation has significant gendered implications which became a key theme in the household analyses, and the *second section* of the present chapter will discuss the findings related to gender across the papers, summarizing their contribution to this topic.

While this dissertation has studied emerging technologies and everyday practices, it has also facilitated a study of the home. The home not only makes up the setting for SHT implementation; it is simultaneously being shaped with this implementation, reconfigured, and created. Thus, a *third section* reflects on the (changed) meaning and (re)making of home when smart technologies move in.

The practice theoretical framework has provided a focus on competences and meanings across all papers, and provides analytic sensitivity towards materiality. However, a thorough elaboration of SHT's material properties was beyond the scope of the journal papers. The *fourth section* of this chapter will, therefore, provide analytical reflections on materiality, showing how this perspective points towards future directions for research on SHT and social practices.

The *fifth and final section* summarises the conclusions by showing how the journal papers address each of the research questions and how the dissertation as a whole contributes to the overall research objective.

6.1. IMAGINARIES AND PRACTICES (UN)RELATING

Although most research conducted for this dissertation has focused on the lived experiences of SHT households (papers 2, 3, and 4), the professional perspective of SHT developers (paper 1) has also provided critical insights. Importantly, by bringing the two perspectives together, it is possible to see how professional and user practices both relate, diverge, and influence each other. This chapter section will describe how findings across the papers demonstrate the relationship between the practices and visions of the industry and the daily experiences and everyday practices of households. In the first part of the section (Section 6.1.1: *Passive or active users?*), I discuss the found discrepancies between professional visions and user practices, and in the second part (Section 6.1.2: *The shaping of standards and needs*) I reflect on the implications for consumption, energy, and demand.

6.1.1. PASSIVE OR ACTIVE USERS?

As described in Chapter 2 (*The smart home designed and lived*), sociotechnical and user imaginaries not only influence the design of technology, but also, they shape and project our futures. Thus, research must pay attention to these imaginaries to guide the technological and smart transition in both an environmentally and socially sustainable direction. Paper 1 explores professionals' sociotechnical imaginaries, analysing how they relate to user imaginaries. The professionals' visions of the technology as enabling smooth automation and enhancing comfort and convenience (leaving existing everyday practices unchallenged) relate to an idea of the SHT user as passive and disengaged, e.g., from operating the technology and from energy management. These latter 'mundane tasks' should therefore be taken care of by technology. As such, sociotechnical and user imaginaries reflect a certain view of how everyday practices should look (Strengers and Nicholls 2017, 88).

While paper 1 depicts these quite coherent user imaginaries, the three remaining papers of the dissertation show that people engage with the technologies in very different ways. The participants in the smart heating study (paper 3) and the female participants in the 'frontrunner' households (papers 2 and 3) reflect the user imaginaries expressed by the interviewed SHT professionals in some respects. Most of these participants preferred to interact with the technologies as little as possible and expressed a wish for them to not disrupt their everyday practices. Despite these

preferences, their actual interactions with the technologies were characterised by very different scenarios, often bringing challenges and frustrations. The male participants in the ‘frontrunner’ households (papers 2 and 3) on the contrary enjoyed controlling, playing, and tinkering with the technologies and not minding disruptions, which were difficult to avoid when purchasing new technologies, trying out new settings, or making updates.

Another finding from paper 2 was that the ‘frontrunner’ participants showed an awareness that not all members of the household were interested in changes or tolerated disruptions. Therefore, they took on the responsibility, with pleasure, to oversee the digital housekeeping with an aim of running their smart homes as smoothly as possible. As both papers 2 and 3 show, digital housekeeping requires competences and engagement, and as paper 4 illustrates, it involves critical processes of learning. Being the principal digital housekeepers, the male ‘frontrunner’ participants differed from other research participants in being not only interested in the technology as part of performing a practice, but also showing interest in the technology ‘in itself’. In this way, they displayed a further level of patience and motivation than, e.g., their female partners and members of the smart heating households – and also differed substantially from the user imaginaries of the SHT professionals that were characterised by passivity. Nor did the male ‘frontrunners’ conform with Strengers’ (2013; 2014) description of the industry’s user imaginary ‘Resource Man’ (described in Chapter 2, Section 2.1.3: *Resource Man, Flexibility Woman, and the Smart Wife*), as they did not appear to be calculating, optimizing agents, utilizing the technology in a predictable or straightforward manner. Rather, the male ‘frontrunners’ expressed playfulness, experimenting, and tinkering with the technologies, also in non-‘optimizing’ ways.

6.1.2. THE SHAPING OF STANDARDS AND NEEDS

The papers illustrate different forms of engagement with the technology, and these differences have consequences for the use of energy. For the most part, male ‘frontrunner’ participants did not express concern about energy savings (some explicitly stating that SHT was more likely to increase their energy consumption), in line with smart home owners in other studies (Jensen et al. 2018). This corresponds to the SHT professionals’ imaginaries of SHT users as not caring too much about the energy perspective (a “cold benefit”, as one of the SHT professionals called it in paper 1 (Aagaard 2021, 574)). Several female partners however did highlight this as a reasonable basis for accepting new SHT (e.g., like Eva in paper 2 (Aagaard 2022, 12)). Also, the smart heating households in paper 3 did express environmental concerns and emphasized sustainability as important to their SHT choices, and this was reflected in the auto-ethnographic study as well (paper 4).

While the qualitative research conducted for this dissertation cannot draw conclusions on households' actual energy consumption, it does indicate that (gendered) practices involving SHT and their related meanings have important implications for energy consumption. As described in paper 1, user passivity means that users are alienated from their own energy consumption; they are not confronted with it and cannot always control it, meaning that it becomes potentially invisible. Relating to the existing literature, increasing implementation of new (smart) technologies and appliances in homes has been linked to new household standards and the normalization of these new standards (Nyborg and Røpke 2011; Nicholls and Strengers 2019). The accumulation of appliances and increasing digitalization involve (masked) energy consumption, and SHT potentially contributes to this by normalizing new energy demanding practices and accelerating expectations to comfort, cleanliness, and convenience – what Shove (2003) terms the 'three C's'.

These findings exemplify how consumption is an outcome of interrelated practices (Shove et al. 2015). The issue of energy and (un)sustainable consumption practices relate to the question of 'need to have' versus 'nice to have', as described in paper 2. This issue was somewhat contested in the 'frontrunner' households in which male and female participants had different opinions about the usefulness and necessity of the different technologies. The technologies in the 'frontrunner' households were diverse and included many gadgets, while those in the smart heating households and in the auto-ethnographic study were fewer and less 'spectacular'. While heating is considered a necessity (existing prior to 'smartification'), it can be debated whether smart lighting and music control are 'need to have' or 'nice to have'. However, many participants had become used to these technologies, indicating that the SHT *creates* new needs. This relates to Watson and Shove's (2022) point about needs being created, and how specific materialities (i.e., SHT) invoke demand, encapsulating the interplay between materialities and professional and user practices.

In terms of the practice theory framework, people are not to be seen as merely users of technology but rather as carriers of practices in which technologies take part. In people's performance of practices, both practices and technologies are shaped (Watson and Shove 2022; Reckwitz 2002a). Thus, when referring to the 'user perspective' throughout this dissertation, the term has been applied for simplifying reasons and should be considered with caution. The papers together show that, rather than 'using' the technologies, people are putting them into *practice* (and vice versa: technologies take part in shaping and creating practices, being more or less accessible to practitioners depending on the competences and meanings that are part of the practice in question). With a focus on social practices, the papers of the dissertation provide insights into 'technologies-in-practice' (Suchman et al. 1999) rather than having explored 'technologies in themselves' (in their ideal forms as envisioned by developers).

6.2. THE IMPORTANCE OF GENDER

Although not initially planned as a focus of this dissertation, the gender perspective was impossible to ignore. Arising as a central theme in the household studies, gender also shed new light on the professional perspective as described in Chapter 2, Section 2.1.3: *Resource Man, Flexibility Woman, and the Smart Wife*. In the writing of paper 1 on SHT professionals, I did not have a gender focus. But after conducting the user studies, the gender perspective illuminated how both the industry and the user side is male dominated, as men design and operate the SHT business and are the primary users (Strengers and Kennedy 2020; Chambers 2020). My participant sample of SHT professionals also reflected this general trend, as only two out of twelve participants were women. The existing gender imbalance within the industry and among users (meaning that men design for men) both produces gendered divisions in use and uptake of SHT and risks further reinforcing traditional gender roles (Strengers and Kennedy 2020). From a constructionist approach, the framework of feminist technology studies has shown how gender and technology shape each other, thus challenging perceived notions of technological neutrality (Wajcman 1991; 2004; 2010; Cockburn and Fürst-Dilić 1994; Faulkner 2001). Following this tradition of thought, the present section will elaborate on the gendered implications of the research findings, particularly with a focus on digital housekeeping and the division of housework. The section is structured around the key analytical findings that emerged from the household studies.

6.2.1. GENDER FLUIDITY AND THE (RE)PRODUCTION OF ROLES

The analyses in papers 2 and 3 reflected a fluidity and contestation of gender in the way it was both reproduced and changed in the interaction with SHT and in the performance of everyday practices. In the 'frontrunner' households, the clear gendered divisions in terms of SHT integration into everyday practices is illustrative of how digital housekeeping is described within the literature as a form of masculinized tech-work (Chambers 2020; Strengers and Nicholls 2018). In the 'frontrunner' households, male participants were the ones primarily responsible for purchasing, managing, and controlling the SHT, while female participants were more reluctant to engage with the technology and seemed to be 'tagging along', accepting the technology but not always appreciating or interacting with it. As argued in paper 2, and supported by existing research, such differences are likely to reinforce traditional gender roles, confirming 'the digital' as a male domain and 'traditional' housekeeping as female (Strengers et al. 2019; Strengers and Kennedy 2020).

However, when comparing the results with the smart heating households in paper 3, a participant sample characterized by less gadgets, the gendered division of practices was different. As argued in paper 3, the division of practices is not a result of inherent

gendered categories; rather, it relates to particular competences and meanings associated with the technologies. Although the clear gendered differences in SHT engagement, found in the ‘frontrunner’ households, potentially lead to a reinforcement of the division between traditional housekeeping associated with femininity and digital housekeeping associated with masculinity, this is not an inherent aspect of gender. As paper 3 shows, rather than gender in itself, the way technologies are integrated into practices is a question of competences and meanings, resulting in particular divisions of household tasks and responsibilities. When practices are starkly divided, traditional gender roles are likely to be reproduced. The differences between the ‘frontrunner’ households and the smart heating households were also linked to the particular forms of materiality that comprised the different SHTs (which will be further elaborated in Section 6.4: *Smart home materialities*).

6.2.2. COMPETENCES AND MEANINGS IN GENDERED PRACTICES

To understand the gendered consequences and possible inequalities that result from divisions of digital and traditional housekeeping, it is necessary to consider what digital housekeeping concretely entails in terms of housework and domestic chore-doing. Should (male) digital housekeeping be seen as a welcome expression of domestic labour finding a masculine form? Could SHT implementation lead to “more work for father”⁶ as Strengers and Nicholls (2018, 78) speculate? In paper 2, this question is related to whether SHT is considered as something nice to have or need to have (which also has implications for energy consumption, as described above in Section 6.1.2: *The shaping of standards and needs*). Does the technology resolve necessary housework or does it rather add on new (perhaps not ‘needed’) extra activities in the home? This question relates to Cowan’s (1985) work on the paradox of implementing new household technologies which eventually end up meaning more work because of accelerating household standards.

Although SHT is framed within the industry as something that saves people time and energy, in reality this is not always the case. As some of the male ‘frontrunners’ said, tinkering with the SHT did not save them time or energy, quite the contrary; they spent a lot of time on the technology out of interest, enjoying it because it was *fun* (with an awareness of the likelihood of increasing their energy consumption). On the other hand, for the smart heating households (paper 3) and in the auto-ethnographic study (paper 4), managing the technology was more of a duty, a mundane task that caused frustration not associated with pleasure or play. In these households digital housekeeping was shared between male and female participants. These findings show

⁶ A rephrasing of the title of Cowan’s (1985) seminal book, *More Work for Mother*.

how the gendered expressions of digital housekeeping is a matter of meanings ascribed to the practices performed and to the competences that people possess.

Thus, the papers together show that the role of SHT in the gendered division of housework relates to what type of housework the technologies resolve and how the balance between digital and traditional housekeeping is practiced and negotiated. For gendered consequences of SHT implementation in the long run, the findings highlight a need for more research on time use in households. The auto-ethnographic approach that paper 4 demonstrates could further provide longitudinal insights on daily gender dynamics. Although this paper does not focus on gender, it does show a direction for potential future studies, including how learning is important in mastering digital housekeeping, and how learning biographies play a role and intersect across household members in the process of ‘learning to live’ in the smart home.

6.2.3. POWER, CONTROL, AND CARE

An empirical finding from paper 2 was that male participants as primary digital housekeepers also expressed care and acts of inclusion towards other household members in their digital housekeeping. However, caring and inclusive SHT solutions would often relate to the monitoring properties of the technologies, inevitably reflecting the technological control and power of the principal digital housekeeper. The conflation between care and control in the smart home has been described by Sadowski, Strengers, and Kennedy (2021) who explore this in relation to the capitalized forms of care and digital surveillance that the smart home enables, capturing this tendency with their concept of ‘Big Mother’. While internal and external surveillance was not a main focus in the papers of this dissertation, the issue was touched upon and is important with respect to the social and gendered consequences of SHT implementation.

In the ‘frontrunner’ households, female participants in general expressed more concern about surveillance than their male partners, for instance, voicing a discomfort regarding the listening function of some of the SHT (paper 2). Participants (both male and female) had often made up their minds about setting some limits, e.g., regarding more explicit forms of surveillance. Most participants were for instance uncomfortable with the idea of video recordings inside their home. However, other more subtle forms of surveillance exist plentifully in the smart home, such as motion sensors and listening functions of voice assistants. As a male ‘frontrunner’ said: “I can see who is home and that’s kind of controversial. I mean, you have to be a family allowing this. [...] We have been married for over 30 years, we keep no secrets from

each other”⁷. When the digital housekeeping and technological control is unequally distributed, as in the ‘frontrunner’ households, unequal gendered consequences of privacy risks will follow.

The surveillance theme was also touched upon in paper 4 in which the auto-ethnographer reflected on (unwillingly) monitoring her house cleaner. Although gender was not mentioned explicitly here, the cleaner was a woman (like the majority of the global domestic workforce, e.g., cleaners and care workers (ILO 2021, 13)). Thus, these new forms of surveillance not only find gendered expressions between household members, but also in relation to new possibilities of monitoring (predominantly female) domestic workers. The surveillance practice, when accounted for in both papers 2 and 4, appeared to happen accidentally, as a kind of ‘side-effect’ of the technology. Regardless, or perhaps even more so, it exemplifies how the technologies have properties that are sometimes complicated to manage, raising moral dilemmas, and creating new privacy risks in the smart home.

Within a practice theoretical framework, “power must be understood as an effect of performances of practices, not as something external to them” (Watson in Mechlenborg and Gram-Hanssen 2020, 6). Related to gender, looking at everyday practices in households, including digital and traditional housekeeping, has enabled an insight into the gendered distribution of practices and mechanisms of power and control. In developing a practice theoretical approach to gender, Mechlenborg and Gram-Hanssen (2020) describe gender as something ‘threading through’ practices, arguing that “gender should not be considered a practice in itself. Rather, *gender is performed while we carry out the diverse practices that make up our everyday lives*” (p. 5, emphasis added). The performance of gender is shown to be diverse in the papers, both conforming to and diverging from traditional gendered categories. For instance, paper 2 illustrates how male participants, through their digital housekeeping, both express masculinized technological control (Strengers and Nicholls 2018; Chambers 2020), but also engage in activities traditionally associated with femininity, namely, home creativity (Pink 2004) and cognitive labour (Daminger 2019). In this way, male digital housekeeping can be seen as a way of performing ‘new domestic masculinities’ (Gorman-Murray 2008; Pink 2004). This illustrates how gender is both produced, reproduced, and changed in the daily performance of practices, and how traditional gender roles are by no means fixed or definite. Importantly, technological control is not bound to be a male domain, illustrated in both papers 3 and 4.

⁷ Quote translated from the Danish interview transcription. Interview transcriptions will be published in a data repository once they have been anonymized.

6.2.4. A NORMATIVE MAJORITY

While the studies of everyday life with SHT in this dissertation are limited to include opposite-sex households (which was not a deliberate choice, as stated in Chapter 4: *Methodologies*), it is important to note that inequalities and contestations are not limited to this type of household constellation. Gendered inequalities and power dynamics take many forms, and, as voiced by post-colonial and queer feminist scholars among others, gender is not a binary concept including only ‘male’ and ‘female’ categories. Rather, gender is fluid and continuously changing through time and across geographical contexts, intersecting with class, ethnicity, bodily ability, and more (Butler 2004; 2006; Taylor, Hines, and Casey 2010). As all the user participants in this research were white, middle-class, and lived predominantly in opposite-sex households, the empirical material does not represent intersectional diversity, but on the contrary reflects what can be seen as the normative way of life in Western households conforming to the nuclear family (Blunt and Dowling 2006; Mallett 2004). However, looking at white, middle-class, opposite-sex couples that (at least on the surface) conform to dominant norms and ideals of the Western home enables an understanding of how gender asymmetries are (re)produced, and how these asymmetries can be analytically deconstructed (Mechlenborg and Gram-Hanssen 2020; Butler 2004). As such, studying the normative majority enables critical reflections on the importance and value of gender equality and diversity. Integrating gender in the analysis of technological development is useful and necessary not only in adding value to research, but also within policy in ensuring inclusive and qualified innovation on an overall level across technology, research, and society, as also acknowledged on a political level by the European Commission (2020).

6.3. THE MAKING OF HOME

Studying SHT and everyday practices also implies studying what the home is and how it is changing. Not merely a setting for SHT, the home is being reconfigured through the new and changed social practices that the technologies take part in. As such, SHT is involved in the *making* of home, illustrating how the home is not only a place, but also a *practice* (Mallett 2004).

While paper 1 reflects an SHT industry that envisions the smart home as a place of comfort and convenience enabled by smooth and seamless automation, papers 2, 3, and 4 show that SHT implementation takes work, requires learning, and often involves creativity. These papers illustrate that SHT is not simply adapted to existing household practices, but that the technology reconfigures them, forms new practices, and becomes part of *homemaking* practices. The integration of SHT into everyday practices can thus be seen as a way of ‘doing home’ (Bowlby, Gregory, and McKie 1997).

In the studied households, SHT was used for creating certain home atmospheres or ambiances, for instance, with light settings (paper 2). The technology was also used for optimizing, supporting, and automating existing practices, such as heating (papers 3 and 4), and enhancing security with the installation of smart alarms (paper 4). As such, SHT was implemented for both aesthetic reasons as well as comfort, convenience, and security. Although the home is associated with normative meanings in Western societies, such as the home understood as a house, the home associated with family, or the home imagined as a calm and secure place, meanings and experiences of home vary according to class, gender, age, ethnicity, etc. (Gorman-Murray 2007; Mallett 2004). Scholars have shown that rather than a physical and stable place, home is continually being created and ascribed meaning in the performance of everyday practices (Blunt and Dowling 2006; Pink 2004). With reference to Pink and Mackley (2014), Madsen (2017) defines homes as “affective environments created through homemaking practices” (p. 37). The notion of ‘affective’ in this regard underlines the relational and emotional aspects that are also part of the making of home.

While comfort is generally valued in Western homes, in the Danish context, this specifically relates to the concept of ‘hygge’, or cosiness. As Bille (2015) points out, hygge is used to describe atmospheric qualities, and the term also “denotes a particular feeling of space and way of being together” (p. 58). As a form of homemaking, hygge can be achieved, for instance, by “creating indoor environments that include a warm home and lighting lamps and candles around the house” (Madsen 2017, 53-54). As such, values of comfort and cosiness in Denmark relate to analogue things; hygge is associated with candles, fireplaces, and cuddling up on the sofa. Can the digital facilitate hygge? Or does it disturb it?

There were different opinions about whether the SHT contributed to a nicer, more ‘homey’ atmosphere. Some participants were in favour of SHT supporting homeyness (e.g., male ‘frontrunners’), others less so (e.g., their female partners). Thus, although practices of home creativity could be seen as instances of homemaking, this did not necessarily result in all household members feeling more at home. In other words, SHT implementation as homemaking practices is both divided and sometimes contested. When professionals were asked about this aspect in paper 1, comfort and notions of cosiness underlined their smart home visions of SHT running smoothly, not disturbing family life, and supporting sociality. As a professional framed it, SHT should support the ‘warm benefits’ (Aagaard 2021, 574). However, papers 2, 3, and 4 show that the home can become a contested space when SHT moves in. The papers illustrate that different needs exist, and these sometimes clash in the making of home.

The professionals’ visions of technology supported existing ideas of home in paper 1, such as a warm, safe atmosphere, family life, and room for sociality. In the auto-ethnographic paper, SHT was among others implemented for automated heating, thus facilitating warmth, related to a way of homemaking that ensures comfort (Madsen

2018; Madsen and Gram-Hanssen 2018) and underpinning the notion of *hygge*. However, in paper 4, the auto-ethnographer and her husband had, for instance, encountered various problems, e.g., the heating did not work according to what they thought to have scheduled, disturbing their home life as a result. This both illustrates the vulnerability of the technological dependence and the importance of learning and mastering the technologies in the making of home, evident in paper 2, 3, and 4.

As described previously in Section 6.2.3: *Power, control, and care*, issues of privacy and surveillance often arise in the smart home. Such issues can clash with ideas of the home as a private and secure place. As Namian (2022) notes, “while culturally dominant ideals of a house in Western societies see it as a private, enclosed space [...] a house does not necessarily equate with the notion of ‘shelter’ or haven” (p. 335). SHT can disturb these notions as the technology involves digital control and monitoring, both internally among household members and externally in relation to data flows that move beyond the home connecting it with companies and breaking down barriers of intimacy. Although this theme was not the main object of analysis in the papers, it was touched upon by some participants voicing concerns about privacy issues. In relation to the meaning of home, these issues recast its connotations of shelter, haven, and privacy. As such, although SHT is involved in new homemaking practices and can facilitate warmth and aesthetic ambiances, its implementation in the making of home is contested and related to profound security and privacy issues. These new possibilities as well as challenges together recast the meaning and making of home.

6.4. SMART HOME MATERIALITIES

With reference to the practice theoretical ‘three elements’ model (Shove, Pantzar, and Watson 2012), SHT has in the journal papers been conceptualized as a material element in practices. However, as noted in Chapter 3, Section 3.4: *Materiality in and around practices*, materiality can take various forms and play different roles according to the performance of practices. In this section, I discuss how ideas from theories of practice can further reveal the role of SHT as a particular form of materiality. This is relevant not only to the present study of SHT but also to future research on emerging technologies.

Watson and Shove (2022) distinguish between different types of material-practice interactions relating to whether the materiality is engaged with directly, e.g., devices and appliances, or whether it is in the background of practices, e.g., infrastructures. Paper 3 compares different household engagement with SHT, and in this, competences and meanings are found to be central in the division and performance of housework. However, the two empirical studies in the paper represent quite different technologies. While the ‘frontrunner’ households are characterized by many different

devices and gadgets, among others relating to entertainment, the smart heating technology in the accompanying study is more in the background, forming part of the rather mundane practice of heating. As such, the different types of technologies invite different material-practice interactions (Watson and Shove 2022).

In Shove's (2016) review of materiality within practice theory, two overall conceptual differences are detected, namely, materiality conceptualized as one of three 'elements' comprising practices (Shove, Pantzar, and Watson 2012) or materiality as 'material arrangements' surrounding practices (Schatzki 2010). In the three elements model, Shove, Pantzar, and Watson (2012) do not distinguish between different forms of materiality. Nor does Schatzki (2010) distinguish between direct or indirect material-practice interactions. According to Shove (2016), this theoretical conflation is not necessarily a problem; the importance of the distinction simply depends on one's inquiry and object of study. However, when looking at infrastructures, for instance, it is useful to distinguish between different forms of materiality: does the object of study appear in the foreground, in direct interaction (e.g., devices), or does it appear in the background, as a backdrop to practices (e.g., infrastructures, electricity, data)? In relation to SHT, its status of relating to either device or infrastructure is ambiguous. In this dissertation, SHT has been explored primarily as manifested in direct interfaces and devices, implying direct interaction. However, a significant part of SHT's materiality *is* in the background, for instance, characterised by its connectivity (e.g., Wi-Fi, Bluetooth, Zigbee, and Z-wave) that enables remote control and connections between technologies.

SHT's reconfiguration of domestic practices is shaped by its materiality, among others comprised by flows of data and often internet dependency. Shove relates the growing dependence on technological systems, including internet dependency, to a "collective transformation in the material relations of many practices at once" (Shove 2016, 158). This means that, when infrastructures change, other material relations also change, as "things in the background are of necessity tied to things in the foreground and to the ongoing mobilization of things in action" (p. 158). The increasing flow of data and the growing internet-dependence can be seen as examples of such collective material transformations.

Things, objects, and technologies can switch status and change from being in the background to being in the foreground, depending on the practices in which they are entangled. Shove mentions automation as an example of this process: "The 'full' automation of heating or lighting systems removes the possibility of direct interaction, meaning that these services are actively provided by building managers and designers, but passively encountered by building occupants" (Shove 2016, 164). This point about the active engagement of building managers and designers and the passivity of occupants relates to the visions and imaginaries of the SHT professionals described in paper 1. However, as papers 2, 3, and 4 have shown, 'full' automation is difficult to accomplish and the SHT encountered in the households *did* imply many interactions. The nature and scope of this interaction, however, varied substantially.

While the SHT implementation involved direct engagement for some (i.e., the main digital housekeepers), it appeared more in the background for others, being sometimes inaccessible and ‘black-boxed’. Thus, material roles can be repositioned, depending on how they are integrated into the practices performed. These mechanisms are important to highlight as “uneven patterns of ownership and access are significant for discussions of social inequality” (Shove 2016, 166).

While such theoretical reflections have not received just elaboration in the journal papers, mentioning them in these final remarks of the dissertation indicates the extensive scope and complexity of these emerging and expanding technologies. The complexity of SHT’s very materiality invites further critical research on SHT and its implications for everyday life. To rephrase a quote by a professional in paper 1:

“The technology is so new in many ways that we do not entirely understand it yet. [...] Sometimes we just have to try something and then see how people will use it, in order to really understand what it is and what it does” (research participant in Aagaard 2021, 578).

Although this quote reflects humble watchfulness, it also underlines how the consequences of expanding and pervading digitalisation are still not fully grasped and that the industry is willing to experiment. To safeguard against unwarranted risks in the smart home ‘test laboratory’, continuing the research on SHT and emerging technologies is crucial.

6.5. CONCLUDING REMARKS

The aim of this dissertation has been to explore *how SHT is implemented in households and how this has implications for everyday practices*. To conduct this inquiry, qualitative studies of users and of professionals have been included. Based on my own empirical research and in collaboration with colleagues, involving their empirical research, a number of themes and perspectives have emerged that shed light on the dissertation’s objectives. While the present chapter has sought to synthesise the findings across the papers, this last section will summarise the conclusions, first by recapping how the papers’ findings address the four research questions (rephrased below), and then by responding to the overall research question of the dissertation (rephrased in the beginning of this paragraph).

1. *How is the notion of convenience tied into smart home technology development and how might this impact on user practices and sustainability?* (Paper 1)

2. *How does smart home installation and digital housekeeping impact on everyday practices and gender relations?* (Papers 2 and 3)
3. *What are the gendered implications of differences in competences, meanings, and forms of knowledge among variously tech-engaged smart home users?* (Paper 3)
4. *How does the implementation of smart technologies in the home interact with learning processes and the establishment of new everyday practices?* (Paper 4)

Paper 1 investigated professional practices and sociotechnical and user imaginaries to understand how the prevalent vision of convenience has come into being and how this might impact on SHT implementation in households. The paper showed that the convenience vision is closely related to a user imaginary characterised by passivity which may have negative impacts on energy consumption. Furthermore, the paper highlighted how convenience is related to the notion of interoperability which refers to a smooth integration between technologies and the possibility of continual expansion of the smart home. The interviews with professional actors and the mapping of technology development practices illuminated the practical embedding of developers' sociotechnical imaginaries, and how these are an outcome of collective practices and interdependent relations within the SHT industry.

Papers 2 and 3 empirically demonstrated scenarios of SHT implementation, showing how the technology both forms new practices of digital housekeeping and reconfigures existing household practices. This can result in a divide between digital and traditional housekeeping that risks reinforcing gender roles, as seen in the 'frontrunner' households. However, digital housekeeping can also be shared more equally as in the smart heating households. The gendered implications of SHT implementation relates to which competences and meanings are involved in household members' performance of practice. When the digital housekeeping primarily lies within the domain of only one household member, this results in unequal technological power and control, problematic from both a gender- and a digital-equality perspective.

SHT implementation also involved practices of homemaking in the households relating to home creativity and cognitive labour, which are domains traditionally associated with femininity (Pink 2004; Daminger 2019). This finding reflects how gender is neither clear-cut nor stable, but fluid and continually produced in the daily performance of everyday practices. This adds nuance to the notion of digital housekeeping as masculinized tech-work (Chambers 2020; Strengers and Nicholls 2018) by showing how digital housekeeping can also provide an arena for performing new domestic masculinities (Gorman-Murray 2008; Pink 2004) involving practices of homemaking.

SHT implementation is not a straightforward operation; it takes learning for the technology to be integrated into everyday practices. Based on the analysis of an auto-ethnographic diary, paper 4 demonstrated how concepts from practice theory can help describe this process. Thus, the paper showed how interactions with materiality, learning via remote assistance, and learning through social relations resulted in extending practical intelligibility and achieving augmented operability, which became visible from ‘knowing how to go on’ in everyday practices with SHT.

By combining studies of SHT users and social practices with insights into the professional perspective, the dissertation demonstrates how qualitative studies of everyday life can deconstruct sociotechnical imaginaries of the industry. While paper 1 illustrated how the prevailing vision of convenience within the industry relates to a user imaginary characterised by passivity, paper 2, 3, and 4 together demonstrated how SHT is far from a smooth enabler of convenience. Both involving new practices of digital housekeeping and reconfiguring existing household practices, SHT disrupts social life, influences domestic roles, and redefines the meaning of home. SHT implementation requires technological competence and engagement, and involves critical processes of learning. Further, some of the new technological solutions that SHT provides can risk increasing energy and resource consumption, as it relates to heightened standards of comfort and convenience. This shows how needs and standards are created by the implementation of technology into everyday practices, being an outcome of the relation between user practices, professional practices, and materiality.

While the dissertation has contributed to the literature through insights into SHT’s implications for everyday life, the findings of the dissertation are by no means exhaustive in understanding the social consequences of SHT implementation. Importantly, the research undertaken here points to several perspectives that deserve further investigation in future studies to accompany and guide the ongoing smart transition in homes. To understand the implications of the distribution of digital housekeeping, further research on routine housework time-use is needed. Further, the complex and ambiguous materiality of SHT, including its device-interfaces and infrastructural properties and its ability to switch roles between being in the foreground and background of practices, calls for further investigation to understand the changing roles and implications of the technology.

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APPENDICES

Appendix A. Information letter and consent form, households (translated from Danish): p. 91

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Appendix A. Information letter and consent form, households (translated from Danish)

Research objective

The aim of the research project eCAPE (New Energy Consumer Roles and Technologies – Actors, Practices and Equality) is to shed light on smart home technology from an everyday perspective, in the transition towards a sustainable and flexible energy system. This present part of the project – eCAPE QUAL3 – particularly focuses on the role of the technology, how it is manifested in everyday life, and how the relation between humans and technology changes when household activities become automated through smart home technologies. Through a qualitative study including interviews with households owning smart home technology and interviews with technology developers, the role of the technology will be explored and discussed in an everyday life and social practice perspective. Thus, the focus will be on how the technology figures in everyday living, how it is developed, and how the automation processes of the technology change routines and habits. The aim of the study is to enhance our understanding of the meaning of smart home technology and (changing) human-technology relations in everyday life.

The interview

The interview will cover the themes described above and take an open form. Thus, there are no right or wrong answers, and the focus will be on your own experiences and understandings.

To fulfil the research objective, it is necessary to collect personal data such as name, gender, education and employment. All personal data will be handled in accordance with the General Data Protection Regulation (GDPR). It will be ensured that no more than the necessary data is processed, and technical and organizational requirements are met in securing data processing and storage. On the next page, you will find a consent form to be signed prior to the interview.

Kind regards,

Line Kryger Aagaard
PhD student at the Department of the Built Environment
Aalborg University

Consent form for interviews in the eCAPE research project

Responsible researcher: Line Kryger Aagaard, lkaa@build.aau.dk

Data protection officer: Aalborg University, dpo@aaau.dk

Aalborg University (AAU) needs your consent in order to handle your personal data in connection to the research project eCAPE, and furthermore, your data can be used for other research relating to the topic. This will be done in accordance with the General Data Protection Regulation.

It is voluntary whether you wish to give your consent to AAU handling your personal data, but a lack of consent will result in AAU being prevented from using your data in the research project. You are free to change or withdraw your consent anytime. However, your consent cannot be withdrawn with retroactive effect and will thus only apply to future use of your data. In case you wish to change or withdraw your consent, please contact the responsible researcher.

According to the General Data Protection Regulation, Aalborg University is required to give you the following information in relation to the processing of your personal data for research purposes. In case you have questions, please contact the responsible researcher.

AAU collects and uses the following personal data:	<input checked="" type="checkbox"/> General personal data (<i>name, email, public data, CV, work circumstances</i>) <input type="checkbox"/> Sensitive personal data (<i>health information, religious beliefs etc.</i>) <input type="checkbox"/> Special personal data (<i>national identification nos.</i>)
Possible recipients of the personal data:	Apart from the primary researcher, other researchers involved in the eCAPE project can access the data, including potential student assistants in the transcription of interviews. All of this will be done in accordance with the General Data Protection Regulation.
Lawful basis:	

	Your information is processed on the basis of consent, cf. GDPR article 6 (1a) and article 9 (2a).
Rights:	<p>Rectification: You have the right to have personal data rectified in accordance with the GDPR.</p> <p>Erasure: You can request that AAU erase your data. If your data is no longer necessary for fulfilling the research objective, and if erasure of your data is not probable to hinder the completion of the research project, AAU will erase your data.</p> <p>Restriction of processing: You can request that AAU restricts the processing of your data. This can be relevant if AAU is unable to erase your data as this may cause restriction, or that AAU only store your data in a limited amount of time.</p> <p>Right to object: You have the right to object to AAU processing your data, unless the processing is necessary in order to fulfil a research related task in the interest of society.</p> <p>Complaint: You can file a complaint to the Danish Data Protection Agency if you find that AAU disregards the rules under GDPR in relation to the university's processing of your data for research purposes. You are encouraged to contact the primary researcher or AAU's data protection officer before filing a complaint to the Danish Data Protection Agency, as the case will possibly be solvable internally.</p>

Transfer to countries outside the EU:	Your data will not be transferred to countries outside the EU.
Time period:	After the end of the project (2023) all interviewees will be fully anonymized and personal data will be erased, as the anonymized interview data (including written experts) will be filed. It is possible that the completion of the project can be postponed, if the research project is delayed, or if data from the project, including your data, is reused in a new research project in accordance with the GDPR.

To be filled out by the interviewee:

I hereby give my consent that AAU may collect and process my data for research purposes in the eCAPE project:

Check the box: ☐

I hereby give my consent that AAU may collect and process my child(ren)'s data for research purposes in the eCAPE project:

Check the box: ☐

I hereby give my consent that the researcher may take photos in my home (check the box): ☐

- and that these photos may be published in relation to research dissemination (check the box): ☐

Date and name:

Signature

Appendix B. Information letter and consent form, professionals (translated from Danish)

Research objective

The aim of the research project eCAPE (New Energy Consumer Roles and Technologies – Actors, Practices and Equality) is to shed light on smart home technology from an everyday perspective, in the transition towards a sustainable and flexible energy system. This present part of the project – eCAPE QUAL3 – particularly focuses on the role of the technology, how it is manifested in everyday life, and how the relation between humans and technology changes when household activities become automated through smart home technologies. Through a qualitative study including interviews with households owning smart home technology and interviews with technology developers, the role of the technology will be explored and discussed in an everyday life and social practice perspective. Thus, the focus will be on how the technology figures in everyday living, how it is developed, and how the automation processes of the technology change routines and habits. The aim of the study is to enhance our understanding of the meaning of smart home technology and (changing) human-technology relations in everyday life.

The interview

The interview will cover the themes described above and take an open form. Thus, there are no right or wrong answers, and the focus will be on your own experiences and understandings.

To fulfil the research objective, it is necessary to collect personal data such as name, gender, education and employment. All personal data will be handled in accordance with the General Data Protection Regulation (GDPR). It will be ensured that no more than the necessary data is processed, and technical and organizational requirements are met in securing data processing and storage.
On the next page, you will find a consent form to be signed prior to the interview.

Kind regards,
Line Kryger Aagaard
PhD student at the Department of the Built Environment
Aalborg University

Consent form for interviews in the eCAPE research project

Responsible researcher: Line Kryger Aagaard, lkaa@build.aau.dk

Data protection officer: Aalborg University, dpo@aaau.dk

Aalborg University (AAU) needs your consent in order to handle your personal data in connection to the research project eCAPE, and furthermore, your data can be used for other research relating to the topic. This will be done in accordance with the General Data Protection Regulation.

It is voluntary whether you wish to give your consent to AAU handling your personal data, but a lack of consent will result in AAU being prevented from using your data in the research project. You are free to change or withdraw your consent anytime. However, your consent cannot be withdrawn with retroactive effect and will thus only apply to future use of your data. In case you wish to change or withdraw your consent, please contact the responsible researcher.

According to the General Data Protection Regulation, Aalborg University is required to give you the following information in relation to the processing of your personal data for research purposes. In case you have questions, please contact the responsible researcher.	
AAU collects and uses the following personal data:	<input checked="" type="checkbox"/> General personal data (<i>name, email, public data, CV, work circumstances</i>) <input type="checkbox"/> Sensitive personal data (<i>health information, religious beliefs etc.</i>) <input type="checkbox"/> Special personal data (<i>national identification nos.</i>)
Possible recipients of the personal data:	Apart from the primary researcher, other researchers involved in the eCAPE project can access the data, including potential student assistants in the transcription of interviews. All of this will be done in accordance with the General Data Protection Regulation.
Lawful basis:	

	Your information is processed on the basis of consent, cf. GDPR article 6 (1a) and article 9 (2a).
Rights:	<p>Rectification: You have the right to have personal data rectified in accordance with the GDPR.</p> <p>Erasure: You can request that AAU erase your data. If your data is no longer necessary for fulfilling the research objective, and if erasure of your data is not probable to hinder the completion of the research project, AAU will erase your data.</p> <p>Restriction of processing: You can request that AAU restricts the processing of your data. This can be relevant if AAU is unable to erase your data as this may cause restriction, or that AAU only store your data in a limited amount of time.</p> <p>Right to object: You have the right to object to AAU processing your data, unless the processing is necessary in order to fulfil a research related task in the interest of society.</p> <p>Complaint: You can file a complaint to the Danish Data Protection Agency if you find that AAU disregards the rules under GDPR in relation to the university's processing of your data for research purposes. You are encouraged to contact the primary researcher or AAU's data protection officer before filing a complaint to the Danish Data Protection Agency, as the case will possibly be solvable internally.</p>

Transfer to countries outside the EU:	Your data will not be transferred to countries outside the EU.
Time period:	After the end of the project (2023) all interviewees will be fully anonymized and personal data will be erased, as the anonymized interview data (including written experts) will be filed. It is possible that the completion of the project can be postponed, if the research project is delayed, or if data from the project, including your data, is reused in a new research project in accordance with the GDPR.

To be filled out by the interviewee:

I hereby give my consent that AAU may collect and process my data for research purposes in the eCAPE project:

Check the box: ☐

Date and name:

Signature

Appendix C. Companies and SHT professionals

Supplemental data from Aagaard, Line Kryger. 2021. 'The Meaning of Convenience in Smart Home Imaginaries: Tech Industry Insights'. *Buildings and Cities* 2 (1): 568–82. <https://doi.org/10.5334/bc.93>.

Companies represented in the interviews:

- Small company, developing IoT hardware and software (for SHT among others)
- Small start-up, installation of smart energy technology, resale, and partnerships
- Small electrical contracting company specialized in setting up SHT in private homes
- Medium-sized company developing and producing white-label IoT devices and software
- Large company operating in electrical equipment and automation technology
- Large company selling telecom and energy services
- Large company operating in mechanical and electrical components and systems
- Large company mainly producing building materials
- Large company selling energy services
- Large company working with a wide range of software and hardware products

Summary of participants:*

Participant	Role	Customer focus
P1.	Managing director Approaching customers and forming partnerships with other companies	Houseowners, prosumers
P2.	Technology developer, R&D Developing software for smart devices and smart home solutions	Other tech companies
P3.	Industrial PhD student Researching, testing, and prototyping a smart home system and its sales potential for the company	Construction companies
P4.	Sales and marketing director Strategic development, managing salespersons	Installers, electricians
P5.	Business developer Developing concepts based on user insights among others	End-users
P6.	Product development manager Working in sales, development projects, and partnerships	Installers, wholesalers
P7.	Director of product development Communicating between tech and sales departments	Installers, wholesalers
P8.	Project manager Managing employees, partnerships, and contracts	Smart home tech companies
P9.	Managing director and owner Managing projects and employees, on-site electrician's work	Affluent house-owners
P10.	Product and business development manager Managing projects, employees, and partnerships	End-users
P11.	Interface designer Not specifically SHT but smart technologies in general	End-users

*To ensure anonymity, the order of companies in the list does not correspond to the order of participants in the table.

Appendix D. Summary of household interview participants

Supplemental data from Aagaard, Line Kryger, and Line Valdorff Madsen. 2022. 'Technological Fascination and Reluctance: Gendered Practices in the Smart Home'. *Buildings and Cities* 3 (1): 677–91. <https://doi.org/10.5334/bc.205>.

STUDY 1 (conducted by Line Kryger Aagaard in the Fall of 2020)				
Pseudonym(s) and Age	Household size	Residential type	Examples of SHT	Location
Adam (34), Cecilie (34)	4 household members (2 preschool children)	Owner-occupied detached house	Automated lights, smart alarm system, robotic vacuum cleaner, smart speakers, digital voice assistants	Suburb
Nadia (28), Erik (29)	4 household members (2 preschool children aged 4 and 2)	Rented apartment	Automated lights, smart speakers, digital voice assistants	City
Sara (23)	3 household members (1 male partner and 1 preschool child)	Rented house	Automated lights, smart alarm system, robotic vacuum cleaner, smart heating, digital voice assistants	Village
Frederik (48), Charlotte (45)	4 household members (1 school-aged)	Owner-occupied detached house	Automated lights, smart speakers, digital voice assistants,	Outskirts of city

	child, 1 adolescent)		temperature and humidity sensors	
Mikael (39)	4 household members (1 female partner, 1 preschool child, 1 school-aged)	Owner-occupied detached house	Automated lights, smart alarm system, robotic vacuum cleaner, smart speakers, digital voice assistants	Outskirts of city
Oliver (29), Anna (27)	1 household member (they live separately, the interview is conducted in Oliver's home)	Cooperative apartment	Automated lights, smart speakers	City
Hans (52), Susanne (?)	4 household members (1 preschool child, 1 school-aged)	Owner-occupied detached house	Automated lights, smart speakers, digital voice assistants, smart alarm system	Village
John (52), Connie (47)	4 household members (1 school-aged child, 1 adolescent)	Rented house	Automated lights, smart speakers, digital voice assistants, smart alarm system, homemade gadgets	Suburb
Karl (32), Eva (29)	2 household members	Rented apartment	Automated lights, smart speakers, digital voice assistants, smart heating	City

APPENDIX D. SUMMARY OF HOUSEHOLD INTERVIEW PARTICIPANTS

Kasper (48)	1 household member	Cooperative apartment	Automated lights, smart speakers, digital voice assistants, smart alarm system	City
Martin (47), Tina (47)	4 household members (2 school-aged children)	Owner-occupied summer house	Automated lights, smart speakers, digital voice assistants, smart alarm system, smart heating, robotic lawn mower	Village
Markus (35)	2 household members: (1 female partner (35))	Rented apartment	Automated lights, smart speakers, digital voice assistants	City
Nikolas (29), Laura (29)	2 household members	Owner-occupied detached house	Automated lights, smart speakers, digital voice assistants, smart alarm system, smart heating, robotic vacuum cleaner	Town
Peter (65)	2 household members (1 female partner)	Owner-occupied detached house	Automated lights, smart speakers, digital voice assistants, smart alarm system, smart heating, robotic vacuum cleaner	Outskirts of city
Ida (31), Andreas (33)	2 household members	Rented apartment	Automated lights, smart speakers	City

STUDY 2 (conducted by Line Valdorff Madsen in Winter 2019-2020)				
Pseudonym(s) and Age	Household size	Residential type	Examples of SHT	Location
Poul (70), Karen (62)	2 household members	Owner-occupied apartment	Smart heating	City
Kristian (70)	1 household member	Owner-occupied apartment	Smart heating, smart alarm system	City
Nanna (46), Allan (40s)	3 household members (1 adolescent)	Owner-occupied apartment	Smart heating, robotic vacuum cleaner	City
Thomas (49)	1 household member	Terraced house (cooperative ownership)	Participated in project with smart heating technology, air-to-air heat pump	Town, Island
Svend (70)	1 household member	Owner-occupied town house	Participated in project with smart heating technology	Town, Island
Niels (64) & Susan (61)	2 household members	Owner-occupied detached house	Participated in project with smart heating technology, air-to-air heat pump	Town, Island
Marianne (75)	1 household member	Owner-occupied town house	Participated in project with smart heating technology, air-to-air heat pump	Town, Island

APPENDIX D. SUMMARY OF HOUSEHOLD INTERVIEW PARTICIPANTS

Johannes (70) & Ruth (69)	2 household members	Owner- occupied detached house	Participated in project with smart heating technology	Town, Island
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Appendix E. Interview guide – SHT professionals (translated from Danish)

Aim:

- Understanding how SHT is developed and envisioned by the professionals
- Mapping the different practices related to the development of SHT and how these practices are connected
- Illuminating understandings and competences within SHT development
- Exploring the technology's and materiality's role in the development and in the relation between humans and non-humans
- Exploring motivation and purposes in the professional practices
- Exploring the role of users and how they really or ideally figure in the technology development

Introduction

- Thank you for participating in the research project and sharing your knowledge and experiences within this field
- I am a PhD student at Aalborg University BUILD, researching how smart home technology plays a role in people's everyday life and how it is developed
- So I have an interest in people living with the technology as well as people developing it
- I am highly interested in understanding all the processes involved in developing the technology, and also the practical aspects of your daily work life. So if some of the questions I ask seem banal, it is because I also aim for this detailed, practical insight
- Is the letter of information read and understood?

Themes	Questions	Elaboration
Introduction	<p>Please introduce yourself. What is your education and professional background? What have you previously worked with?</p> <p>When did you begin here in xx? What was your way in here? (Regular job application, network, etc.). Did you know of the place beforehand?</p> <p>What is your title and job description? What are tasks and responsibilities?</p>	<p>Uncovering the participant's professional background</p> <p>Connection to and role in the company</p>
Teleoaffective structures (Schatzki 2002) / engagement (Gram-Hanssen 2014)	<p>Please describe what you are currently working on? (alternatively, something that is already on the market?) What does it do/is it able to do? How do you make sure that this is possible?</p> <p>Which function does xx perform? Which user need does it accommodate? Why did you focus on these particular functions?</p> <p>Where do you find inspiration in your work?</p>	<p>Uncovering motivation, purpose, and meaning</p> <p>Professional and personal preferences</p> <p>View of the future/ technology development</p>

Actors	<p>How are your roles divided in the company, e.g., can you describe the division of roles in the work on xx?</p> <p>Who did you mostly work together with? How will you describe this cooperation/what are the division of tasks?</p> <p>Do you have any external partners? How did this external collaboration come into being? What are the advantages of it? Are there any challenges?</p>	Mapping the different actors and the relations between them
Technologies, materialities, tools	<p>Please describe the equipment you use in your work (tools, software, technologies). Which roles do these things play in your work?</p> <p>Is there a tool or program you use more than others? What does it do? How do you use it?</p> <p>What other materials/technologies do you use in your work? For what purpose/what do these technologies do? How do you use them?</p>	<p>Mapping, objects used in technology development practices</p> <p>Uncovering the function and purpose of different objects, their relation in practices (dispersed, integrated)</p>

<p>Knowledge and competences</p>	<p>Where do the knowledge you draw on and the competences you have in your work come from? (e.g., professional background, education)</p> <p>Do you exchange knowledge within the company? Do you exchange experiences? How?</p> <p>Do you also acquire new knowledge outside a work context? (hobbies, personal interests and relations, activities, fares, holidays)</p>	<p>Uncovering the knowledge need in SHT development and where it comes from</p> <p>Exploring the interplay between shared knowledge, outside inputs, and personal experiences</p>
<p>Everyday activities and routines</p>	<p>Please describe a typical work day from beginning to end, preferably a concrete day, e.g., yesterday? (If it was different/not representative, how was it so? And then describe another typical day)</p> <p>To which degree do your work tasks vary?</p> <p>Do you have any routines – perhaps particularly related to what you are working on right now? How do the different work tasks differ from each other?</p>	<p>Uncovering different activities, places, times</p> <p>Uncovering variation, special activities versus routinized tasks</p>

Stability and change	<p>Do the products that you are currently working on – e.g., xx – differ from the ones you have worked on previously? What characterizes your current products/which functions do you aim for?</p> <p>Have your working procedures changed? How?</p> <p>Are there some elements that are more stabile, e.g., the composition of employees, division of roles, physical surroundings, etc.? (concrete examples in relation to product xx)</p>	Exploring how the field has changed while mapping more stabile elements
The role of users	<p>Do you involve the users in any way, e.g., in your current work? Or: Does user involvement play any role in your technology development, e.g., in your current project?</p> <p>Please describe some examples of user involvement – or perhaps this is not something you do in the company?</p> <p>When you are developing the technology, e.g., the product(s) you are currently working on, do you have a particular kind of user in mind?</p> <p>How do you acquire knowledge on the users' needs?</p> <p>Do you also draw on your own experiences?</p>	Exploring the role of users in processes of technology development

<p>Personal views and relation to SHT</p>	<p>Do you have SHT installed yourself? Which kind? When did you acquire it? How do you use it? Which functions are important to you?</p> <p>Does your own use of SHT influence your work with the technology?</p> <p>What is your favorite type of SHT? Why?</p> <p>What are you less fond of? Why?</p> <p>How do you see SHT develop within the next 5 years? 10 years? 20 years?</p> <p>What is your vision for the technology?</p> <p>What could a possible worst case scenario be?</p>	<p>Uncovering personal preferences and views of the technology</p>
	<p>Thank you for your time!</p> <p>Do you know anyone else working with SHT smart home technologies who could be interested in doing an interview? Possibly from your company or from elsewhere?</p>	

Appendix F. Interview guide – households (translated from Danish)

Aim:

- Mapping the different practices related to smart home technologies
- Illuminating everyday routines, understandings, and competences
- Mapping when and where the technologies are installed
- Exploring potential changes in practices, newly emerged practices, discarded practices
- Exploring the relation between people and technologies
- Exploring choices, preferences, decisions à (human versus) non-human agency

Introducing the project

- PhD fellow at Aalborg University BUILD, researching how smart home technology plays a role in people's everyday lives.
- I am interested in understanding everyday activities and also the practical details around the division of roles and how everyday tasks (practices) are performed. So if the questions I ask sometimes seem banal, it is because I am interested in gaining a detailed, practical insight.
- Is the information letter read and understood?
- The interview will take approx. 1.5-2 hours.
- Involving a home tour to see the technologies you have installed.

Themes	Questions	Elaboration
Introduction	<p>Please introduce yourselves – age, family relations, education/training/professional background, occupation, leisure activities?</p> <p>Who do you live here with? For how long have you lived here? Where did you live previously?</p> <p>How many smart home technologies do you have in the house? Which ones? (if you remember them all). In this interview, we will just focus on some of them.</p>	Uncovering the participant's age, gender, personal relations, how long they have stayed at the address, earlier residences.
Home tour: Mapping everyday life with smart home technology	<p>Home tour: Would like to see</p> <ul style="list-style-type: none"> - Lighting or heating (predetermined) - The participant's most often used - The participant's favourite <p>Can you show me where xx is installed?</p> <p>For how long have you had xx?</p> <p>How did xx enter the household?</p> <p>Can you describe the process from getting the idea until the technologies were installed? (how did you get the idea, was the installation difficult, did it happen at once or gradually)</p> <p>What is xx able to do? (does xx solve specific tasks?)</p> <p>How often is xx used? Daily? Weekly or rarely?</p> <p>How did you install xx? (standard installation, own installation/adaption). Who installs? Did you experience any difficulties in the installation process? Are you satisfied with the current settings?</p>	<p>Home tour:</p> <p>Mapping the different technologies</p> <p>Uncovering the motivation for installing the technologies, when and how it happened</p> <p>Uncovering knowledge and competences</p>

<p>Everyday practices and routines</p>	<p>Please describe your home activities during a typical day, e.g., yesterday? Who does what morning, afternoon, and evening?</p> <p>Which function do xx and xx perform respectively? What do they each do and when?</p> <p>What is the difference between a typical weekday and the weekend? Does your use of the technologies differ?</p> <p>Do you think that your everyday routines would look different if you did not have smart technologies installed?</p>	<p>Uncovering different activities, places, times during the day</p> <p>Exploring the tasks that the technologies perform, which practices they are part of</p>
<p>Teleoaffective structures (Schatzki 2002) / engagements (Gram-Hanssen 2014) / meanings (Shove, Pantzar, and Watson 2012)</p>	<p>How did you hear about xx (websites, internet forums, friends, work, etc.)</p> <p>Which functions of xx are you particularly fond of? Why?</p> <p>What are you less fond of? Why? Do you miss some functions?</p> <p>How would you like to arrange your home in the future with smart technologies?</p> <p>If you could design smart home technologies yourself, what would it be? What should it be able to do? Why?</p> <p>Are there types of smart technologies you do not wish to have in your home? (E.g., related to privacy and surveillance issues)</p>	<p>Uncovering motivation, preferences, purpose, and meaning</p>

Stability and change	<p>Have your everyday practices and routines changed since you installed xx, xx, and xx? How? (temporality, division of roles)</p> <p>Has xx (e.g., smart lighting) changed your view of what the practice of xx (e.g., controlling the lights) entails?</p> <p>Are there things you are currently practicing in your everyday lives that you would like to change? E.g., your social interaction in the home, the division of tasks, practical arrangements, etc.? Could the technology play a role in this?</p>	<p>Uncovering how the technology has potentially changed practices and changed people's views of certain practices</p> <p>Temporality – changed perception of time?</p>
Knowledge and competences	<p>Which knowledge have you drawn upon – possibly acquired – when you installed xx? (e.g., technical knowledge, personal reflections). Did you lack any knowledge?</p> <p>Where did you acquire knowledge about these technologies? Have you any prior experience with technology? (e.g., at work, in leisure activities, in education, etc.)</p> <p>The Facebook group – how often do you use it? What do you use it for?</p> <p>Do you know anyone else with smart home technologies installed? Do you exchange experiences? How?</p>	<p>Uncovering which kind of knowledge that is important (technical, intuitive, curiosity)</p> <p>Exploring the interplay between shared knowledge, outside inputs, personal experience</p>
	<p>Thank you for your time!</p> <p>Do you know anyone else with smart home technologies installed who could be interested in doing an interview?</p>	

Appendix G. Facebook post (translated from Danish)

Interview participants wanted for research project on smart home technology

Dear members of [name of Facebook group]

In a current research project at Aalborg University BUILD (Copenhagen), we are investigating how smart home technology plays a role in people's everyday lives. Therefore, we are searching for interview participants in the whole country who have smart technology installed in their home and who are interested in talking about their experiences and lives with the technology. The interview will last approx. 1.5-2 hours and will take place in your home at a time suiting you.

Please send an email to lkaa@build.aau.dk if you are interested in participating. Hope to hearing from you.

Kind regards,

Line Kryger Aagaard

PhD fellow, BUILD, Aalborg University

Research project link: <https://vbn.aau.dk/da/projects/new-energy-consumer-roles-and-smart-technologies-actors-practices>

PAPERS

Paper 1: Aagaard, Line Kryger. 2021. 'The Meaning of Convenience in Smart Home Imaginaries: Tech Industry Insights'. *Buildings and Cities* 2 (1): 568–82. <https://doi.org/10.5334/bc.93>.

Paper 2: Aagaard, Line Kryger. 2022. 'When Smart Technologies Enter Household Practices: The Gendered Implications of Digital Housekeeping'. *Housing, Theory and Society* 0 (0): 1–18. <https://doi.org/10.1080/14036096.2022.2094460>.

Paper 3: Aagaard, Line Kryger, and Line Valdorff Madsen. 2022. 'Technological Fascination and Reluctance: Gendered Practices in the Smart Home'. *Buildings and Cities* 3 (1): 677–91. <https://doi.org/10.5334/bc.205>.

Paper 4: Aagaard, Line Kryger, Toke Haunstrup Christensen, and Kirsten Gram-Hanssen. 2022. 'My Smart Home: An Auto-Ethnography of Learning to Live with Smart Technologies'. Submitted to *Personal and Ubiquitous Computing*.



The meaning of convenience in smart home imaginaries: tech industry insights

RESEARCH

LINE KRYGER AAGAARD 

]u[ubiquity press

ABSTRACT

Smart home technology (SHT) is being promoted for the enhancement of occupants' convenience, as well as more efficient and sustainable energy consumption. However, recent research indicates that convenience often takes precedence over energy reduction, threatening to affect inhabitants' everyday practices in a non-sustainable way. In order to understand the social and environmental consequences of SHT, the meaning of convenience is investigated. How is the concept of convenience developed in concert with technological development? Presenting SHT imaginaries from the industry, the paper builds on qualitative interviews with 11 SHT professionals. By exploring the practices, roles, and relations at play in SHT development, it is demonstrated how the vision to enhance convenience in everyday life is related to a user imaginary characterized by passivity and disengagement from energy savings. Furthermore, convenience is enabled and enforced through the notion of interoperability. Interoperability refers to not only technologies 'speaking together' but also a strong interdependency between professional actors. By exploring the practices at play in SHT development, the meaning of convenience is revealed to be an outcome of this interdependency as well as the collectively shaped ideas, and technological standards embedded in the industry.

POLICY RELEVANCE

SHT is shaping our domestic futures, influencing material environments as well as social life and energy consumption. Currently, SHT is promoted and supported widely in policy. For instance, the European Commission stresses automation as a means to ensure the more efficient operation of buildings, generating cost and energy savings. However, a focus on convenience risks counteracting sustainability considerations. This study shows how convenience can take precedence across various branches of SHT development, with a consequence of creating passive users who are disengaged from sustainability issues. When policymakers promote the adoption of SHTs and automation of the built environment, a more critical stance is needed toward convenience in order to avoid user passivity and masked energy consumption. Policy instruments, such as the smart readiness indicator (SRI), should not only include calculations of what is technically possible in terms of automation but also examine the outcomes, practices, and behavior that SHT promotes.

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KEYWORDS:

agency; convenience; energy demand; interoperability; smart home; social practices; technology development

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1. INTRODUCTION: NEW TECHNOLOGIES, NEW DOMESTICITIES

The smart home revolution has arrived.

(Furszyfer Del Rio *et al.* 2020: 1)

Smart home technology (SHT) covers a wide range of products, from voice-controlled home assistants and smart speakers to automated lighting, heating, and security systems. SHT is developed and promoted with promises of enhanced comfort, security, entertainment, and more efficient and sustainable energy solutions. Given its potential, the technology is expected to spread in the near future (Sovacool & Furszyfer Del Rio 2020; Wilson *et al.* 2017). However, several uncertainties remain. For instance, a number of scholars point out that the actual energy savings from SHT are questionable and that SHT may, in some cases, lead to even more energy-intensive activities and increase energy consumption (Darby 2018; Herrero *et al.* 2018; Strengers *et al.* 2020; Strengers & Nicholls 2017). Furthermore, due to its smart capabilities and enhanced levels of automation, SHT is able to change roles, relations, and practices within the home and influence shifts in domestic labor. As such, the technology is transformative not only technologically but also socially (Hargreaves *et al.* 2018).

To create a sustainable and transparent path for the development and integration of SHT, more knowledge on its meaning and impact is required. This paper explores SHT from the professional perspective, including visions, meanings, and practices at play in SHT development. As Strengers & Nicholls (2017: 87, with reference to Wilson *et al.* 2014) point out:

the smart home is an emerging field full of promises and aspirations, accompanied by very little empirical, social or cultural research.

SHT is developing rapidly and may yet be understood as:

not so much a clearly defined phenomenon as a fluid and unstable field of possibilities.
(Berry *et al.* 2007: 242)

These points highlight the emergent character of SHT and the necessity of ongoing research within a field that is expected to increasingly shape our homes.

Recent reviews indicate that the majority of SHT research has been focusing on the technical challenges of establishing smart home environments (Gram-Hanssen & Darby 2018; Wilson *et al.* 2014). However, there has also been some interest in social and cultural aspects, especially in studies of users. These studies provide valuable insights into how SHT is implemented ‘in the wild’ (Mennicken 2016; Mennicken & Huang 2012), *i.e.* in a real home setting, and the role it plays in everyday life (Hargreaves *et al.* 2018; Paetz *et al.* 2012; Takayama *et al.* 2012). Yet, the user perspective alone is insufficient for developing a full understanding of the meaning and implications of SHT. The professional perspective is also of central importance, as the development of technologies and their accompanying visions and ideas, *i.e.* their ‘sociotechnical imaginaries’ (Jasanoff & Kim 2009), are central in the shaping of our everyday lives and technological futures.

The SHT professional perspective is less researched than the user perspective, but a few studies do exist (Hargreaves & Wilson 2013; Sovacool & Furszyfer Del Rio 2020; Strengers *et al.* 2020; Strengers & Nicholls 2017). These studies explore particular visions and narratives associated with SHT. Convenience is an oft-identified core theme in these studies and stands as an overarching vision held by SHT professionals: living smart should mean living easy. The notion of convenience is linked to certain behaviors, lifestyles, and social practices promoted simultaneously by the technology. However, as shown by the work of Strengers *et al.*, the strong focus on convenience in the industry often comes at the expense of sustainability considerations, potentially risking the enhancement of energy consumption and influencing people’s everyday practices in a non-sustainable way (Strengers & Nicholls 2017; Strengers *et al.* 2020).

Despite its value to professionals, convenience thus poses as a somewhat problematic element in social practices—a general point of concern that is also raised elsewhere in the literature on consumption and social practices. For instance, Shove *et al.* (2012: 147) propose ‘the valuing of convenience’ as a type of ‘bad’ element in practices in relation to climate change. To address

this issue and the implications of convenience for the field of SHT, it is worthwhile to supplement existing research with an exploration of the meaning of convenience. A critical examination of this concept and its embedment in the SHT industry, including its practical entanglements and underlying problems, will help to broaden our understanding of the visions at play in SHT development and lay the groundwork for a critical discussion of these. Thus, this paper addresses the following question:

How is the notion of convenience tied into SHT development and how may this impact user practices and sustainability?

To do so, the paper draws on qualitative interviews with SHT professionals representing various branches and positions within the field.

The remainder of the paper is structured as follows. Section 2 provides background information on the SHT industry, including an overview of its composition. This background is followed by an elaboration of SHT imaginaries in the form of a brief literature review, then a presentation of the concept of convenience and the paper's theoretical framework. Section 3 presents the research design. Section 4 gives the main analytic themes concerning the meaning of convenience in user imaginaries, the connection between convenience and interoperability, and the practical aspects of SHT development, including various processes, actors, and relations. The fifth section summarizes the findings and discusses the relations between the analytic themes.

2. BACKGROUND, CONCEPTS AND THEORY

2.1 A MAPPING OF THE SMART HOME ECOSYSTEM

The SHT industry is expanding rapidly, thus, mapping its potential size is difficult, and estimates vary (BCG 2018). However, the major consulting firm Boston Consulting Group's (BCG) analysis of the SHT field is a useful starting point for an overview. As BCG points out, investments in SHT are increasing greatly. The development in this field can be characterized by tech giants, such as Google, Apple, and Amazon, acquiring valuable SHT companies. For instance, Amazon purchased Ring (smart doorbells and cameras), and Google purchased Nest (smart thermostats, smart smoke detectors, and other smart items). In their analysis, BCG identify around 1500 SHT companies that can be divided into 11 sectors: security and safety systems (21% of SHT investments), audiovisual (15%), smart energy (13%), software platforms (12%), heating, ventilation and air-conditioning (HVAC) and lighting (10%), components (8.2%), artificial intelligence (AI) and natural language processing (6%), connected health (3.5%), wearables and mobile apps (3.5%), smart kitchen (2.7%), and robotics (2.2%). However, these sectors are not completely mutually exclusive since many companies deliver products across different sectors, thereby positioning themselves more strategically in the market.

Amazon (with Alexa) and Google (with Google Home) are among the digital giants that recognize that smart speakers and digital assistants serve not only as a gateway into the home but also as a critical control point within the smart-home ecosystem.

(BCG 2018)

BCG identify Amazon, Samsung, and Google as 'the most aggressive investors' in SHT. In spite of the heavy presence of these big tech companies, the SHT market is not described as being dominated by them but rather as being a 'robust environment populated by multiple key players in various subsegments' (BCG 2018). In this paper, this multiplicity will be explored in terms of, for instance, the various roles, practices, and strategies at play in SHT development.

2.2 SMART HOME IMAGINARIES

As mentioned in the introduction, a small number of scholars have already conducted research into the ideas and visions that prevail in the SHT industry. Hargreaves & Wilson (2013) conducted a content analysis of SHT marketing material that explored representations of the technology, users, and technology-user interactions. Strengers & Nicholls (2017) conducted interviews with Australian

SHT professionals and analysed media articles to explore the particular visions and narratives associated with SHT. Sovacool and Furszyfer Del Rio's (2020) study includes interviews with British actors from SHT companies, organizations, and research institutions on what they perceive as the potentials, benefits, and barriers to SHT adoption. Apart from identifying convenience as a core theme in SHT visions, these studies also indicate that SHT professionals often have low expectations regarding users' engagement in technical matters and involvement in questions of sustainability and energy efficiency. As such, users are often imagined to be passive and disengaged.

The SHT visions that these studies illustrate, which also include understandings of users and the relationship between humans and their material environments, can be seen as examples of 'sociotechnical imaginaries', a concept introduced by Jasanoff & Kim (2009). Sociotechnical imaginaries express shared understandings and dominant ideas regarding what is scientifically and technologically possible and desirable. They are broadly represented by actors, such as authorities, utilities/institutions, businesses, policymakers, and experts, and, as such, express collective and institutionalized norms (Jasanoff & Kim 2009).

Sociotechnical imaginaries shape not only the design of technologies but also our futures, and the concept has been used in many studies of technological transitions, *i.e.* studies of new energy systems, low carbon housing, and smart homes. Strengers *et al.*'s (2020) study of SHT visions in media articles detects a sociotechnical imaginary, which the authors term 'pleasance', revolving around themes such as frictionless convenience, aesthetics, entertainment, and effortless energy savings (however, as those authors show, in reality risking energy intensification). Cherry *et al.*'s (2017) study of low carbon housing imaginaries among UK experts detects a vision of smart homes in which carbon emissions are reduced, but in which existing behaviors and lifestyles are left unchallenged, and users are regarded as passive and disengaged. In addition, the authors identify a 'techno-fix discourse' (Cherry *et al.* 2017: 40) running through this vision in which the public is imagined as lacking knowledge and interest in technology and climate change.

As these studies show, sociotechnical imaginaries also include particular ideas of users, which can be termed 'user imaginaries' (Ryghaug & Toftaker 2016; Skjølsvold & Lindkvist 2015). These ideas also have implications for how the future is imagined and designed, and the present paper considers how convenience is present through this lens. Sociotechnical and user imaginaries illuminate how designers and other tech professionals play a prominent role in deciding what people's everyday practices should look like. As Strengers & Nicholls (2017: 88) note in their study of SHT professionals, although the professional field does not necessarily reflect actual change in practices within homes, it does reflect visions of how these practices *should* change. Thus, SHT imaginaries are connected to everyday practices, and this link will receive attention in the present paper. The next section will elaborate on how the connection between social practices and technology have been theorized in the literature and present the framework for conceptualizing convenience.

2.3 STUDYING CONVENIENCE IN SOCIAL PRACTICES

Explorations of sociotechnical developments, as exemplified by the above studies, consider general currents within design and consumption research that pay particular attention to the structure of practices. As Shove *et al.* (2012: 12) point out, new forms of technology not only reconfigure the materiality of our daily lives but also, and importantly, they affect social practices, cultural and symbolic meanings, and the skills needed to possess—the latter sometimes resulting in the 'disappearance and cultivation of different forms of competence'. In terms of the present study, the development and spread of SHT also relate to new forms of practices, the cultivation and disappearance of competences, and notions of convenience. In the studies of Strengers and others, convenience appears as a vision and narrative maintained by SHT professionals. Strengers & Nicholls (2017) take a practice theoretical approach and draw on Shove *et al.*'s (2012) three elements of practice: meanings, competences, and materials. They locate convenience as a practice element, interpreting narratives as corresponding to the 'meaning' element (Strengers & Nicholls 2017: 88). This approach is also taken in the present paper, as convenience is explored as a meaning in SHT practices.

In Shove's writings, convenience is defined in various ways, e.g. as a standard of normality (Shove 2003b: 194); a promise held by, and ascribed to, technology (Shove & Southerton 2000); and a dominant convention or ideal (Hand & Shove 2007: 94). The concept is problematized in relation to sustainability and described as one of the 'environmental hotspots of consumption' (Shove 2003a: 3). With regard to SHT specifically, Nyborg & Røpke (2011: 1850) note that:

Smart home technologies can in effect become a dynamic that normalises new energy-demanding practices and supports the construction of new normal expectations to comfort and convenience.

Following these points, this paper unpacks the meaning of convenience within SHT development and explores its implications for everyday practices.

The present research approach is informed by theories of practice. The practice approach illuminates the connections between different practices, *i.e.* 'the here-and-now of the situated practicing and the elsewhere-and-then of other practices' (Nicolini 2009: 1392). Everyday living and household practices involving SHT are connected to the SHT industry and its sales and development practices. These practices (e.g. product development, strategizing, and management) are located in different places and temporalities, and an exploration of a professional field must consider the practices involved and their mutual connectedness (Nicolini & Monteiro 2017).

3. RESEARCH DESIGN AND METHOD

In this study, 11 professionals occupying various niches within the SHT field were interviewed during the spring of 2020 via Skype (physical meetings were impossible due to COVID-19). Two participants from the same company were interviewed together. A semi-structured interview format was followed to allow for an open-ended structure and flow of conversation while adhering to a general list of topics (Bernard 2006). Theories of practice informed the interview guide by facilitating an exploration of technology development as a practice field (Nicolini 2009), meaning that the interviews focused on identifying the various practices involved in technology development, among other topics. For instance, participants were asked about their tasks, job descriptions, routines, materials, and technologies they work with, the skills and knowledge they use in their work, and how they collaborate with others. For the questions used for interviewing participants, see the supplemental data online.

The 11 participants represent 10 different companies, of which seven are Danish, three are multinational and one is Norwegian. Participants work within various branches of the SHT industry (e.g. smart heating, smart home system apps, smart energy management) and on different levels of the production chain (research and development (R&D), sales and marketing, software programming, management, and prototyping), thus enabling diverse insights into the processes, priorities, and decisions involved in SHT development. One exception to the online interview format was an on-site visit to a participant who is an electrician specializing in SHT installations. The author conducted a walk-along interview (Kusenbach 2003) with this participant during his/her workday in a luxury villa where s/he was setting up various SHT installations. Of the 11 participants, nine are men and two are women. To avoid conjectures about gender, all pronouns are written as 's/he' and 'his/her'.¹

The sample provides a qualitative excerpt from the professional SHT field and contributes in-depth insights into some of the various practices performed in SHT development. However, it is important to acknowledge that this limited group of research participants does not represent all stages of SHT development, and quantitative generalizability is beyond the scope of the paper. In spite of this limitation, general trends in participants' responses are apparent, despite heterogeneous perspectives, and exemplify various practices, roles, and relations within the field. For instance, user imaginaries and expressions of convenience were quite similar. As such, the sample provides clear thematic tendencies, which is an indicator of saturation in the material (Small 2009; Merriam & Tisdell 2015).

Participants were recruited by contacting engineering researchers in the SHT field with knowledge of relevant actors in the SHT industry, and referral from these enabled snowball sampling, among others including access to key actors in management positions. Participants at this level in the production chain were important to include because they possess knowledge concerning the strategies and visions of their respective companies and have an overview of their organizational structures. Designers and developers working within R&D, on the other hand, possess skills, technical knowledge, and practical know-how concerning SHT development, and their inclusion illuminated other central aspects of the field, especially those related to the technical challenges of SHT development. The different companies the participants represent are highly variable in size, ranging from a start-up company with only a few employees to multinational corporations with many thousands of employees. The diverse sample of participants enables a closer look into the complex field that SHT development constitutes.

Before the interviews, informed consent was gathered from all participants, who were told that they would remain anonymous in order to provide a confidential space and encourage openness. For the different companies and a summary of the participants, see the supplemental data online. Numbers have been used to tag the participants (P1–P11).

Interviews lasted approximately one hour (from 50 to 80 minutes) and were subsequently transcribed verbatim and coded in the software program NVivo. The coded themes relate to either SHT visions and user imaginaries, or to the practical aspects of SHT development (actors, processes, roles, and relations). The interviews provide the basis of the analysis, and, in the following section, quotations will illustrate and exemplify the most significant takeaways.

4. THE MEANING OF CONVENIENCE IN SMART HOME DEVELOPMENT

When asking about the particular SHTs and participants' focus areas in working with these technologies, prevailing themes were comfort, ease, and savings (of time, hassle, energy, and money)—often with an emphasis on underpinning current user practices, temporal rhythms, and forms of sociality. SHT should not be too disruptive; rather, the technology should work in a smooth and perhaps even seamless manner, thus sparing users from dealing with practical tasks and arrangements in their homes, such as heating and lighting practices. A shared vision among participants was that SHT should make life easier and be easy to use. Thus, *convenience* was an overarching theme in all interviews.

In the following subsections, extracts from the interviews will illustrate the meaning of convenience in user imaginaries, and the relation of convenience with the concept of interoperability. To understand how convenience is brought into being, the work *behind* the technologies is also taken into account. Thus, a section will follow on the roles, relations, and practices that form the work behind SHT development in which the meaning of convenience is embedded.

4.1 CONVENIENCE FOR THE PASSIVE USER

The vision that convenience should be enhanced was brought forth through several cases and scenarios in the interviews. For instance, the smart thermostat is a concrete product that several of the participants work with, either by developing it, selling it, or making apps and platforms with which it can be integrated. One participant, P8, described how his/her company connects smart thermostats to their SHT platform, aiming for 'the least amount of user interaction as possible'. S/he explained the procedure:

What we do with the thermostat is that you [the user] tell me what your comfort temperature is that you like when you're home and awake, you tell me what your minimum temperature is, and we do the rest. So, we use AI to learn your habits. So, if you come home every day around 5 from work or university or whatever, then the system picks up: 'Hey, there is a pattern here, that [name] comes back every day at 5.' So, we'll make sure that at 5 o'clock, the house is at the comfort temperature that you set before. So, if that means that your house has to start heating at 3, it starts heating at 3.

As P8 formulated it, the system ‘picks up’ the habits and temporal rhythms of the user. In this manner, a heating solution is created that does not require user interaction, apart from initially setting up some preferences. As such, the integration of the smart thermostat is synchronized with and underpins existing practices, *i.e.* sleeping, leaving for work, returning home, *etc.* The integration supersedes the previous task of adjusting the heat manually while also adjusting to external factors, such as the weather and the changing seasons.

The smart homeowner targeted by several participants is not particularly technology savvy. Most of the companies hope to reach a broad segment of the population and imagine the user as the average ‘Mr. and Mrs. Smith’, as one participant, P5, formulated it (translated from Danish: ‘*hr. og fru Jensen*’), while shortly after adding: ‘the totally normal, average Dane’. A widely shared aim in the technology development is to interfere as little as possible in people’s everyday lives and avoid confrontations between humans and technology. P8 illustrated this sentiment in the following scenario:

So the scenario would be, if you have your house fully automated, you step on the train—let’s assume you commute by train—the [smart home] app already knows you’re on your way home. So, the app turns on the heat when you come within range, the alarm is disabled, the doors open. So, you step in, the motion sensor detects that you’re in the living room, so lights go on that you have programmed to go on, say, when it’s dark, or the outside light goes on.

Ideally, P8 added, the user should not have to use an app or a phone to trigger the technology. Rather, the technology should be able to turn itself on and off according to the user’s needs. In general, the companies do not wish to challenge people’s existing everyday practices as such. They hope to relieve people of burdens by creating technology capable of automating, for instance, lighting, heating, or home security. Preferably, the implementation should be completely smooth and absent of any barriers, as the following quotation by P10 illustrates:

There have to be no barriers to the implementation of a product. Any barrier, the least barrier to buy or use a product will turn people off. They have to be completely barrier-free.

Furthermore, P10 pointed to the importance of what s/he termed ‘soft’ or ‘warm benefits’ related to sociality and comfort, rather than ‘cold benefits’ related to costs or energy savings. According to him/her, users are primarily interested in the former; therefore, these benefits were prioritized by P10’s company:

We spent 30 years trying to educate people on how they can reduce their energy consumption, and it doesn’t work. People don’t listen, people don’t turn off their oven 10 minutes before they finish cooking. [...] What people want to hear about is the warm benefits of a product. Like when I leave, I always know that my kids’ bedroom is at the right temperature. Or a warm benefit is like maybe I’m sitting down at dinner, I’ve got some friends over, and I want to turn the lights down because it would make it more nice. [...] The soft, warm benefits, that’s what we should talk about.

The soft, warm benefits—features that make the everyday ‘more nice’, as P10 puts it—outweigh the focus on energy savings in this user imaginary. Another participant, P4, also spoke about the dilemma between comfort, on the one hand, and energy savings, on the other, as being weighted heavily toward the first priority. In fact, as P4 saw it, this had been the case for years:

If you wind back five years, then almost everything was about energy savings. [...] But it’s becoming less and less the principal element. I mean, it’s becoming more and more [about providing greater levels of] comfort, *etc.* A Sonos speaker is also about increasing the [level of] comfort in your home. If you have to save energy, then you shouldn’t buy a Sonos speaker. After all, it consumes energy as well, right?

The view that energy savings is not a top priority was also expressed by P9, an electrician specializing in setting up SHT installations in affluent people's homes. In his/her work, the main focus is on providing aesthetic and comfortable solutions rather than energy-efficient ones:

It's a lot about cosmetics. And, as I say, it's not energy optimization or anything, it's comfort and aesthetics optimization.

Two participants who did speak about energy savings as a priority in their work with SHT were P6 and P7 (from the same company). However, just like the other participants, they noted that people are not too interested in the topic. Thus, the company has some special requirements for technological solutions. First, lots of energy savings are needed for the technology to have 'a real impact', as P7 expressed in the quotation below. Furthermore, the technology has to be able to run on its own, without the need for people to continuously adjust or tinker with it:

Take a look at how many people will want to spent time on tinkering with some app and figure out how to save some energy, and keep doing that year after year. That's a very small number. And it won't have a real impact after all, either in terms of CO₂ or commercially. It has to be something that has some big chunks [of energy savings] to it. [...] It has to be set up and then mind its own business and be able to run on its own and provide its functions, without anyone having to go about tinkering with it, right?

A few minutes later, P7's colleague, P6, elaborated on this point by indicating the passivity of the user and the autonomy of the system:

The general consumer expects the heat to be on when they're in their house, and whatever happens aside from that, they take a very minor interest in. So, that's why we need to have automatic systems that switch on and off according to the need for heating.

Thus, a general view in the interviews was that the technology should be designed to ensure convenience and support what P10 termed the 'soft, warm benefits', i.e. aesthetics, preferences for heating, and sociality. P10 provided examples of this type of benefit involving adjusting the lighting when having friends over for dinner or ensuring that the kids' bedrooms are at the right temperature when there is no one home to adjust the temperature. As the interviews indicate, users were imagined to be passive in that they should not be confronted with technical challenges or too much information, and they should not have to play an active role, e.g. regarding energy savings. SHT is designed to 'take care' of such issues automatically—independently of, and perhaps even invisible to, users.

4.2 CONVENIENCE THROUGH INTEROPERABILITY

To enhance the convenience that SHT aims to facilitate, it is of central importance that the different technologies are able to 'speak together' to adjust to each other and thus provide integrated and smooth solutions. All participants highlighted that this aspect was important during the interviews. SHT professionals are at work in a market characterized by competition and rapid development and thus need to adjust to other actors, position themselves strategically, find their market niche, manage relations, and form partnerships. This co-dependence obviously involves more than just other actors and is inherently related to the technologies as well. Several of the participants noted how different SHTs operate on different apps, control systems, and protocols, which can make it difficult to combine certain SHTs into one integrated solution. As P1 noted:

The problem today is that there are so many who are making great products. Then you have an app for that, and you have an app to control your solar cells, you have an app for your heat pump, and you have an app for this, and an app for that. Eventually, you have so many things that should be able to speak together on the same platform, the same control system. And I know, there is a major need [...] that people really want to have this bigger general overview. Something that is easy to access, something that doesn't require much, but a place to go to, and then that is where they can see how things run.

Several of the participants represent companies that develop SHT control systems, i.e. operational systems that group and connect different SHTs into an integrated solution. The focus of technology development for these companies is then to increase the range of SHTs that can be added to the system, as the quotation by P8, who works with smart home apps, illustrates:

So, the thing we are mostly working on is increasing the range of products we support.
New lights, new smoke sensors, [...] water leak detectors, and etc.

These visions of implementing more SHTs into one system and making it 'easy to access', as P1 formulated it, show how interoperability is integral to the enhancement of convenience. In order to be accessible and convenient to users, the different technologies should be able to 'speak together'. As such, the two themes do not constitute separate visions; rather, interoperability is vital in ensuring convenience and making the smart home 'barrier-free' (as in P10's formulation). One company addressed interoperability by selling monthly smart home subscriptions. Users pay a monthly fee for an SHT starter kit (with interoperable SHTs), an app from the company with a single interface connecting all SHTs and access to customer support. Thus, convenience is ensured through preconfiguring and preselecting certain SHTs to be combined into one interoperable package with remote access for the company and support for the user when needed:

Interviewer: How come you need to have a subscription, can't you just do it yourself [select and set up SHTs]?

P5: Sure you can. You can easily buy all the items and then fix it yourself. [...] But what we do is that we take these three [SHT items: a smart thermostat, smart lighting, and sensors] and say, you don't need to—you need our app, then we control it for you and make it more intelligent so you don't need to sit and spend several hours on YouTube. [...] We make it easy and simple so that you can install everything in less than an hour.

The quotation exemplifies how companies make the technology 'easy and simple' to use, as P5 said, by taking on the responsibility of making the SHTs interoperable. Through its subscription packages, P5's company relieves users from dealing with issues of interoperability. Furthermore, users are relieved from the need to learn about technical matters (e.g. by watching tutorials on YouTube, as P5 indicated), as the company takes care of this. In P5's words, his/her company 'make[s] sure that you are comfortable with it'.

When asked about where SHT development might head within the next five to 10 years, participant P2 also highlighted interoperability and pointed to the potential for a unified standard to enable the connection of all devices:

I think we are heading into a unified standard for smart home technology. So, you can have a device, and it doesn't matter if you have Google Home or you have [name of an SHT system developed by the participant's company] or Alexa or it's an Apple HomeKit. Automatically, you are able to connect it.

SHTs' ability to 'speak together' and connect across different brands made up a widely shared vision among the SHT professionals interviewed in this study. Such a finding is also present in other SHT studies (Balta-Ozkan *et al.* 2013; Furszyfer Del Rio *et al.* 2020; Sovacool & Furszyfer Del Rio 2020), and the issue of interoperability has been a challenge in the field for decades (Edwards & Grinter 2001). Sovacool and Furszyfer Del Rio (2020: 10–11) point out that interoperability is not only a question of SHTs working together but also of SHT companies forming cooperative relationships. The interviews of the present study show that the vision of convenience cannot be separated from the notion of interoperability, as the latter is key in providing a convenient and flexible user experience in which different SHTs can be mixed and matched in a functional and smooth manner across different brands. By enabling more devices to be used at the same time, the notion of interoperability also promotes an increase in SHT purchases. Therefore, an awareness of its potential negative impacts is important because it may lead to intensified energy consumption, extraction of resources, and e-waste.

4.3 THE WORK BEHIND CONVENIENCE

The process of recruiting participants and the initial contact with these individuals provided early insights into the specialized and diffuse character of the SHT professional field. SHT is not invented, designed, and produced in one singular place; rather, development and production cuts across different locations and actors. Thus, a first step in the analysis consisted of preparing an overview of the different processes and actors involved and then gaining insights into how people work, what their actual activities consist of and what kinds of practices SHT development involves.

Most participants represent companies that do not work exclusively with SHT, and some of these companies only recently added SHT to their existing portfolio of products and services, or developed the latter into smart solutions (e.g. a heating company developing and selling smart thermostats and smart heating services). As such, participants spoke about following general developments in the market. For instance, when asked about how P5's company started working within the SHT field, s/he pointed towards a general trend among similar companies:

Interviewer: In terms of smart home—which is quite new to your company, right? How come you thought it was relevant to you? Does it relate to your other services or —?

P5: The reason is that we saw smart home generally being adopted by energy and tele companies. So, you see [lists several examples of foreign companies launching SHT solutions]. I mean, we could see this trend of more and more of these big companies going this way.

Thus, the practice of observing and following trends in the company's area of business is a way to initiate work within SHT. Another participant, P3, represents an old corporation in which SHT work is only an emerging and unofficial part. However, as the company indirectly works with comfort in their line of products, there is some potential for SHT here, as technology developers see it as a means of achieving convenience. R&D departments are key driving forces in such development forces because they have the capacity to research and explore new opportunities for companies:

Interviewer: But you also said that [name of P3's company] is not working very much with the smart technology path?

P3: So, this is something that we as researchers [in the R&D department] are trying to introduce and propose to them. [...] Can we maybe make some packages together, can we sell some kind of comfort service instead of selling materials individually? And [...] if you are starting to sell a comfort service, then it would make sense to have some kind of smart technology that allows you to control the comfort package. And this is the stuff I'm trying to push.

P3's role in the company is to conduct a research project on user behavior and interaction with an SHT system. S/he has found the need to improve the communication between the system and the users, make room for negotiation, and enhance the users' feeling of control:

It's like this kind of fine line where you respect occupants' wishes and make them feel good about what is going on in their homes but also still trying to save energy and use energy when the wind is blowing and things like this.

P3 pays careful attention to users' experiences and studies these in his/her work of developing new SHT. Although s/he initially hired assistants to conduct user interviews, P3 ended up conducting many of these interviews him/herself to gain a more thorough insight into users. Several of the participants highlighted the importance of insights into users, but mostly only big companies with many resources can afford to conduct systematic user research. P3 has no commercial responsibilities but is free to explore and push some limits as to what the current technology is able to do—for instance, by challenging the notion that users are passive and should be excluded from technological processes. P3 wishes to enhance users' understanding of the automation process and give them 'the perception of control', as s/he put it. Thus, the task is to find a balance between energy savings done autonomously of users and savings involving users to some degree to give them a sense of control.

Another participant, P11, also represents a big company and works in R&D. P11 is a user experience designer and does not work directly with SHT, although their work involves smart technologies and AI. Like P3, P11 has no direct commercial responsibilities. In P11's work, s/he uses the so-called 'research through design' approach. P11 is part of team that develops digital design by simultaneously studying how it is applied and adopted by users. P11 spoke of technology development as an iterative process, i.e. as trying things out and simultaneously studying the interaction between the user and technology. Thus, the technology is considered to be evolving and, to some extent, unpredictable:

The technology is so new in many ways that we do not entirely understand it yet. I mean, even though I am designing it and have done so for many years, then it's also a lot about sometimes we just have to try something and then see how people will use it, in order to really understand what it is and what it does.

(P11)

This point reflects the generally emergent and processual character of the technology. P11's way of addressing this character is to experiment with and study the technology while developing it at the same time. P11 and P3 express different user imaginaries and slightly different approaches to technology development. While P3 wants more engagement from the users and to provide them with more control, P11 takes an open-ended approach to technology in that s/he awaits users' responses in order to understand the technology's capabilities. In these SHT imaginaries, the meaning of convenience is shifted somewhat because it is decoupled from users' passivity and disengagement. Importantly, both participants have no commercial responsibilities. Thus, it might be within these lines of thought that a more sustainable path for SHTs is to be found.

In the interviews, several participants noted that the competition within the business is fierce and that everyone wants to play with (rather than dare to match) the heavyweights, such as Google, Apple, and Amazon. Most of the participants mentioned the importance of their company 'knowing its place' in relation to other actors in the market and targeting their products and services feasibly, thus securing their particular market niche. For instance, some companies specialize in software and app development, while others focus on developing concepts and services that match their existing customer base (to whom some of the companies, for instance, supply heating and electricity). All the companies have partnerships with other actors in the business. For instance, several of the large companies do not have the capacity to make all the hardware and electronic components they require themselves, and it is much cheaper to buy some of these components from specialized companies that are usually located abroad. However, one company represented in the interviews also carries out 'actual' technology development by building Internet of Things (IoT) devices (and software)—so-called white-label products—and selling these products to companies to use in their own solutions.

These partnerships characterizing all the companies illustrate the complexity of technology development and how the creation of SHT by no means follows a linear course. Rather, SHT development is the result of many different processes and actors negotiating with each other (i.e. about customer needs, technological problems, and solutions) while navigating in relation to other companies and competitors and, especially, adapting to existing products and services offered by the big tech companies, such as Google, Apple, and Amazon. As such, imaginaries of technology and users as well as visions of convenience are not just individual expressions of single companies or employees but should rather be understood as deeply entangled within a larger network of businesses embedded in the global financial market of consumer goods.

5. DISCUSSION AND CONCLUSIONS

This paper has explored the meaning of convenience in smart home imaginaries based on interviews with professional actors occupying different positions within the field. By taking their visions and work into account, it was possible to detect the practical entanglements of convenience and explore how it is brought into being and enforced in technology development.

In this concluding section, the findings of the paper will be summarized by highlighting three major points: (1) the meaning of convenience in SHT user imaginaries; (2) the connection between convenience and interoperability; and (3) the embedment of convenience in collective practices used in SHT development.

In the interviews, users were primarily imagined as passive and disengaged, lacking interest in what one participant termed the ‘cold benefits’ of SHT, e.g. cost and energy savings. In this view, SHT should not require too much interaction or technological skills from the user, and the latter should be able to behave as usual. As such, users’ everyday practices are left unchallenged. Thus, the meaning of convenience was framed as something that does not require any particular competences, e.g. no need to tinker with the technology or be confronted with issues regarding energy savings. This view mirrors the techno-fix discourse described by Cherry *et al.* (2017) and may impact energy consumption negatively since user imaginaries not only contribute to new norms of convenience but also risk impeding intended energy savings (Nyborg & Røpke 2011; Strengers *et al.* 2020).

Second, the interviews showed that the meaning of convenience in SHT imaginaries cannot be separated from the notion of interoperability, as the latter is seen as integral in forming the material arrangements of the former, i.e. providing a convenient and flexible user experience requires several SHTs to be integrated smoothly. Convenience and interoperability are also reflected elsewhere in the SHT literature (Balta-Ozkan *et al.* 2013; Furszyfer Del Rio *et al.* 2020; Sovacool & Furszyfer Del Rio 2020), but their interconnectedness has not been highlighted in particular. This paper shows that the two are mutually constitutive in that convenience as a meaning in practice is enabled and enforced through interoperability in the material arrangements of SHT. The connection between convenience and interoperability deserves ongoing awareness in policy and research, as interoperability promotes increased SHT purchases and may also increase energy consumption and e-waste. Policymakers should play an active role in ensuring that the enhancement of interoperability takes a sustainable direction, e.g. by minimizing e-waste, and that the development of unified SHT standards supports energy efficiency and sustainable consumption.

Finally, focusing on practices in SHT development illuminated the many different roles and skills contributing to, and drawing on, collectively shared understandings and visions among SHT professionals. For instance, the interviews showed that all companies are in partnerships with other companies and that they draw on each other’s specialized skills, knowledge, and technological components through these partnerships. For example, ideas about what the technology should do are formed by mutual influences and commercial interests, but also R&D practices, such as user research. Such practices show how technology development follows a convoluted rather than a linear course. Different SHTs are developed for interoperability, often in alignment with popular products and services provided by big tech companies, such as Google, Apple, and Amazon (BCG 2018). The notion of interoperability thus also has implications for SHT development practices since sales and innovations are dependent on being in compliance with those of other actors to ensure a convenient user experience. Thus, interoperability highlights the close reliance of smaller companies on big tech companies, while user imaginaries are equally shaped by this dependence. The specifics of such influences cannot be concluded from this limited study, but they indicate that further research on professional relations and interdependencies in the SHT ecosystem, which is a yet an under-researched topic in the literature, is necessary.

Earlier SHT studies have shown that visions of convenience in the SHT industry risk overruling sustainability considerations (Herrero *et al.* 2018; Strengers *et al.* 2020; Strengers & Nicholls 2017), and this study concurs. However, convenience is often framed as a vision and narrative in the existing literature (Darby 2018; Strengers *et al.* 2020; Strengers & Nicholls 2017), with limited consideration being applied to the practices and relations forming the SHT ecosystem. The present study illuminated the practical embedment of SHT visions and showed that sociotechnical and user imaginaries are an outcome of relations, interdependencies, and collective practices in SHT development.

To challenge the meaning of convenience, researchers and policymakers need to address all SHT development practices with an awareness of the large commercial powers at play. When SHT is promoted in policy, *i.e.* as a means by which to enhance energy efficiency and savings (European Union 2020), an awareness of user imaginaries in the industry and masked energy consumption in the name of convenience should follow. Policy instruments such as the smart readiness indicator (SRI) should not only include calculations of what is technically possible in terms of automation but also examine the practices and behavior that SHT promotes.

NOTE

- 1 The SHT field is, in general, male dominated in terms of users as well as professionals. This dominance is a significant aspect; however, a discussion on gender is beyond the scope of this paper. For an elaboration of this topic, see, for example, Strengers (2013, 2014) and Strengers & Kennedy (2020).

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COMPETING INTERESTS

The author has no competing interests to declare.

DATA AVAILABILITY

To ensure participants' anonymity, public access to interview data is not available.

ETHICAL APPROVAL

Informed consent was obtained from all research subjects participating in the study. Personal data were anonymized. Research was performed in accordance with the Declaration of Helsinki and was approved by Aalborg University.

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SUPPLEMENTAL DATA

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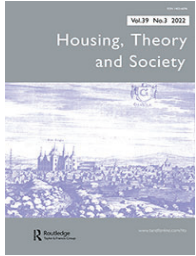
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When Smart Technologies Enter Household Practices: The Gendered Implications of Digital Housekeeping

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ABSTRACT

This paper investigates the social and gender implications of smart home technology (SHT) by looking at its role in everyday practices and domestic relations. Based on qualitative interviews and “show-and-tell” home tours in Danish smart homes, empirical insights on digital housekeeping are presented, a concept often associated with masculinity in the literature. By showing how digital housekeeping also relates to housework traditionally associated with femininity, including home decoration and cognitive labour, the paper nuances the gendered implications of the concept. The meaning and effects of digital housekeeping are discussed by critically examining the gendered manifestations in everyday practices and household members’ experiences. The paper shows how digital housekeeping potentially redistributes (gender) roles of everyday practices and forms a new point of control in the home. Although involving acts of inclusion, digital housekeeping also risks reinforcing power imbalances and existing domestic gender roles.

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Introduction

“Alexa is now being *built* into homes” (Strengers and Kennedy 2020, 82). Phillips Hue lights, Sonos speakers, Google Home and Alexa voice assistants – in the Global North, we fill our homes with more and more of these smart home technologies (SHT), sometimes building them into new houses before occupants move in. Although SHT uptake has been lower than expected for quite some time (Katuk et al. 2018), especially among women (Strengers et al. 2019), the market is growing and expected to more than double in size from 2020 to 2025 (Statista 2020). Denmark is a case in point, holding the European record for SHT use with 23% of the country’s population using SHT in 2019 compared to 10% for Europe as a whole (Statistics Denmark 2020). Smart lighting, heating, alarm systems, speakers, voice assistants, lawnmowers, and robotic vacuum cleaners are some of the SHTs that characterize Danish homes. Notable is an overrepresentation of male users; almost two out of three SHT users are male (Statistics Denmark 2020).

While technology has historically been coded as masculine, the home has often been categorized as a female domain; a place of maternal care and labour (Berg 1994; Mechlenborg and Gram-Hanssen 2020). In spite of these historical associations,

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masculinity and femininity are neither stabile, inherent, or “natural” phenomena, rather gender can be understood as fluid and constituted through social interactions and performance of practices, as established by gender studies (Butler 2006; West and Zimmerman 1987). Furthermore, existing research has demonstrated the mutually constitutive relationship between technology and gender, underlining that to understand what technology is and to challenge its gendered meanings we must look to the cultures and practices around it (Wajcman 2010; Mechlenborg and Gram-Hanssen 2020).

Although new domestic technologies are often promoted as enablers of time savings and convenience, their consequences are not always predictable or desirable when implemented in real-life settings. In Cowan’s (1985) historical account of the rise of modern domestic technologies, she documents how appliances like washing machines and vacuum cleaners actually intensified the gendered housework by accelerating cleaning standards and extending the responsibilities of the housewife. Cowan’s study exemplifies the importance of looking at housework and everyday practices when understanding the gendered implications of new domestic technologies.

A new area of domestic practices that has emerged with the widespread use of smart technologies has been called *digital housekeeping*, referring to the different tasks and work involved in setting up and maintaining a networked home (Tolmie et al. 2007). In most households, one person tends to be in charge of the digital housekeeping, one “guru” (Poole et al. 2008) so to speak, and this person is frequently male (Kennedy et al. 2015; Strengers et al. 2019; Chambers 2020). Digital housekeeping as a male domain relates to smart homes not only being primarily targeted and designed for men; the industry behind the technology also reflects a male culture (Strengers and Kennedy 2020). Whether or not digital housekeeping relieves or intensifies domestic labour is contested in the literature, and some researchers argue that its gendered distribution may reinforce traditional gender roles and household responsibilities:

“[D]igital housekeeping may create more work in the household, and further reinforce existing gendered divisions of labour by occupying more of a man’s time in a heteronormative household rather than becoming one of many responsibilities shared by all within the home unit” (Sadowski, Strengers, and Kennedy 2021, 10).

In order to explore the gendered implications of digital housekeeping, this paper unpacks the concept by looking at how it is enacted in daily life and how it relates to other household practices. As such, digital housekeeping is approached not merely as a “male domain” but rather as an area of homemaking practices that contributes to the production of certain *kinds* of masculinities (Pink 2004; Gorman-Murray 2008).

Based on qualitative interviews and home tours, the paper presents empirical insights on digital housekeeping in a Danish context. It will be shown how digital housekeeping relates to other forms of housework traditionally associated with femininity, presented in the first section of the research findings. In the second section, it is illustrated how digital housekeeping forms a nexus of control within the households. Section three describes how digital housekeeping involves acts of inclusion and negotiation. Section four discusses the gendered implications of the research findings for existing everyday practices.

Before elaborating on the paper's findings, a literature review is provided to describe the conceptual and theoretical framework of the paper. Following this, the methods are described, and afterwards, the findings. Finally, the conclusion discusses how SHT not only reconfigures the performance of gender in the home, but also reconfigures the gendered meanings of everyday practices. These dynamics deserve ongoing attention in addressing issues of digital inequality and power imbalances within the home.

Gender, Technology, and Social Practices in the Home

Existing research shows that homes constitute significant types of places as nodes of social networks and intimate household relations (Easthope 2004). Households are organized around different tasks, roles, and positions in the household hierarchy (Ellsworth-Krebs et al. 2015; Thoyre 2020), and technologies play a role in shaping their organization. As Wajcman (2010, 150) notes: "The materiality of technology affords or inhibits the doing of particular gender power relations". Gender, technology, and everyday practices are closely entangled and mutually shape each other.

Digital housekeeping comprises a new domain of domestic practices, e.g. installing, programming, and maintaining SHT. Digital housekeeping somewhat contrasts with traditional forms of housework, such as cooking and cleaning, which are coded as feminine. Like traditional housework, digital housekeeping is also gendered, but is associated with masculinity (Kennedy et al. 2015). Being most often performed by men, digital housekeeping is conceptualized as a form of masculinized tech-work in existing research (Chambers 2020; Strengers and Nicholls 2018). Furthermore, the ideal SHT user is often framed within the smart technology industry as what Strengers (2013) has termed the "resource man": a male, rational, and tech-savvy individual. Gendered stereotypes of this kind reinforces norms about who the technology is for and how it should be used (Strengers and Kennedy 2020). As a new practice domain, it can be discussed to what extent digital housekeeping should be considered housework. People who engage in digital housekeeping often find it enjoyable and fun, as a form of leisure and play, and it is questionable whether it actually saves time from existing household labour (Strengers et al. 2019; Strengers and Nicholls 2018).

Strengers and Nicholls (2018) have conducted research on the implementation of SHT in Australia. Their findings indicate that "other household members may end up taking back more of the traditional household responsibilities if the digital housekeeper's time becomes increasingly occupied with troubleshooting and maintaining the networked (and smart) home" (Strengers and Nicholls 2018, 78). This element of shifting time use and household responsibilities was also observable in this study. However, to further unfold the gendered implications of digital housekeeping, the present paper explores how digital housekeeping relates to and involves other forms of housework. As the findings will show, digital housekeeping in the interviewed households was not just characterized by rational calculations and technical installations, but also closely related to caring for other household members and to aesthetic considerations. To illuminate these aspects, the notion of cognitive labour and home creativity provide useful as will be described below.

Although often overlooked in sociological studies of housework, cognitive labour is a central dimension of housework that includes anticipating needs, making decisions, and overseeing family logistics (Daminger 2019). More specifically, Daminger defines cognitive labour as the work of:

- (1) Anticipating needs
- (2) Identifying options for meeting those needs
- (3) Deciding among the options
- (4) Monitoring the results

(Daminger 2019, 618)

According to Daminger, cognitive labour is highly gendered, and her study points towards women more often than men are the ones carrying it out. To illuminate gendered divisions of labour in the home, cognitive labour is therefore useful to include in line with other forms of more visible forms of housework.

Similar to cognitive labour, home creativity has historically been associated with femininity, “as a feminine creation of visual imagery and physical and emotional comfort” (Pink 2004, 43). However, (male) digital housekeepers indeed engage in creating aesthetic experiences and atmospheres as both the present paper and existing research show (Kennedy et al. 2015; Strengers and Nicholls 2018; Strengers et al. 2019). To include acts of home creativity in the analysis of digital housekeeping questions the division of the two domains as either pure feminine or masculine and instead draws attention to the fluidity of gendered categories. Practices of homemaking and home creativity are closely related to self-expression and identity creation (Gram-Hanssen and Bech-Danielsen 2004). These practices can be understood as something through which people “constitute their diverse gendered identities, and as such participate in changing gender” (Pink 2004, 45). Thus, to understand how gender is related to technology, it is useful to look at different kinds of household practices and the relation between them. In exploring this and men’s engagement in digital housekeeping, it is possible to see how a certain “domestic masculinity” emerges; a concept that “draws attention to how men’s [gender] identities are made through domestic ideals and homemaking practices” (Gorman-Murray 2008, 376).

Methodology

The study is based on qualitative interviews and “show-and-tell” home tours in 15 Danish households with SHT installed, conducted in the Fall of 2020. The households were located in both rural and urban areas including the mainland part of the country, Jutland, and the two biggest islands, Zealand and Funen. No strict requirements were applied regarding how much or what type of SHT households should possess. However, the study aimed to include participants with multiple types of SHT. Thus, in the sample selected, some households had smart lighting combined with a few separate gadgets (e.g. a smart bathing scale or plant watering sensors), while others had more comprehensive smart homes with voice assistants, robotic vacuum cleaners and lawn mowers, automated heating, automated blinds, smart alarms, etc.

Nine of the 15 selected households were recruited through Facebook groups in which people exchange experiences and advice about SHT. These groups mainly consisted of male members, and only men replied to the research call. An additional six households were recruited through snowball sampling, referred from participants recruited through the SHT Facebook groups and from the author's social network. With the exception of one single male, all participants were living in opposite-sex couple households and were encouraged to bring their partners with them to the interview. 12 out of 14 households did this. Thus, the final sample comprised a total of 26 participants including 14 men and 12 women.¹

Experiences and meanings of home vary across gender, class, ethnicity, and more (Gorman-Murray 2007), however, as the majority of the study's participants live in opposite-sex relationships, the findings are limited to this particular group. Rather than quantitative generalizability, the study provides an in-depth insight into a small segment of SHT users with an outspoken interest in SHT. People engage with SHT on many different levels. Larsen and Gram-Hanssen (2020) for instance differentiate between *tech-savvy* and *reluctant* households. Although participants of this study could be categorized as tech-savvy, this only applies to the male participants. Most women were characterized by reluctance towards the technology, as will be clarified in the paper. Thus, the 15 households can neither be categorized as solely tech-savvy nor reluctant, but rather by a mix and an internal tension between the two.

To investigate the implications of SHT in an everyday setting, a focus during the home tours and interviews was to explore the different practices directly related to, or indirectly affected by, SHT. Furthermore, an aim of conducting the interviews was to map particular routines, competences, and meanings (Shove 2012) and to investigate possible changes in practices, newly emerging practices or those that had been discarded. Questions of agency were also explored in asking about choices, preferences, and decisions in relation to SHT implementation and its use in everyday life.

In analysing how SHT take part in household practices, the study draws on practice theory. This theoretical framework takes social practices as the unit of analysis and draws attention to the mundane doings and sayings of everyday life (Schatzki 1996, 2002). Materiality (including technologies) plays a central role in practice theory, as materiality is seen as an integral element constituting practices. In Shove, Pantzar, and Watson's (2012) model of practices, practices are, apart from materiality, defined by two other elements: competence and meaning. When one element is changed in a practice, the other elements often also change, reconfiguring the practice in question. E.g. when a manual vacuum cleaner is replaced with a robotic one, the practice of vacuuming will suddenly require digital competences. Thus, when SHT enters household practices, these are performed in new ways and change accordingly. Although focusing on the materiality in practices, namely SHT, the present study also pays attention to how competence and meaning are reconfigured in the performance of household practices.

The home visits lasted from one and a half to two hours and included a semi-structured interview and a "show and tell" home tour which were both audio-recorded. During the home tours, which took place in the beginning or middle of the visit, I was shown around to see the technology, where it was located, what participants used the most, the stories behind, how they were acquired, how and when they were used. The semi-structured interviews, which were conducted both during the home

tours, before and after while sitting down, took an open form and the gender topic was not initially planned as a focus of the study. Thus, the questions asked during the interviews were not gender-specific but related to different roles and experiences in the family on a general level, focusing on the performance of everyday practices, various routines, preferences, understandings, meanings, and competences. All interviews were conducted in Danish by the author and subsequently transcribed verbatim. Quotes in the paper have been translated by the author from these transcriptions. The coding of interviews was conducted in the software tool NVivo, and during this process, gender emerged as a key theme. This will be clarified in the next section, which presents the findings of the study.

Findings

The Gendered Expressions of Digital Housekeeping

This part of the analysis shows what the performance of digital housekeeping entailed in the interviewed households, how it was divided among male and female participants, and how it related to other household practices, including home creativity (Pink 2004) and cognitive labour (Daminger 2019).

During the home tours and interviews it became clear that male participants were primarily, and in many cases solely, in charge of the digital housekeeping. Male participants described practices within this domain as enjoyable, fun, a matter of playing around, and satisfying when they could make things work:

Adam: I feel I discovered even more of my ‘inner nerd’ with [our] smart home. It’s kind of like playing with Lego again, that thing about it suddenly being fun, because it’s not just about some coding on a screen. The fun part about smart home is that when I do something in here [the Home Assistant dashboard], then the lights turn on and off. It’s something tangible. That the speaker gives you some kind of message. I think that’s fun.

Digital housekeeping requires interest, knowledge, and competence. All male participants had an outspoken interest in technology, with some specifically referring to themselves as “nerds”, such as Adam in the quote above. Many had a technical background, education and/or a job in technology, and several mentioned that they had been fascinated by technology since childhood. The technical language they used in the interviews revealed their knowledge and technological interest and segmented their role as the main driving force of SHT implementation in the household. Female participants would more often rely on their male partners to take care of the technology as the latter enjoyed and engaged in digital housekeeping more:

Interviewer: Is it Martin who sets it [the SHT] up, or do you do it yourself?

Tina: I would like to be able to do it myself, but it ends up being Martin. He gets to play with it, then I can do something else.

Tina’s view of Martin “playing” with SHT is notable. Their division of tasks seem like a matter of interest, although Tina would ideally like to be more involved – as she says, she would like to be able to set up the SHT herself. Most participants in the study made a connection between making their home smarter and its aesthetics and atmosphere: the smart home should look

and feel nice, and some of the technological installations should add to the decor and cater to the senses. The most common examples of this were: smart lighting, including designing the perfect light settings (e.g. those automated with particular colours) for watching movies or creating a cosy atmosphere; and music settings, which were set for particular times of the day to create a pleasant atmosphere in the living room or when having friends over for dinner. A concrete example is provided by Frederik who had created lighting and music settings, controlled by a Flic button (a button that can be connected to smart lighting, music, TV, etc.) which he could move around between the living room and the dining area:

Frederik: When I press [the button] once, then it turns off [the music] and turns on a lighting scene in the living room with these kinds of dimmed TV lights. [...] When I press it twice, that's if I have guests over for instance, and I'm not going to watch TV, but I still want a lighting scene and if I'd like a bit of music, then I put on a playlist.

These acts of creating an atmosphere through aesthetic and sensory elements show how digital housekeeping relates to acts of home creativity. During interviews and home tours it became clear that most male participants would engage in these forms of creative housework practices as part of their digital housekeeping. There are differences in how much participants engaged in the different parts of digital housekeeping. Kasper was a participant who was not particularly interested in spending a lot of time on programming. However, he enjoyed making light settings, especially with his favourite colour magenta-blue:

Kasper: I like magenta-blue, I don't know if it's the feminine side of me finding expression there. I love coloured lights.

Notably, Kasper associates his SHT implementation with his "feminine side", as something not to be associated with masculinity. In his living room, he has designed a particular lighting effect with the magenta-blue colour, aimed to create a calm and sophisticated atmosphere. Even though not all participants have chosen to have coloured lights in their homes, all male participants engaged in forms of home creativity to some degree, especially with the creation of lighting and music settings. Although associated with femininity by Pink (2004) and by Kasper in his interview, home decoration is obviously not a female activity per se. Rather, male participation in home creativity shows how the gendered organization of these practices is dynamic and subject to change.

During the interviews, male participants described the design of their smart home and how it involved a mapping of the household members' routines and preferences, accommodating for these. Thus, apart from the physical performance of setting up and running the smart home, the main digital housekeeper would also engage in cognitive labour. Most cases of SHT installation are designed to meet a need, involving cognitive labour to identify and implement that need. For instance, in several examples of digital housekeeping involving cognitive labour, the households have installed automated dimmed lights and adjusted them to the bedtime routines of the household to avoid the triggering of bright lights when household members use the bathroom at night-time. In a second example, John and his wife Connie installed a light signal in their children's bedrooms. Instead of having to knock on the children's doors when dinner was served, John and Connie blink the lights in their children's bedrooms through an app. This arrangement serves a number of purposes: first, John and Connie can communicate with their son

while he is wearing headphones and playing computer games; and second, they avoid disturbing their teenage daughter's privacy (as John said, "It's not always a good idea to walk into a teenager's room"). Furthermore, Connie suffers from joint pains, describing it as hard to run up and down the stairs to the children's rooms; she therefore appreciated the light signal solution.

Although the light signal solution for the children's bedrooms came from John's cognitive labour, the act of monitoring the results was shared by both John and Connie. Indeed, Connie's evaluation was central to the SHT solution being considered a success. John also installed dimmed lights under his and Connie's bed that would turn on automatically during the night if they got up, to avoid them stepping on their dog. As John said, "This is product development happening on the spot, where we can adjust everything to our peculiar habits". Thus, in making their home smart, John analyses the routines of the household and creates solutions to fit with what he refers to as the household's "peculiar habits". This exemplifies that cognitive labour is an important part of digital housekeeping, including anticipating needs, creating solutions, and monitoring the results. John's notion of "product development" furthermore indicates how digital housekeeping relates to the broader field of DIY activities which are likewise characterized by enjoyment, leisure, and home creativity in the pursuit of creating the ideal home (Mackay and Perkins 2019).

Another illustration of how cognitive labour relates to digital housekeeping was the case of a so-called smart cube that John had programmed with a "night routine" for Connie. The cube was about the size of a small fist and looked like a toy building block. It was "smart" in the way it could control devices via bluetooth when shaken. Connie explained:

Connie: After 9 pm it turns on the flytrap, turns off the kitchen lights, locks the front door, turns on the bedroom lights, also the bed light, uhm, and draws the blind [. . .]. It's kind of because my joints are so weak as they are and my memory by now is like a sieve, then that thing about remembering to do this and that and do all sorts of stuff – it's just been – it's been a help.

John had programmed this "night routine" for Connie to give her less stuff to do and fewer things to remember when she went to bed. Integrating different SHTs into such "routines" or "flows" is a central part of the digital housekeeping that entails one knows about and analyses the needs and rhythms of the household. As such, smart "routines" or "flows" represent certain ways of remembering and managing domestic chores, reflecting a cognitive dimension of the digital housekeeping.

SHT as a Point of Control

When participants spoke about their everyday practices involving SHT, it became clear that being the main digital housekeeper implies a central position of control in the household. In the case of Nadia and Erik, for example, Erik had purchased their Google Assistant on a weekend when Nadia was out of town. As he said jokingly, he "almost forced it on Nadia", to which Nadia confirmed that she indeed thought it was "silly". Once it was installed, she was still reluctant to use the voice commands and preferred Erik to do it for her:

Nadia: I don't do it myself [make voice commands]. Instead, I say to Erik, could you fix the light, or change the colour of the lamps, or turn up the ... I mean, in that way. Where I might do it myself, but ... there is something about it being yours [Erik's]. Like when I say, turn off the music [to Erik], where I could have just said it myself, I mean, I just had to add one more word [Google], then it would have done it. Then I put it on you [Erik], all that fancy stuff.

Erik: What I started up, I get to control myself.

Nadia: Yes, exactly.

Nadia's reluctance to use the SHT is clear from the quote; she considers SHT to be Erik's domain. Furthermore, Erik's words are notable: "What I started up, I get to control myself". Being the initiator of their smart home, Erik also becomes the one in control and the gateway to the technology in their smart home. On the other hand, Nadia's position in their smart home is rather passive; she is more detached from the technologies and primarily uses them *through* Erik. This kind of gendered relationship with SHT was expressed in most of the interviews, for instance by Sara who also referred to her partner Tobias as the one in charge of their SHT:

Sara: It's him who knows all about it. Then I'm told what he has set up. [...] It's mostly Tobias who does the research. I sometimes have a look at what could be nice to have, and then I tell him what I wish for.

Although Sara did express an interest in the technology – she herself had SHT wishes and ideas – it was Tobias who evaluated her requests and made the final decisions about what SHTs they would eventually install in their home. Gendered differences also found expression in terms of engagement and interest:

Ida: In the beginning when we got the new lights, I would ask Andreas [Ida's partner] to turn it on every time. Because I didn't bother to study the app, I didn't bother to download it.

Ida's unwillingness to use the technology appears as a question of impatience and a lack of interest, but the resistance or scepticism – which all female participants to a greater or lesser extent expressed – were for many also related to a feeling of awkwardness when using the voice commands:

Nadia: I still find it a little difficult to speak to it [...] it feels quite unnatural.

Tina: I speak to it [Google Assistant] once in a while, but then I'm told [by her children], 'Oh mum, now you sound real sulky again'.

Some of the participants also noted that the voice assistants would have more trouble picking up the voice commands of women than those of men – a tendency that is confirmed by research. For example, Perez (2019) found that Google Home is 70% more likely to respond to men's voices than to women's. This gender bias may be further reinforced by what is indicated by this study: that men use the voice assistants more often than women, and that the voice assistants therefore become more familiar with the sound of a male voice:

Karl: I think it [Google Home] generally takes me more seriously. I use it more.

Eva: It knows you better. [...] It learns to recognize Karl's voice because he uses it more.

The unequal use and gendered distribution of control over SHT in the home is also reflected in SHT ownership. Some SHTs require that users have an account for their software. Male participants are more likely to oversee these accounts, and in some cases have sole access to configuring the devices, as illustrated below:

Connie: The only one who can tell her [their Google Assistant] to configure the devices is her 'Lord and Master' [the name that John has programmed into the Google Assistant for addressing him]. [..]

John: Yes, one of the problems with the Google Assistant is that there is only one owner of what's called the 'home'. [..] I'm the owner, it's my Google account, I own it.

Thus, John is not only the driving force making the home smarter and the main digital housekeeper, but also the formal "owner" of the SHT technology and software which inevitably grants him more control over the SHT than Connie. The quote above further illustrates how people joke about the way they interact with their smart devices. As noted, John has programmed their Google Assistant to address him as "Lord and Master". This playing with relations and hierarchies is a common tendency in smart homes and human-technology relations. Other participants such as Kasper described how he addressed his Alexa voice assistant as "Lady A", and Frederik said during an interview with his wife and teenage daughter present: "I really enjoy that at least one woman [their Google Assistant] speaks nicely to me". Although these exchanges and terms of address have a humorous intention, the gendering of the technology – i.e. the feminization of smart assistants – may have implications for how we perceive gender and technology thereby risking the reproduction of feminized servant stereotypes (Strengers and Kennedy 2020).

Despite the clear tendency of male participants to be more in control of the SHT than their female partners, many of the female participants also had access to the control software, such as through smart home interfaces on their mobile phones. Although female participants did not express as much interest and engagement with the technology as their male partners, many did appreciate how the technologies had enhanced their lives, through added convenience and feelings of control. For instance, Susanne described how she had very quickly become accustomed to using apps to control different things in the home, describing how she would drive into their garage and open the gate via her phone. She particularly highlighted the value she gave to feelings of control provided by some of the SHT. For example, before going to sleep every night, she checks an app on her phone to make sure that the front door is locked. From the smart home interface, she is also able to turn off the lights and other devices from the bed. She said that these things had contributed to a "new normal", characterized by more convenience and control that she had come to appreciate:

Susanne: It quickly becomes the new normal, that it's easy. And I like it – and that's not just our particular [smart home] system – but that you have the overview, that you can see whether the door is locked and check stuff [..]. That kind of comfort, that's difficult to give up now, I think.

The “Wife Acceptance Factor” and Household Negotiation

As described above, the male participants took a leading role in the digital housekeeping. However, the opinions and preferences of their female partners were not seen as irrelevant; in fact, in some instances, they were seen as decisive. One participant, Mikael, ran a blog where he reviewed different types of SHT. He maintained that the key factor in determining whether his (male) readers would approve of the SHT reviewed was whether their female partners would approve:

Mikael: After all, it is up to them [the readers of the blog] to decide whether or not [the technology] fits well with Pia or Hanne [Danish female names] or whoever they live with. They [female partners] are the ones who must feel ok looking at it.

During the interviews, there were examples of negotiation and dialogue in relation to what kind of SHT and how much of it couples should have in the home. During a few of the interviews, a particular term came up referring to the importance of female partners' opinions, namely the “wife acceptance factor” (or simply the abbreviation “WAF”). Although not literally referred to in most interviews, “WAF” was somehow present in all household decision-making over SHT. As the name suggests, “WAF” was understood as the likelihood of female partners accepting a new piece of technology. For instance, Nikolas explained:

Nikolas: Well, it's a whole concept. If you go down to HiFi Klubben [a Danish electronics shop] for example, some of those most well-known speaker stores, then they use the slang ‘WAF’, that's the ‘wife [acceptance] factor’ - if a speaker has a high or low ‘WAF’. And it's not on a scale from one to ten, I guess it's just the feeling of whether it generally goes down well with the wives or not.

Nikolas elaborated that the technology can “have a low wife [acceptance] factor, if you have a lot of chords lying all over the place”. His partner Laura also used the “WAF” term, e.g. when she spoke about what kind of technology she did not approve of and gave an example of something with a “low WAF”:

Laura: In the place we lived before, you [Nikolas] had your router on display. And it had four antennae, so that one didn't have a high ‘WAF’.

Nikolas: No, it looked like a kind of spaceship.

Laura: So that was a bit difficult, having it on top of the TV stand.

Notably, the quotes from Nikolas and Laura, as well as the quote from Mikael, indicate that “WAF” does not necessarily relate to whether women are likely to use the technology or not, but rather whether they “feel ok looking at it” as Mikael said. “WAF” is thus closely linked to aesthetics. Although only a few participants used the “WAF” term, this aspect of whether the technology “goes down well with the wives” as Nikolas formulated it, was something that all participants deemed fundamentally important. During the interview with Karl and Eva, Eva said that she needed to be “persuaded” when Karl wanted to purchase new SHT. When describing how they got their smart thermostats, she said that she was “sceptical” at first, but that she was eventually convinced by the possibility of saving energy and money:

Eva: [...] so the deal was that we would spend less on heating, so we could both save energy and money on it. It would almost pay for itself; that was kind of like the sales pitch.

Karl: That was my USP [Unique Selling Point].

The terms “sales pitch” and “USP” underline the element of persuasion that is part of the negotiation taking place when couples implement new SHTs. Referring to their Google Home, Nadia said that Erik had “really tried to sell it”. The female partner’s approval is important in relation to how well the technology is integrated into the household. Many male participants expressed a concern that their SHT should be accessible not just to themselves, but to everyone in the home, including their female partners. These considerations about accessibility found expression in various acts of inclusion. For instance, Peter had designed a smart home interface so that his wife could become more familiar with it:

Peter: I chose to make it a bit like Apple on purpose, because we already use Apple products, so it’s something my wife knows about. She can relate to those kind of buttons [...] she is used to that from her phone. [...] I designed the buttons, so it looks like what she is used to looking at. And that’s for her sake, it’s not for my sake.

Another participant, Markus, spoke about how SHT was primarily his interest and domain in his and his female partner’s home. However, when he started making their home smart with automated lighting, the first thing he did was to purchase a smart makeup mirror, connected to Phillips Hue, and give it as a gift to his partner for the home. He had a feeling that his partner would be sceptical about the smart lighting, but by getting something specifically for her – the makeup mirror – he calculated that she would more readily accept it:

Markus: If I’d asked her whether we should have a big fat mirror in the bathroom that would light up, then she’d probably have said that we shouldn’t have that. So, I just bought it, I gave it as a gift for the home, then it was accepted.

Interviewer: Was there any resistance?

Markus: No, it was quickly accepted, mainly because it has this makeup function, then it was very quickly accepted.

Although Markus’ gift for his partner appears calculated, the example shows how the smart home is also framed as something through which household members consider each other’s needs and try to include each other.

(Re)configuring Household Practices

With the implementation of SHT, not only practices of digital housekeeping were introduced. SHT also reconfigured existing household practices. Smart speakers and voice assistants for instance became part of the practice of listening to music, making the practice easier, as Hans noted:

Hans: Alexa, we use it all the time. I mean, we use Alexa a lot for listening to music. We never listened to as much music as we do now. No doubt about it.

Another outcome of SHT implementation was a change in how existing traditional housework practices were performed and by whom. After Adam and Cecilie had purchased a robot vacuum cleaner, a robot lawn mower, and sensors for their plants giving notifications about when they needed watering, Adam had become more interested in traditional household practices:

Adam: You're [Cecilie] actually lucky, now I water the plants way more. I never watered the plants before, it's only within the last year I began doing it. When I get a notification, then sure I'll do it.

Cecilie: Yes, I never do it anymore. Only if Adam says they need watering.

Adam: But now I'm doing the watering, I just got a notification about doing it today. Vacuum cleaning, lawn mowing, watering plants, that's all something I love doing now.

Thus, existing practices and roles are reconfigured with the implementation of SHT. The introduction of SHT into the household is changing the gendered organization of traditional practices resulting in changes in the necessary competences required to complete these tasks. Thus, vacuum cleaning no longer implies running around the house with a manual vacuum cleaner but instead requires programming a route and time schedule for the device, and activating the technology via a voice command or an app. Traditional housekeeping has become "smart" in Cecilie and Adam's home and has become Adam's domain to a greater degree than before. This example of traditional household practices changing also raises the question of whether their very meaning has changed in the process. Adam was not necessarily motivated to perform these practices because he wanted a clean house, but also because he enjoyed programming and controlling the technologies. Thus, the very meaning or goal of the practices might also change in this process.

SHT is not only involved in new practices within the home, but also reconfigures existing ones such as cooking and cleaning; activities associated with "traditional" housework. Bringing SHT into these practices in some cases motivated male participants to participate in them more. For instance, with the installation of the plant sensors, Adam had become very keen on caring for the plants, while his wife Cecilie had originally thought that the device was unnecessary.

When asked directly about whether roles and the division of tasks and housework within the home had changed with the implementation of SHT, most participants denied this. However, many male participants said that they spend more time on various forms of digital housekeeping than previously, and as a result perhaps they participated less in other household tasks. This can reinforce existing roles in the household, as the following quotes from Erik and Nadia illustrate.

Interviewer: Do you feel that the division of tasks has changed with these technologies [...] that any roles have changed?

Erik: I think the roles have just become more affirmed. I would say, at least in our home, it's always been me who takes care of all technical and technology –

Nadia: Yes.

Erik: – and since we've added more technology to our everyday lives, then I've been granted a bigger part of those tasks.

Such traditional gender roles were also apparent among other participants, resulting in a division of what parts of the home that ended up “being smart”:

Peter: We are still that traditional that it's my wife who does the cleaning, does the laundry, etc. And her approach to this [the smart home] is . . . Let's say, more hesitant than mine, right? Before we moved, we had an automatic washing machine that you could operate online. But she never used it. The only thing she used was that it was very nice just to be notified when it had finished.

Peter and his wife no longer had a smart washing machine, and the quote shows how new technology does not necessarily lead to practices being performed differently. By making some practices “smart” and others not, the division of housework and gender roles generally become reinforced. Peter's quote also shows that it is possible to work around the affordances of the technology: Although they had a smart washing machine at first, his wife simply refrained from using its smart properties.

Such workarounds were a recurring theme in the interviews. Oliver had for instance installed smart lighting in his bathroom, with the lights turning on automatically via motion detectors and turning off automatically after five minutes. Thus, the practice of lighting was changed, making manual switching unnecessary. However, his partner Anna had not adjusted to this change. As Oliver said, “she can't figure out how to use it”. Anna kept switching off the lights manually, which would hinder the lights from turning on automatically afterwards. Oliver would then have to turn on the switch again before the automated lights would work.

Anna: I do it [use the switch] because I think [the automated lighting] works too slowly.

Anna and Oliver had different preferences and degrees of patience with the technology, as Anna's quote illustrates. Their different engagement with the technology shows that while the introduction of SHT reconfigures practices for some, others refrain from performing existing practices in new ways because of SHT. These differences in the performance of practices around the smart home can collide potentially disrupting the nature of these new material arrangements: When Anna turned off the lights manually, the lights could not turn on automatically afterwards thus disrupting the smart solution.

Differences in the performance of practices around the smart home and engagement with new technology could be resolved through parallel SHT systems, for instance, installing a manual switch or button that could work alongside voice commands or motion sensors. During a home tour, Martin described the household's smart speaker system, and how they would operate it through voice commands to their Google Assistant. However, Tina was not fond of making the voice commands as it felt unnatural to her. Therefore, Martin had instead installed a smart button remote located on their dining table, a “music button” for Tina, making her able to control the music without having to speak to Google. As Martin said, half-jokingly, “It's only Tina who's allowed to use it”. The button was a way for her to stay comfortable within the practice of operating music. This example also illustrates the cognitive labour involved in the digital house-keeping as Martin had detected a special need on Tina's behalf which had led to the button as a solution.

Concluding Discussion

When the home becomes smart, everyday practices and gender relations are rearranged in a number of ways. Previous studies of smart homes have illustrated how digital housekeeping is central in the process of SHT implementation (Tolmie et al. 2007), and that practices associated with this field are primarily a male domain (Kennedy et al. 2015; Strengers et al. 2019). However, as the present study shows, practices of home decoration and cognitive labour – often associated with femininity (Pink 2004; Daminger 2019) – are also closely related to digital housekeeping. According to Pink, housework and home creativity are “decisive in the production of continuity and change in contemporary gender” (Pink 2004, 41). In line with Pink (2004), the present study shows how digital housekeeping both changes and reinforces gender roles. This study further illustrates how gender roles and technologies dynamically interact, reinforcing Mechlenborg and Gram-Hanssen’s argument that “gender, home, and technology are not just formal features but are subjects of negotiation and positioning” (Mechlenborg and Gram-Hanssen 2020, 4).

The study has demonstrated how the gendered division of roles between digital and traditional housework can reinforce traditional gender roles as men spend more time on digital housekeeping and less time on other household tasks. This tendency is also highlighted in other SHT studies (Sadowski, Strengers, and Kennedy 2021; Strengers et al. 2019; Strengers and Kennedy 2020). However, the findings presented in this study add further nuance to this issue. They show that SHT can change the very meaning of housework and shift the way practices are gendered, an aspect of digital housekeeping that has received less attention in the literature. Such shifts were illustrated by the case of Adam who had become more engaged in traditional household practices, but at the same time, the meanings, materials, and competences related to these practices were changed. Further examples showed that when men engage in home decoration as part of the digital housekeeping, technologies can reconfigure how gendered practices are performed as well as the gendered meanings of those practices (Pink 2004). Thus, as this study has shown, home decoration does not necessarily involve putting flowers in a vase or hanging pictures on a wall but can also be performed through making settings in an app. These homemaking practices illustrate how “[d]ifferent masculinities are constructed, lived and represented uniquely in relation to the structural, spatial, material, visual, sensory and social elements of men’s homes” (Pink 2004, 119).

As Daminger (2019) notes, the tendency of women more often performing cognitive labour than men at the household level can lead to gender inequality, however, the present study shows that digital housekeeping often involves (male) performance of cognitive labour as well, for instance, anticipating needs and providing care for the household. Important to discuss in this regard, is the nature of this form of care, and whether it for instance relieve household members from housework. As reflected in other research (Strengers and Nicholls 2018, 2018; Kennedy et al. 2015), this study shows that there are clear gendered differences in terms of the interest in SHT and whether it is considered “nice to have” rather than “need to have”. Several female participants noted that although they had come to appreciate many of the smart solutions, if they lived alone, they would not install SHT in their homes. While the present study indicates that SHT does not always resolve traditional household tasks, the study’s small, qualitative

scope does not allow to conclude on the actual time spent on manual housework and digital housekeeping among men and women respectively. To gain a better understanding of and ensure a just and gender inclusive development of future smart homes, the paper calls for further studies on the relation between digital and traditional housework, particularly in relation to time of use.

In some ways, SHT enables multitasking and more efficient housework – thus several participants noted that their robotic vacuum cleaners saved them time. However, this would also require that they cleaned up more since the frequent run of the robot vacuum cleaner requires a clear floor space. Like other domestic technologies, SHT contributes to heightened standards of comfort, cleanliness, and convenience (Shove 2003; Cowan 1985). This study of SHT indicates that such accelerating standards are highly gendered.

In line with existing research, the paper illustrates how digital housekeeping is central to the process of SHT implementation (Tolmie et al. 2007) and that practices associated with this field are most often performed by men (Kennedy et al. 2015; Strengers et al. 2019). As with the male participants in this study, when household members spend a considerable amount of time on digital housekeeping, they are likely to spend less time on traditional household tasks. This risks reinforcing existing gendered roles in the division of household labour (Sadowski, Strengers, and Kennedy 2021; Strengers et al. 2019; Strengers and Kennedy 2020). In the findings presented from this study, female participants were more reluctant to use SHT and often became reliant on their male partners in various SHT interactions. When (male) household members oversee the digital housekeeping, they simultaneously have access to a central point of control in the home. These aspects require further awareness and research if we wish to challenge not just digital inequality, but also general power imbalances within the home.

Notes

1. All participants received written and oral information on the research project and gave their written consent to participate. They did not receive any gifts or economic compensation for their participation. Names were pseudonymized and personal data were protected in accordance with the EU General Data Protection Regulation (GDPR). Interviews and home tours were conducted physically in participants' homes except one interview and home tour which was conducted virtually via Skype.

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Disclosure Statement

No potential conflict of interest was reported by the author(s).

Ethical Approval

Informed consent was obtained from all research subjects participating in the study. Personal data were anonymized. Research was performed in accordance with the Declaration of Helsinki and was approved by the author's research institution.

Data Availability

Interview transcripts will be made accessible after publication.

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Technological fascination and reluctance: gendered practices in the smart home

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ABSTRACT

Smart home technology (SHT) is becoming more widespread, implemented to enhance convenience as well as energy flexibility and efficiency. Smart heating, lighting, security and entertainment systems are affecting social practices and the use of energy in different ways. This paper explores differences in competences, meanings and forms of knowledge involved in the performance of (gendered) household practices based on two Danish qualitative studies of different user groups: SHT frontrunner households ($n = 15$) and less tech-interested households ($n = 12$). The former had incorporated a broad range of smart technologies, e.g. vacuum cleaners, lighting and entertainment systems, while the latter were primarily engaged with smart heating systems. In the frontrunner households, internal differences in competences and meanings between men and women were more apparent than in households with less tech interest. A clear division between traditional and digital housekeeping is apparent that reinforces gender inequality. Evidence shows the variation in how SHT is part of gendered everyday practices; how SHT changes meanings and competences in practices and induces new ways of performing practices that can involve gendered digital inequality. Thus, it is necessary to consider competences and meanings in everyday practices as well as gendered ideas behind the technology.

POLICY RELEVANCE

Strategies and policies for a green transition of the energy systems in Denmark and the European Union include a digitalisation of consumption in households. This transition will induce reconfigurations of everyday practices potentially entailing both digital and gendered inequality. The home has often been a contested space, relating to gender roles, inequality and division of household labour. This paper shows that SHT potentially reinforces gender inequality by creating a gendered gap between digital and traditional housekeeping. To avoid potential reinforcement of gender inequality within the home, SHT promotion and development needs to account for gender differences. Actions by industry would include differences of gendered housekeeping, showing an awareness of varying technology competences and meanings in everyday practices as well as the gendered vision of SHT and its users.

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1. INTRODUCTION

Smart technologies are increasingly being adopted in homes and becoming part of mundane everyday practices such as heating, lighting and vacuuming. Smart home technology (SHT) holds the potential of technological and social disruptions in the everyday lives of households, including gender roles, the divisions of household labour and everyday routines (Hargreaves *et al.* 2018; Strengers 2013). There can be differences and inequities in how householders with different genders and socio-economic characteristics consume and benefit from the introduction of new energy services and technologies in the home. With regard to the envisioned and ongoing transformation of energy systems to engender flexible and sustainable consumption of renewable resources, it is essential to understand such differences within and between households, as those related to gender, to ensure a successful and just transition in energy practices (Gram-Hanssen *et al.* 2017).

Smart technologies are already shown to be altering everyday life and the divisions of household tasks. However, this is a rather new area of research that needs to be scrutinised more thoroughly. Traditionally there are gender distinctions in the division of household tasks, although there are cultural and geographical differences and differences between households. Cowan's (1985) seminal work on gender and household technologies showed how the introduction of new technologies in the home increased women's housework burden instead of relieving it envisioned. With the introduction of new smart technologies in households, new ways of performing household practices arise and the technologies might induce new meanings to household practices, just as the competences needed to perform these practices might change.

This paper investigates the different ways that SHT involves and reconfigures gendered everyday practices related to the daily performance of housework. Drawing on two qualitative studies conducted in Denmark by each author, it explores how SHT affects the performance of household practices in different ways among SHT 'frontrunners' and less tech-interested users. This provides new knowledge on everyday life with SHT in comparison with the technology visions of the future. A concept related to everyday life with SHT is digital housekeeping (Tolmie *et al.* 2007). Digital housekeeping comprises a new area of practices that arise with the increase of SHT and the wiring, functionality and maintenance of these, which potentially changes the distribution of everyday activities in households.

Does the division between traditional and digital housekeeping increase with the introduction of smart technologies—and how does it differ between the different households? Applying a gender perspective, the paper illustrates how existing and new household practices are differently performed and distributed among male and female household members. A focus is on how gendered practices of traditional and digital housework are reconfigured by SHT, and how this reconfiguration is mediated by particular meanings and competences (related to technological interest and skill) among more and less tech-engaged users.

2. APPROACHES TO GENDER INEQUITIES IN THE DIGITAL HOME

Gender studies have evolved around issues of power and inequality as well as dualistic gendered characteristics assigned to men and women, their life opportunities and spheres in which to work and live, including the home (e.g. Pink 2004). This involves understanding all social relations as gendered and explicating gendered visions of the home and domesticity as well as technology and everyday practices connected to the home. The home has been and remains a contested space with inequality issues, for example, related to housework, income and energy poverty (Tjørring 2016; Petrova & Simcock 2021). At the same time, homes are both material and social entities, and are subject to transformation through homemaking processes that include the use of energy and resources in the production and reproduction of the home (Blunt & Dowling 2006; Petrova & Simcock 2021).

In the literature concerned with housework, it is widely stated that women undertake a major proportion of unpaid work in Western households, although the numbers vary across countries (Clancy & Roehr 2003; Robinson 2019; Sullivan 2018). A divide between the types of unpaid work

that women and men undertake at home is also persistent, which influences the responsibility and performance of everyday practices in households (e.g. Allison *et al.* 2019). Women spend more time and resources on activities such as cooking, cleaning and laundering, and tend to be responsible for more of the care activities in the home. On the other hand, men are more often responsible for maintenance, technical decisions and tasks in relation to household energy (Carlsson-Kanyama & Lindén 2007; Clancy & Roehr 2003; Ellegård & Palm 2015; Tjørring 2016). Divisions of housework and childcare are, however, undergoing changes and households' compositions are becoming more diverse (e.g. Pink 2004).

Connected to inequities in the division of housework is also gender inequality in relation to access and use of energy resources. A vast amount of literature is concerned with how different genders are affected by a scarcity in resources for the accomplishment of everyday practices and development of household and energy technologies in both the Global North and South (Feenstra & Özerol 2021). Studies have shown that women are more adversely affected by energy poverty. More women than men struggle to afford energy services that meet their needs, and more women than men head low-income families (Robinson 2019; Feenstra & Clancy 2020). Clancy & Roehr (2003) establish that gender issues are influencing how energy is consumed in terms of choices, attitudes and knowledge on energy use and environmental issues. Energy studies have shown that men and women tend to have different capacities to act and also legitimise decisions differently according to their gendered identities, influenced as well by other social characteristics such as age, economy and ethnicity (Clancy *et al.* 2020, Tjørring 2016). Petrova & Simcock (2021: 852) also state that energy poverty exists in 'developed' countries as 'fuel poverty':

Here, an inability to attain adequate domestic energy services typically results from unaffordable energy services, rather than a lack of material access to electricity. Although emphasis typically is placed on space heating deprivation, recent work has suggested the importance of other energy services such as cooling, lighting, and ICTs [information and communication technologies].

Both energy and digital inequality are gender issues to be aware of in the development of new, smart energy systems based on increased flexibility and digitisation of households' energy use.

Gender studies have underlined that gender is performative and that the dualism of feminine and masculine can be performed and ascribed to identities and practices in multiple ways, for example, in the negotiation and repetition of performing household practices (Butler 2006; Pink 2004). Following Pink (2004), gender is produced and reproduced while performing everyday practices in the home, such as housework that includes resources, material objects, appliances and technologies. Householders can perform household tasks in multiple ways confirming, resisting or altering their gendered identities (Pink 2004: 16). Feminist technology studies have highlighted the relation between gender and technology and their mutual shaping of each other while criticising the traditional conception of technology as masculine (Wajcman 2010). This conception is rooted in the binary oppositions ascribed to male and female gender identities and refer to the technologies of industrialisation. However, symbolic gender binaries are often also at play in the production, design, and use of household and energy technologies (Mechlenborg & Gram-Hanssen 2020). This means that the 'masculine' sides of gender binaries, such as technical, hard, objectivist and abstract, are most often highlighted and connected to technological development, also within the home (Offenberger & Nentwich 2009). In terms of smart technologies, Stengers (2013) coined this masculine connotation of the imagined user of the technologies 'Resource Man'.

The concept of digital housekeeping developed by Tolmie *et al.* (2007) can describe the different tasks and processes required when smart technologies are adopted. Installing, maintaining, updating and adapting the SHT to the organisation and routines of the household are all parts of the digital housekeeping. To perform this successfully, technological skill, competences and knowledge are needed. Without the necessary competences, living in a smart home can be challenging and time-demanding and lead to frustration and feelings of inconvenience (Hargreaves *et al.* 2018; He *et al.* 2019). When people lack interest and refrain from learning how to use the technologies, the properties of the technologies are left unused and people tend to perform workarounds (Wright 2019; Larsen & Gram-Hanssen 2020).

As recent research shows, the design of SHT is also gendered (Strengers & Kennedy 2020). Smart technologies and artificial intelligence (AI) are developed in male-dominated industries that reproduce heteronormative stereotypes, having negative impacts on gender equity (Perez 2020). While Perez (2020) presents statistical material on gendered inequalities, these issues are also reflected in qualitative empirical research. As Kennedy *et al.* (2015) found in their field and interview studies of Australian households, different genders engage with smart technologies in different ways, and often men rather than women are found to be the ones in charge of the smart home. In Denmark, which has recently been ranked as number one in terms of SHT usage among European countries, approximately two-thirds of the users are male (Statistics Denmark 2020). The gendered distribution of SHT use has important implications for households' tasks and responsibilities as it might lead to a clearer division between traditional manual housework, on the one hand, and digital housekeeping, on the other, reinforcing traditional gender roles and spheres, as found by Strengers & Nicholls (2018) in their empirical studies of Australian households. Building on this existing research, the present paper explores gender and (digital) housekeeping in a Danish context.

3. RESEARCH APPROACH AND METHODS

In exploring household practices and everyday life with smart technologies, this paper takes inspiration from theories of social practice. Within this framework, practices can be defined as the nexus of sayings and doings situated in specific times and places (Schatzki 1996, 2002). Furthermore, practices are understood as constituted by interlinked elements. Following Shove *et al.* (2012), a focus is not only on the materials in practices, such as the physical house and technologies, but also on the particular *competences* forming (household) practices, defined by forms of understandings and practical know-how, and on *meanings*, referring to the social and symbolic significance of a practice, emotions and motivations, exploring the interdependent relations between them (Shove *et al.* 2012: 23). In particular, the paper investigates how competences and meanings differ among the different research participants in their performance of practices that include SHT and how this relates to gender dynamics.

The paper builds on two qualitative studies conducted by each author, in total comprising 23 in-depth interviews combined with show-and-tell home tours in Danish homes with various smart technologies installed. Study 1 (15 households, 26 participants)¹ was conducted in autumn 2020 and included households with a combination of various forms of SHT (e.g. smart lighting, smart heating, digital voice assistants and robotic vacuum cleaners). The first nine households in the study were recruited via SHT Facebook groups where people share experiences and advice, and six additional households were recruited via snowball sampling referred from the initial participants and from one contact of the authors. Only men responded to the posted research call and common to all of them was an outspoken interest in technology. They all lived in opposite-sex relationships, except one single man, and were asked to bring their female partners for the interviews, which 12 out of 14 did.

Study 2 was conducted in the winter of 2019–20 and included households with smart heating installed by outside professionals as part of smart energy demonstration projects. The sample thus represents more mixed users in terms of technology interest and engagement compared with those in study 1. These participants were recruited via publicly accessible contact information on internet sites and the sample (eight households, 12 participants) included four opposite-sex couples and four singles (seven male, five female). Households in both studies were located in different parts of Denmark, including both rural and urban areas (see Appendix A for a summary of participants).

The combination of interviews with show-and-tell home tours in which participants showed and talked about their different technologies was able to spark participants' memories and gave a practical insight into their everyday engagements and concrete scenarios. Interviews took an open and semi-structured form, following an interview guide with a list of themes relating to everyday life and different components of social practices (e.g. materials, competences, meanings, roles,

interests, comfort, energy consumption and technology use). The interviews lasted about 1.5–2 hours and were audio-recorded, transcribed and analysed in the software tool NVivo through an open-coding process in which prevalent themes were identified.

In study 1, there was a general tendency of male participants being primarily or solely in charge of setting up and maintaining the smart technologies, while the women were less engaged. In study 2, both men and women were in general less interested in SHT and to a larger degree shared the responsibility of running the technology. The following section presents four cases, two from each study, that exemplify these prevalent gender dynamics and distributions of housework. The discussion of cases is not meant as a one-to-one comparison, nor generalisable. Rather, it illustrates several different gender dynamics and possible outcomes of SHT implementation that links with competences and meanings at play in everyday practices. The cases were selected for being generally illustrative of recurring gender dynamics in the two studies respectively and as such synthesise central tendencies in findings.

4. CASE STUDIES

4.1 CASE 1: ENJOYING DIGITAL HOUSEKEEPING

Adam and Cecilie are both in their mid-30s and live with their two small children in a detached house in a suburb to a larger city. Adam works as an accountant and Cecilie as a nurse. Their home contains a vast number of different technologies: digital voice assistants, smart lights, smart music control, a robotic vacuum cleaner, a robotic lawn mower, smart blinds, a smart security system with cameras, etc. Adam is the driver of the smart home and in charge of it. He has a do-it-yourself (DIY) approach and enjoys programming, integrating the different technologies, creating flows and exploring new possibilities for smart solutions in the home. Cecilie, on the other hand, is not very interested in SHT. She learns the necessary things from Adam, e.g. how to operate their robotic vacuum cleaner through an app, but she does not spend time tinkering with the technology as does Adam.

Adam has set up smart switches in the living room so they can control not only the lights but also the music, the robot vacuum cleaner and the window blinds. The switches make the connection run through wires (e.g. not Bluetooth), which allows for an instant signal with no delay, which is what Adam prefers. Adam has no technical background and does not work with information technology (IT). However, his father has always been interested in technology and Adam believes he has inherited this.

Adam describes himself as a hi-fi nerd: he is interested in technological quality (sound, vision, fast signals and gadgets). He prefers an open-source control system because it allows more technologies to be integrated. He aims to create the cheapest solutions possible while not compromising in terms of stylishness. In his own words, it has almost become a sport to him to create cheap homemade solutions and avoid buying the expensive technology. Rather than having the readymade software from SHT companies, he prefers buying the hardware and then build the automations himself, trying to create SHT solutions that use the least power. However, he estimates their total energy consumption as being higher now compared with if they did not have any smart technologies. During the interview he states that although the time he saves from the technological solutions does not make up for the time he spends on tinkering with SHT, he finds it valuable, nevertheless.

Cecilie often has trouble with operating the technology, especially when Adam has changed the settings, made updates or added new features. In the beginning when they obtained their robotic vacuum cleaner, it was only Adam who was able to operate it since Cecilie did not have the app on her phone. Sometimes she would call or text Adam at work and ask him to turn it on, which he was able to do remotely, via the app. Eventually, Cecilie also got the app and now they both estimate that she has been more in charge of vacuuming lately, in contrast to the beginning when it was always Adam (however often prompted by Cecilie). They vacuum on an ad-hoc basis, approximately once a week. Adam also installed sensors for their plants that can send notifications

to his phone when they need watering. Before, Cecilie would usually water the plants, but now Adam does it when he receives notifications. Cecilie finds this set-up 'totally unnecessary'. When she waters the plants, she checks whether the leaves are drooping or if the soil is dry, but now it has become Adam's domain. As Adam says during the interview:

You're [Cecilie] actually lucky, now I water the plants way more. I never watered the plants before, it's only within the last year I began doing it. When I get a notification then sure I'll do it.

4.2 CASE 2: SIMPLIFYING DAILY CHORES

Nadia and Erik are both in their late 20s. They live with their two small children in a rented three-room apartment in a big city. Nadia works as a nursery schoolteacher and Erik as a facility operations manager. Apart from working fulltime, the couple primarily spend their time on running the household and taking care of practical matters related to having small children. It is Erik who has purchased the different SHT, and he is in charge of installing and updating it. As he says, he kickstarted their smart home while Nadia just 'tagged along'.

Nadia and Erik's SHT set-up consists of two Google Home speakers integrated with digital voice assistants which they use for controlling the television, music, adding things to their shared digital shopping list, setting timers during cooking, browsing the internet and controlling their smart lights. One example of the digital housekeeping that Erik performs is creating chains of actions in Google. He has, for instance, recently created one called 'Good night'. Thus, when saying 'good night' to their voice assistant during night-time, the television and the lights turn off and a dimmed night light in the hall is switched on. However, they rarely use this function: Erik estimates he uses it once a month. As he says, he just set it up to see if the function worked. Erik uses the digital voice assistant mostly in the mornings and evenings to turn the music or television on while looking after the children, e.g. when preparing their meals. During this, the children tell him what they want to watch and he then puts it on via voice command. As he says:

I think it makes life much easier, especially having small children who wants one thing, then the other, and you're constantly occupied. [...] So, it can simplify things and make them easier.

Nadia, on the other hand, does not use the voice assistant very often because she still finds it difficult to talk to. However, she has slowly begun to use some of its functions, for instance, setting timers while cooking or asking about the weather. She describes herself as not being very interested in technology and prefers when it just works without requiring too much effort or skill from her side. As she says, she does not care 'to learn the ropes'. Furthermore, she has had troubles with getting used to the technology and often uses it through Erik. For example, she asks him to perform the voice commands for her. As she formulates it, she feels like it belongs more to him: 'I have something about it being yours [Erik's].' When she eventually does give the voice commands, it feels unnatural. She reflects that if she and Erik did not live together, she would not have the smart technologies installed. One of the things that makes her uncomfortable about the technology is, for instance, their voice assistant's listening function which she sometimes finds 'creepy' when it suddenly interacts at random points in their conversations.

4.3 CASE 3: MINIMISING HOUSEWORK

Nanna and Allan are in their 40s and live with their teenage daughter in a newly built owner-occupied apartment in an expensive part of a big Danish city. Allan has a leading position as a business services manager and Nanna works as a senior consultant. Their new-built apartment has underfloor heating, mechanical ventilation and is highly insulated. The apartment has a smart heating system installed with digital thermostats in each room and one in-home display (IHD) screen in the hallway. They also recently obtained a robotic vacuum cleaner which they were trying out at the time of the interview.

Both Nanna and Allan work quite long hours and sometimes also in the evenings. Allan has for many years done much work-related travelling, and around the time when they moved into the new apartment he was living abroad for a period. Therefore, Nanna was the one taking care of most things in relation to decorating and getting settled in the new apartment. She also took on the responsibility of learning how to use the heating system and was in charge of the heating. After Allan moved back home and into their new apartment, he also learned how to use the system. Now, a few years after moving in, Allan is the primary user of the IHD screen, which they use to control temperatures in all rooms rather than the digital thermostats in each room. They have played with programming a schedule for the heating according to when they are at home so that the heat is turned down during night- and daytime on weekdays when they are at work. They have also used the vacation mode when going away on a holiday. In relation to this, money saving is not very relevant to them, although Nanna mentioned that it is nice to save money at the same time as contributing to the green transition and maintaining high comfort levels. They are usually happy with the system and find it quite easy to use, although at the time of the visit they were have some problems with controlling it. The system does not confer to their set temperatures, and they felt out of control at that moment. This could be related to the demonstration project, as their temperature settings could also be controlled remotely by the project partners experimenting with avoiding heating peaks.

Their new apartment is smaller than their old traditional apartment and therefore they feel that they live more compactly now, but with all the functions they need in their everyday life. Also, they think their current apartment is more energy efficient. They enjoy living in a new and smaller apartment because they have less housework and maintenance and more time to relax when at home, which is important to them. Nanna explains that her home should be simply decorated to induce calmness as she needs to relax her mind when she comes home after a long working day. During the week they do not cook themselves as they return quite late. Instead, Nanna buys and brings home an evening meal from the cantina at her workplace. On Fridays they often buy takeaways or eat out, but during the weekend they cook themselves. When living in the old apartment they had a cleaning service as they felt it was a hassle to clean. Living in the new apartment they feel it is much easier to clean (as it has a smaller area) and therefore they have agreed to do it themselves. They do this together spending a few hours at the weekend along with doing the laundry. Nanna does not really expect that the robotic vacuum cleaner will take over their cleaning routine.

4.4 CASE 4: TESTING GROUND

Karen and Poul live in a newly built apartment similar to the one in which Nanna and Allan live. It has the same smart heating system with digital thermostats in each room and one IHD screen in the hallway. This system was installed in all apartments in the building complex before the new owners moved in. Poul and Karen have an electric car, but they do not own any other smart technologies. Karen is 62 and works fulltime as an associate professor, and Poul is 70, a pensioner and, in his own words, a 'stay-at-home dad'. They have grown-up children and grandchildren.

Because he is a pensioner, Poul does most of the housework during weekdays. He shops for groceries and most often also cooks so that meals are ready when Karen arrives home from work. Karen cooks more often at the weekends. Before, when they were both working, they would share housework responsibilities. Poul also does much of the cleaning during weekdays and is in charge of charging the electric car. This cannot be done from their apartment or a private parking lot in connection to the apartment, so he takes it to a neighbouring public parking space or somewhere else in the city and goes for a walk while it charges. Thus, the charging activity is not connected to a smart system in the home, but rather a manual practice which entails moving the car. Even though they feel it is a bit of hassle, they have the electric car because of environmental values as they do not wish to pollute the city, and also a feeling that electric vehicles are 'the future'. Karen furthermore stresses that she normally cycles to work, and if she needs to travel somewhere else in the country in relation to work, she mostly goes by train. They also try to limit the use of the tumble drier to only bed linen, leaving the rest of the clothes to dry on racks either in

one of the two bathrooms or one of the two balconies. Besides from this, they feel that they live energy efficiently in the new-build apartment and do not think much about lowering their energy consumption additionally.

Karen and Poul have had many problems with managing the heating system in their new apartment. They have both learned to use the system by reading the manual to start with, and then trying out the technology and different strategies to make it work according to their temperature preferences. They have been very confused about the technology and how it works because they sometimes feel that they cannot control the temperature; sometimes it has heated too much or been lowered too much either during the day or the night. Some of this confusion is also related to the demonstration project in which the apartments in this building were involved for a period during the first years after the apartments were built. The project was carried out by a Danish technology company and a university partner, and the aim was to experiment with controlling the heating remotely to avoid heating peaks, e.g. during mornings. However, Karen and Poul have been very confused by when their discomfort was related to the demonstration project and when it was their control of the technology. They have not tried to schedule a heating routine or use the vacation mode as they feel it has been much of a hassle to use the system to heat the apartment according to their comfort notions. Karen has mostly been in charge of using the technology and trying to figure out how and when it worked or not (e.g. by manually writing on paper noting the temperatures in each room). She also demonstrates how it works during the visit. She has been the one to contact the project partners to get assistance with the technology. Before, when they lived in their old house, Poul was in charge of the heating system with radiators that needed seasonal maintenance work.

5. THE GENDERED DISTRIBUTION OF DIGITAL HOUSEKEEPING

As the four cases illustrate, the distribution of household practices and digital housekeeping take many forms, and the degree of motivation, technological interests and competences vary greatly among the participants. The smart home set-ups in the households are quite different and have been implemented in different processes and for different purposes. Cases 1 and 2 represent more extensive smart home set-ups than cases 3 and 4, as the former have various forms of integrated SHT such as automated lights, voice assistants and smart gadgets. Cases 3 and 4, on the other hand, represent more modest smart homes, mainly consisting of the built-in smart heating systems which to some degree are also operated by outside staff. When comparing the four cases, it is evident that the division of tasks is more clearly divided in households containing 'frontrunners', whereas roles are more equal in the less tech-interested households. How this relates to different meanings and competences involved in the performance of practices is considered next.

5.1 TECHNOLOGICAL FASCINATION, RELUCTANCE AND DIVIDED RESPONSIBILITIES

Cases 1 and 2 both represent households characterised by a male technological frontrunner and a less tech-savvy woman. The male frontrunners were the main drivers of the smart home, selecting and purchasing the technology, installing and maintaining it, and were primarily or solely in charge of the digital housekeeping. They had the necessary competences and digital skills for programming, connecting the technologies, creating settings and getting new ideas for further technological installations. Common to these male participants was an outspoken interest in technology that they both experienced since childhood.

Implementing SHT into the household's everyday practices gave new meaning and motivation for Adam when he performed household practices, and Erik felt that SHT made his everyday life more fun and convenient. On the other hand, the female participants were reluctant to interact with the SHT and only found it valuable when it worked smoothly, without requiring new skills or forms of interaction (e.g. voice commands). The passion for smart technologies was not equally shared within individual households. For instance, Cecilie would learn the basic commands of their smart technology systems by using an app on her phone which was needed to make the technology work

in her everyday in order to avoid changing the practices too much. Nadia would slowly try to learn using the voice assistant by voice command, although she did not feel comfortable. Often, these female participants would rely on their male partners when they needed to integrate the SHT into their everyday practices. Erik said that the implementation of SHT had led to a clearer division of roles in their household because he would now spend more time on digital housekeeping (installing, maintaining, updating and adapting the SHT) and thus less time on 'traditional' housework.

The SHT not only added new practices in the form of digital housekeeping, but also made changes to existing practices. The robot vacuum cleaner, for instance, changed traditional cleaning practices as vacuuming was now done by managing an app and involved communication between the partners. Also, the plant sensors that Adam had bought to send notifications when the plants needed watering changed the watering practice. Adam explained how he had come to enjoy vacuuming and watering plants after adding smart technologies to these traditionally manually performed practices. Thus, traditional housework is changed with SHT implementation and also the meanings ascribed to household practices. Adam had not become more engaged in vacuuming because of heightened cleaning standards, but rather because of his technological interest and enjoyment.

5.2 SHARED RESPONSIBILITIES AND TECHNOLOGY AS ENABLER OF COMFORT

In cases 3 and 4, the SHT set-up mainly consisted of the integrated smart heating which was installed through an energy demonstration project as part of building the new apartments. Thus, the implementation was carried out by outside professionals who held the necessary skills and knowledge about the technology, and the participants had not themselves taken initiative to install SHT. Both households had varied experiences with the technology and were frustrated when it did not work. None of the participants was interested in tinkering with the SHT for fun and enjoyment. They only regarded the technology valuable in terms of comfort enhancement, as well as convenience, if they could make the technology work. In contrast to the frontrunners, these participants were not curious about exploring or experimenting with the technology as such.

The smart heating was appreciated when it worked smoothly, adding comfort to the households and saving them time or energy. Nanna and Allan described time as a valuable resource to them and considered SHT ideal when saving them time. They did not enjoy housework and when at home they preferred to relax. Therefore, housework should be easy to overcome, also in relation to time. Most housework activities were shared, but also considered something to just get over and done with and something they wished to minimise. In the same way, digital housekeeping was in general not particularly enjoyed by the participants in cases 3 and 4 but was an occasional necessary practice that both genders would perform on quite equal terms. Male and female household members took turns sharing the responsibility for managing the heating system, shared the successes when it worked and the frustrations when it failed. The outside responsibility was furthermore outspoken, for instance, when Poul and Karen talked about having limited control with the system because the outside operators would manage it, turning the heat up and down. In both cases they also needed to contact the outside operators for help with controlling the system. This sometimes led to a feeling of lack of control, but it was also appreciated, for instance by Nanna, who spoke about not thinking so much about heat adjustment anymore.

In sum, the participants in cases 3 and 4 primarily valued the technology when it provided comfort and convenience, operating easily and invisibly. Besides time savings, the environment was also mentioned as a value in these households' consumption practices. To manage the technologies, they would sometimes do workarounds or apply alternative methods, such as Karen checking the thermostats with pen and paper. Thus, the digital housekeeping was performed quite differently than seen in the cases of the frontrunners, as these held other competences, forms of knowledge and motivation for engaging with the technology than less tech-interested users. In study 2, digital housekeeping was more evenly distributed between male and female partners than among the couples in study 1.

5.3 THE IMPORTANCE OF MEANINGS AND COMPETENCES IN (GENDERED) DIGITAL HOUSEWORK

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The above analysis illustrates different competences and meanings connected to the implementation of SHT, which not only implies changes in the material arrangements of the home but also influences which competences are necessary in the performance of household practices, as was also shown by Aagaard (2022). These competences and meanings reflect how household practices are affected differently as the materials change by the introduction of SHT. Comparing the cases illustrates the link between internal gender dynamics and the distribution of household practices, including digital housekeeping, as the householders represent different competences and meanings in relation to SHT, affecting gender roles in the household. The meanings ascribed to traditional and digital household practices have implications for how, why and by whom the practices are performed. While participants with less technological interest reluctantly perform practices of digital housekeeping, frontrunners on the contrary enjoy spending considerable amounts of time programming, tinkering and playing with the technology. In this way, digital housekeeping can be a joyful activity for some practitioners, while for others it feels like a hassle or a duty. In the households counting frontrunners, the digital housekeeping was a male domain, implying a clearer gendered division of also other household responsibilities. As Erik said during the interview:

I think the roles have just become more affirmed. I would say, at least in our home, it has always been me who takes care of all technical and technology. And since we've added more technology to our everyday lives, then I've been granted a bigger part of those tasks.

These cases of SHT implementation indicate that household responsibilities can become more divided and gender roles more reinforced when the interest, competences and ascribed meanings to the technology are unequally distributed. On the other hand, in the less tech-interested households, the distribution of digital household practices and traditional household practices was more evenly distributed as the competences and meanings towards SHT were also more similar among the householders.

The four cases represent different SHT set-ups: households with smart heating systems and households with a combination of various forms of SHT. These technologies in themselves afford particular forms of use. Heating is seldomly associated with fun and gadgets, but rather considered as something that should just work smoothly in the background, providing comfort and not require too much interaction, as has been shown in studies on heating practices and technologies (e.g. Larsen & Gram-Hanssen 2020; Madsen 2018). The SHT set-ups with various devices, on the other hand, require more work as the devices need to be integrated in order to function together. Some of these devices can also be described as gadgets as they relate to entertainment or creating a certain mood or atmosphere in the home with lights and music. These material differences underpin different meanings of the smart home. In the smart heating households, the technology, when working, played a quite invisible role in the participants' everyday lives, requiring less interaction than other technologies in the more extensive smart homes. For instance, the smart lights and digital voice assistants involved daily interactions via voice commands and app operations. Considerations of sustainability and energy consumption were quite absent among the frontrunners while being a more outspoken concern in the smart heating households.

6. DISCUSSION

Feminist technology studies have demonstrated the gendered construction of technology and how it has been associated with masculinity throughout time (Wajcman 2010). The home and domestic practices, on the other hand, are traditionally viewed as women's domain (Berg 1994; Mechlenborg & Gram-Hanssen 2020). While the findings of this paper in some respects reflect these insights, they simultaneously reflect a degree of contestation to traditional gender norms, i.e. in cases 3 and 4. The variation between the four cases relates to the point that:

men and women practice their housework [...] as modes of resistance or conformity to conventional and contradictory discourses on gender and morality.

(Pink 2004: 16)

Thus, masculinity and femininity are not bound to be associated with technological power and subordination (Berg 1994), but are continuously renegotiated in people's everyday lives. In study 1, men were in general the main digital housekeepers, which is a tendency also reflected in existing research (Kennedy *et al.* 2015; Strengers *et al.* 2019). In study 2, however, the digital housekeeping was to a much higher degree shared between male and female household members. These differences between the two groups (frontrunners plus reluctant; reluctant plus reluctant) found expression in terms of different competences and meanings at play. In this way, gender was performed differently in the two groups in relation to practices of digital housekeeping, but also to traditional household practices. For example, in cases 1 and 2, household practices such as vacuuming and watering plants were changed by adding smart technology to the practices (and new competences). This changed both the way the practice was performed and who performed it. The analysis therefore indicates that in order to overcome gendered divides and digital inequality in the home, it is necessary to consider competences and meanings in everyday practices as well as the gendered ideas of the technology itself.

Khalid & Razem (2022) in a similar way used practice theory to investigate the nexus of gender, domestic space and energy technologies in everyday practices, addressing power dynamics and gendered relations in households. Focusing on Global South contexts, they found that energy technologies such as lightning and air-conditioning and appliances such as washing machines can both signify domestic control for women according to their position in the household, at the same time as the energy infrastructures, spatial outline of homes and household technologies can take part in upholding a patriarchal structure and division of gender roles. Even though some of the working women in the study found liberation in energy technologies and appliances, in the form of freeing time to have both paid and unpaid work, this technological development has not changed gender relations and divisions of work in countries such as Pakistan and Jordan. This is following Cowan's (1985) seminal work that showed the technologic development to result in 'more work for mother'. However, Khalid & Razem (2022) also conclude that it is necessary to address the differences in access and needs between different groups of women according to the context of their role in the household in an attempt to reach both equality and sustainability.

Related to this, one should:

take better account of chore-doing and the gendered nature of energy consumption
both to avoid negative unintended consequences for the gendered division of labour,
but also to improve the design and implementation of smart electricity systems.

(Johnson 2020: 2)

In continuation of these arguments, the present analysis calls for specifically taking competences and meanings into account in the focus on chore-doing or housekeeping and in the development of SHT. This approach can contribute to strengthening future feminist investigations of the relation between gender and technology and their mutual shaping of each other.

7. CONCLUSIONS

Four household cases illustrated how the distribution between digital and traditional housework varies. This revealed how different technologies shape social practices and how differences in competences and meanings have implications for the gendered use and implementation of smart home technology (SHT). Comparisons of household usage of SHT identified different characteristics of these competences and meanings by analysing how gender is performed differently in participants' everyday practices. The gendered distribution of digital housekeeping and other forms of housework is impacted not just by gender but more specifically by gendered forms of knowledge, competences and meanings ascribed to everyday practices and how these are performed, including the technologies in use. Gender is neither static nor naturally inherited,

but rather performed in different ways. Furthermore, SHT and tech savviness are not inherently a masculine domain. More specifically, technological engagements and digital and traditional forms of housekeeping are distributed according to household dynamics and negotiations, configured by the interplay between competences and meanings in the performance of practice.

The introduction of SHT changes the competences needed in practices and the meanings attached to them. Thus, SHT requires new forms of tech competences in performing everyday practices such as heating, lighting, vacuuming and controlling music. Also, the meanings of these practices related to comfort, cleanliness and convenience are changed by the new technologies. Both competences and meanings related to the use of SHT in everyday practices are gendered in different ways according to gender roles and negotiations within households. These changes are induced into traditional housework practices but are also at play in new practices of digital housekeeping. Therefore, the design, functionality and intentions with SHT need to include differences of gendered housekeeping as well as the gendered vision of SHT and its users. It is thus critical to consider competences and meanings in everyday practices to avoid digital inequality and accommodate a sustainable transition of everyday energy consumption for different members and different household types.

NOTE

1. Empirical findings from this study have also been used by Aagaard (2022).

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COMPETING INTERESTS

The authors have no competing interests to declare.

DATA AVAILABILITY

Anonymised interview transcripts will be publicly accessible and stored in a data archive.

ETHICAL APPROVAL

Research was performed in accordance with the Declaration of Helsinki and was approved by Aalborg University, complying with data management guidelines. All participants were informed about the purpose of the research projects and gave their written consent to participate, having their personal data protected in accordance with the European Union's General Data Protection Regulation (GDPR). Written informed consent was obtained from all research participants and personal data (including participants' names) were anonymised. The names used in this paper are pseudonyms. All participated voluntarily and did not receive any gifts or economic compensation for their research participation. Interviews were conducted via physical meetings in the participants' homes, except for two interviews in study 2, one of which was conducted by Skype and the other by telephone.

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A.1. APPENDIX A

Table A1: Summary of interview participants in studies 1 and 2.

PSEUDONYM(S) AND AGE (YEARS)	HOUSEHOLD SIZE	RESIDENTIAL TYPE	EXAMPLES OF SMART HOME TECHNOLOGY (SHT)	SETTLEMENT/ LOCATION
Study 1				
Adam (34), Cecilie (34)	4 household members (2 preschool children)	Owner-occupied detached house	Automated lights, smart alarm system, robotic vacuum cleaner, smart speakers, digital voice assistants	Suburb
Nadia (28), Erik (29)	4 household members (2 preschool children aged 4 and 2)	Rented apartment	Automated lights, smart speakers, digital voice assistants	City
Sara (23)	3 household members (1 male partner and 1 preschool child)	Rented house	Automated lights, smart alarm system, robotic vacuum cleaner, smart heating, digital voice assistants	Village
Frederik (48), Charlotte (45)	4 household members (1 school-aged child, 1 adolescent)	Owner-occupied detached house	Automated lights, smart speakers, digital voice assistants, temperature and humidity sensors	Outskirts of city
Mikael (39)	4 household members (1 female partner, 1 preschool child, 1 school-aged)	Owner-occupied detached house	Automated lights, smart alarm system, robotic vacuum cleaner, smart speakers, digital voice assistants	Outskirts of city
Oliver (29), Anna (27)	1 household member (they live separately; the interview was conducted in Oliver’s home)	Cooperative apartment	Automated lights, smart speakers	City
Hans (52), Susanne (?)	4 household members (1 preschool child, 1 school-aged)	Owner-occupied detached house	Automated lights, smart speakers, digital voice assistants, smart alarm system	Village
John (52), Connie (47)	4 household members (1 school-aged child, 1 adolescent)	Rented house	Automated lights, smart speakers, digital voice assistants, smart alarm system, homemade gadgets	Suburb
Karl (32), Eva (29)	2 household members	Rented apartment	Automated lights, smart speakers, digital voice assistants, smart heating	City
Kasper (48)	1 household member	Cooperative apartment	Automated lights, smart speakers, digital voice assistants, smart alarm system	City
Martin (47), Tina (47)	4 household members (2 school-aged children)	Owner-occupied summer house	Automated lights, smart speakers, digital voice assistants, smart alarm system, smart heating, robotic lawn mower	Village
Markus (35)	2 household members: (1 female partner (35))	Rented apartment	Automated lights, smart speakers, digital voice assistants	City
Nikolas (29), Laura (29)	2 household members	Owner-occupied detached house	Automated lights, smart speakers, digital voice assistants, smart alarm system, smart heating, robotic vacuum cleaner	Town
Peter (65)	2 household members (1 female partner)	Owner-occupied detached house	Automated lights, smart speakers, digital voice assistants, smart alarm system, smart heating, robotic vacuum cleaner	Outskirts of city
Ida (31), Andreas (33)	2 household members	Rented apartment	Automated lights, smart speakers	City
Study 2				
Poul (70), Karen (62)	2 household members	Owner-occupied apartment	Smart heating	City
Kristian (70)	1 household member	Owner-occupied apartment	Smart heating, smart alarm system	City

(Contd.)

PSEUDONYM(S) AND AGE (YEARS)	HOUSEHOLD SIZE	RESIDENTIAL TYPE	EXAMPLES OF SMART HOME TECHNOLOGY (SHT)	SETTLEMENT/ LOCATION
Nanna (46), Allan (40s)	3 household members (1 adolescent)	Owner-occupied apartment	Smart heating, robotic vacuum cleaner	City
Thomas (49)	1 household member	Terraced house (cooperative ownership)	Participated in project with smart heating technology, air-to-air heat pump	Town, island
Svend (70)	1 household member	Owner-occupied town house	Participated in project with smart heating technology	Town, island
Niels (64), Susan (61)	2 household members	Owner-occupied detached house	Participated in project with smart heating technology, air-to-air heat pump	Town, island
Marianne (75)	1 household member	Owner-occupied town house	Participated in project with smart heating technology, air-to-air heat pump	Town, island
Johannes (70), Ruth (69)	2 household members	Owner-occupied detached house	Participated in project with smart heating technology	Town, island

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SUMMARY

Digital voice assistants, robotic vacuum cleaners, and automated heating – these are just a few examples of the advancing technologies that are increasingly entering the home. ‘Smart home’ technologies reconfigure not only the materiality of domestic space; they also affect social life and everyday practices. Based on qualitative studies of households and technology developers, this dissertation provides insights on the relationship between the visions behind the technology on the one hand and everyday practices on the other. Through an exploration of smart home technologies’ implementation into new and existing household practices, it is shown how the smart home is a locus of challenges, negotiation, and conflicts, with important implications for gender, energy consumption, control, and power.