6-18-2022

Exploring the Behavioral Sprouts of Smart Home Farming

Lars Andraschko
University of Augsburg, lars.andraschko@uni-a.de

Philipp Wunderlich
Reutlingen University, ph.wunderlich@googlemail.com

Saonee Sarker
Lund University, ss2kh@comm.virginia.edu

Daniel Veit
University of Augsburg, daniel.veit@wiwi.uni-augsburg.de

EXPLORING THE BEHAVIORAL SPROUTS OF SMART HOME FARMING

Research in Progress

Lars Andraschko, University of Augsburg, Augsburg, Germany, lars.andraschko@uni-a.de

Philipp Wunderlich, Reutlingen University, Reutlingen, Germany, philipp.wunderlich@reutlingen-university.de

Saonee Sarker, Lund University, Lund, Sweden, saonee.sarker@ics.lu.se

Daniel J. Veit, University of Augsburg, Augsburg, Germany, daniel.veit@uni-a.de

Abstract

In times of climate change and growing urbanization, the way food is produced and consumed also changes. Meanwhile, digitization is transforming farming practices, which also applies to the domestic growing of crops. More and more so-called smart home farms (SHF) are finding their way into private households. This paper conceptualizes the unique nature of enabled smart services and their underlying technology. Following an inductive interpretive approach, this study explores the antecedents of smart home farming practices. Our sample consists of eleven actual smart home farmers. We found six constructs to be of salient importance: expected outcomes related to harvesting, positive feelings, and sustainability; a combination of one's affinity for green and novel technologies; and the smartness and visibility of the enabled services. In the outlook, we present some preliminary thoughts for testing our qualitative findings.

Keywords: Urban Agriculture; Smart Farming; Smart Service Antecedents; Household Technology; Interpretive Research.

1 Introduction

For most of our ancestors, growing food at home was part of everyday life. Nowadays, with 55% of the world population living in urban areas (UN 2019), only a few amateur gardeners supplement their food supply personally: From seed to table. Yet, so-called vertical farms offer households new possibilities in yield and efficiency (e.g., Benke and Tomkins 2017; Kalantari et al. 2018). Advanced smart farming techniques allow even completely inexperienced individuals to deepen their value chains and secure their own supply of greens. But unlike a plant pot, some soil, and a watering can, the upfront costs of such a smart home farm (SHF) are typically many times higher. On top of that, individuals take care of their plants by employing digital technologies.

A recent large-scale survey showed that almost two-thirds of humanity worries about climate change (UNDP and University of Oxford 2021). One existential threat for many is the increasing agricultural vulnerability due to climate change (e.g., Swaminathan and Kesavan 2012). However, agriculture is not only threatened, but it is also a facilitator for global warming as 25 % of anthropogenic emissions stem from agricultural practices like deforestation, livestock, and transport (IPCC 2018). This made the United Nations call to reflect on both sides of the sword: Combat climate change and cope with its consequences (UN 2020). Here is where SHFs can contribute to a healthier and more sustainable diet (Despommier 2011; Kozai 2019; O'Sullivan et al. 2020).

As it is often the case with novel IS phenomena, systems design work is somewhat ahead of our understanding of behavior (see Strobel 2020 for an example on smart farming systems architecture). Hence, little attention has been paid to novel services that SHFs offer to consumers and their unique nature: These (1) affect individuals' food intake, (2) offer the potential for private sustainable behaviors, and (3) impose an agentic role on the technology in leisure activities. The specific reasons why individuals demand SHFs related services remain in the dark. Although there are some insightful foundations that enlighten our understanding of the connections between businesses and consumers or households, the Internet of Things (IoT), and sustainability (Beverungen et al. 2019b; Kim et al. 2017; Wessel et al. 2019; Wunderlich et al. 2019), literature that reflects on the unique nature of SHF enabled services remains scarce (e.g., Jürkenbeck et al. 2019). This leads to an inadequate grasp of the complexity associated with the ongoing digitization of household agricultural practices, which seemingly undergo a complete transformation. Our endeavor aims to gain a deep understanding of the antecedents of SHF-related co-creation. We therefore pose the guiding question of *why do private individuals engage in smart farming practices?*

Understanding more precisely why the interactions between individuals and smart technologies occur can help to leverage enhanced smartness (Wessel et al. 2019). This is important for such young systems, as it allows better designs of smart features that promote required practices and prevent unintended consequences (Wessel et al. 2019). Moreover, the multipurpose sustainability-convenience setting will help to reveal important drivers of individuals engaging in respective co-creation practices.

To unbox the behavioral determinants, we start with exploratory research since theory and related literature could not sufficiently explain the phenomenon under study (see section 2.1). This allowed us to develop anteceding constructs of SHF service practices. To test these insights at large, we pursue a developmental mixed-methods design (Venkatesh et al. 2016) divided into two phases: a qualitative inductive endeavor and a quantitative deductive endeavor. This paper presents and discusses the first findings of our qualitative inductive work (adopting an interpretive stance) (Klein and Myers 1999; Walsham 2006). We suggest a preliminary set of levers driving individual behavior surrounding the emerging phenomenon of SHF.

2 Conceptual Background

This section provides some theoretical foundations on smart services, as our understanding of SHF practices grounds on prior literature related to smart service systems and related technologies in the home environment. Since SHFs are still in their infancy, we also outline a first conceptual scheme of the underlying technology below. By giving an idea of SHFs, their unique characteristics, and individuals´ required engagement in the practice – we seek to form the basis for future purposeful investigations (Lehnhoff et al. 2021) in the smart farming domain.

2.1 Smart Services

Smart services encompass the co-creation of value through a configuration of people, technologies, organizations, and information (Beverungen et al. 2019a; Maglio et al. 2009). More specifically, these services apply specialized competencies through actions, processes, and performances relying on smart products as boundary objects (hereafter referred to as smart technologies) (Beverungen et al. 2019b). Typical distinctive features of smart services are the level of decision autonomy, visibility, and life/ object embeddedness (Wünderlich et al. 2015). In a study examining the interaction between dementia patients, caregivers, and intelligent GPS tracking, Wessel et al. (2019) show that smart services do not automatically contribute to the better. The authors focus on the service system's configuration and identify three types of smartness: degraded, fragile, and enhanced. In order for enhanced smartness to emerge (and for the system to persist in the long term), their research suggests taking a closer look at what the smart technology actually does and how it influences individuals' practices and emotions.

A comprehension of the smart technology is a prerequisite to understanding the behavioral drivers to engage in enabled practices. Although IS literature on the specific phenomenon of SHF is yet nonexistent, we identified related underpinnings on household, sustainable, and smart technologies. Basically, SHFs may be considered as a type of smart home technologies (SHTs), because they are a "separate entity comprising of connected physical and intangible components, which provides an extensive set of applications aiming to enhance individuals' capabilities for a desired outcome within their private residence" (Andraschko et al. 2021, p. 3). Drawing on this conceptualization, the authors propose a taxonomy comprising seven outcome-focused characteristic dimensions: expanded communication, automated and personalized convenience, coordinated surveillance, adjusted and supported health, expanded and informed safety, managed savings, and expanded and automated sustainability(Andraschko et al. 2021). In the senior scholar's basket of eight, two studies more deeply reflect on SHT and its use (Warkentin et al. 2017; Wunderlich et al. 2019). These studies emphasize the sustainability aspect (including social and environmental issues), which has significant behavioral implications. In turn, the studies provide some evidence on the reasons that discourage individuals from using such technologies, mainly related to privacy.

Some further research has been conducted on these service-enabling technologies outside of our field. For instance, Li et al. (2021) and Marikyan et al. (2019) brought forward reviews summarizing the drivers and barriers of using SHT. Accordingly, barriers can stem from financial, ethical, legal, privacy, security, or technological concerns (Li et al. 2021; Marikyan et al. 2019). There is even more nuanced evidence on the promoting side to be found. Although there are some studies on the employment of SHT, antecedents for co-creation in the specific case of SHF are entirely absent. However, engaging in these practices confronts individuals to decisions uniquely involving a combination of hedonic, utilitarian, and altruistic themes (see section 2.2).

2.2 Smart Home Farming

The services SHFs are offering to the consumer (1) affect individuals' food intake, (2) offer the potential for private sustainable behaviors, and (3) impose an agentic role on the technology in leisure activities. The smart technology consists of an artifact in which the plants grow and a smartphone app for control (see Figure 1). Smart home farmers interact with the app to monitor the farms. The app provides information and prompts the individual to perform physical activities around the farming box. The layered nature of SHFs and their potential to save resources (water, transport, packaging, acreage, etc.) appears to be a good match to the characteristics of a sustainable technology being "unique combination of being (1) a tangible good that is installed at a consumer's residence […and] (2) innovative services and applications [.. like] enhanced efficiency" (Wunderlich et al. 2019, pp. 674–675). So technology can contribute to individuals' enjoyment or food supply and serve sustainability goals. But in contrast to other household technologies, food technologies affect the particular domain of eating where consumers attach importance to factors like naturalness, health dreads, or control over the harvest (Siegrist and Hartmann 2020).

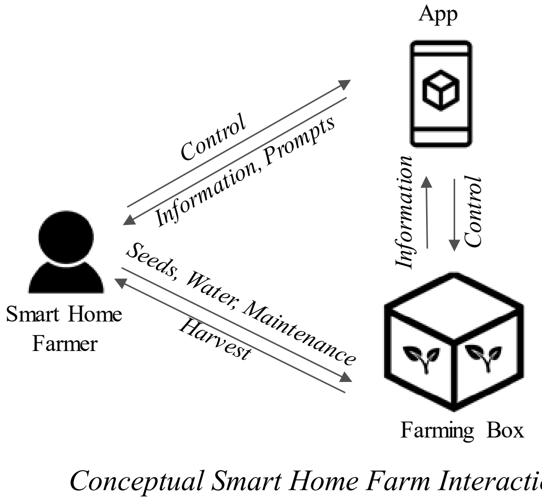

Figure 1. Conceptual Smart Home Farm Interaction Scheme.

The underlying idea for these domestic smart agricultural practices is vertical farming. This concept comprises stacked growing of edible plants by applying controlled agricultural environment (CAE) techniques (Despommier 2011). The salient benefits of smart home farming come mainly from applying the CAE techniques. Accordingly, these are the omission of pesticides and herbicides, the absence of transport ways and packaging for the harvest, high water- and spatial-efficiency, and fast and effective growth (Benke and Tomkins 2017; Kalantari et al. 2018). On the other side, criticism of SHFs refers to energy consumption for lighting and ventilation, the limited range of crops, and high required initial investments (Benke and Tomkins 2017; Kalantari et al. 2018). However, since this technology is still in an early stage, a definitive and comprehensive assessment is hardly possible (see Seidel et al. 2017, for a take on holistic sustainability assessment).

Despite the absence of research on SHFs within our discipline, we would like to point at a few studies from outside: For instance, computer science researchers have investigated what makes commercial farmers adopt IoT applications (e.g., Madushanki et al. 2019). A focus on private individuals' involvement in smart farming practices, however, remains scarce. In interdisciplinary sustainability research, we found one study that focuses on the adoption of SHF. In a comparative survey Jürkenbeck et al. (2019) investigated the consumers' acceptance of SHFs, the produce of supermarket farms, and the produce of large-scale indoor farms. Regarding the SHF, the study shows confirmatory results linked to variables of the technology acceptance model (TAM) (Davis 1989) and the theory of planned behavior (TPB) (Ajzen 1985). The authors also found that the most influential antecedent for usefulness was perceived sustainability. This aspect directs us further to consider SHF as an interesting phenomenon to explore smart services at the largely unexplored intersection between convenience and sustainability.

3 Method

The exploratory phase of our mixed-method study relies on qualitative data. We adopted an inductive, interpretive approach and assumed the role of an outside researcher (Klein and Myers 1999; Walsham 2006). Such qualitative work is about understanding individuals' perspectives and behavior in specific settings by conceptualizing and making sense of what is happening (Kaplan and Maxwell 2005). Before empirically reaching out, we obtained a preliminary understanding of the phenomenon under study by making use of 'up-front theory' (Sarker et al. 2018). This guided our study design as follows.

For data collection, we relied on in-depth interviews. To conduct these interviews, a semi-structured interview guideline was developed based on our preliminary understanding. As our work progressed, the guideline was adapted because we took an iterative approach to data collection and analysis (Walsham 2006).

Our sample consists of eleven active smart home farmers from Germany and the Netherlands (see Table 1). For interviews in the upper single digit range, further data did not spark in major novel themes (Charmaz 2006, p. 113). Therefore, we recognized a sufficient level of saturation for this progressing work. Since the phenomenon is not yet widespread, and we wanted to understand individuals' reasons for engaging in the specific smart service practices, we used a purposive sampling strategy (Myers 2019). We directly contacted a SHF manufacturer to negotiate access to individuals who engage in these activities. Thereby, also two experts of the company were recruited for our interviews. These provided particular interesting views owed to their twofold angles. First, they are private smart home farmers themselves. Second, they contributed to a broader understanding of the underlying technology and the emerging phenomenon in general. Our sample of smart home farmers can be considered as quite heterogeneous, meaning we interviewed individuals of different ages and household lifecycle stages (cf. Brown and Venkatesh 2005). In addition, our participants engage in various occupations representing a wide range of income levels.

#	Farming Experience	Duration	Profession	Gender	Household Members
1	3 years	68 mins	Product Manager	male	3
2	3 years	33 mins	Managing Director	male	1
3	3 years	35 mins	Entrepreneur	male	3
4	2,5 years	24 mins	Homemaker	male	2
5	2,5 years	28 mins	Social services Manager	male	2
6	2 years	23 mins	Streetcar Driver	male	1
7	0,5 years	40 mins	Homemaker	female	4
8	0,5 years	35 mins	Sales Manager	male	4
9	3 years	32 mins	Accountant	female	4
10	1,5 years	31 mins	Entrepreneur	male	2
11	0,5 years	42 mins	Telecom services Manager	male	1

Table 1. Sampling of Smart Home Farmers.

The interviews were conducted in June and July 2021, recorded, and then fully transcribed. The texts were coded manually using the qualitative data analysis software MAXQDA. We followed established three-step guidelines, typically associated with inductive theorizing to systematically analyze the data. This starts with a systematic interpretive description of the textual data, followed by the formation of sub-categories, which are finally aggregated to major conceptual themes (Corbin and Strauss 1990). The application of this procedure can frequently be found in interpretive studies published in top journals (e.g., Cram et al. 2021; Seidel et al. 2013). Figure 2 exemplarily shows how we increased the level of abstraction from formalized text descriptions to key concepts. Our analysis and interpretation resulted in 168 first-order codes forming 21 sub-categories, ending up in six major themes.

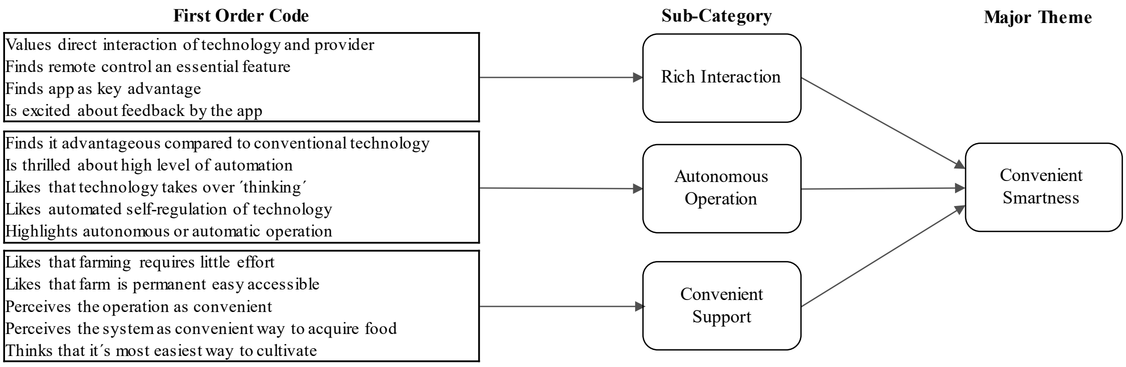

Figure 2. Excerpt from the Coding Procedure.

4 First Phase Results and Discussion

At an early stage of our endeavor, we recognized that the salient reasons for individuals to engage in smart farming practices vary by far. After extensive data analysis and a thorough reflection on this variety, three behavioral antecedent categories emerged: expected outcome, service characteristic, and personality trait. An overview of the first findings is shown in Figure 3, comprising the three categories and our six key constructs.

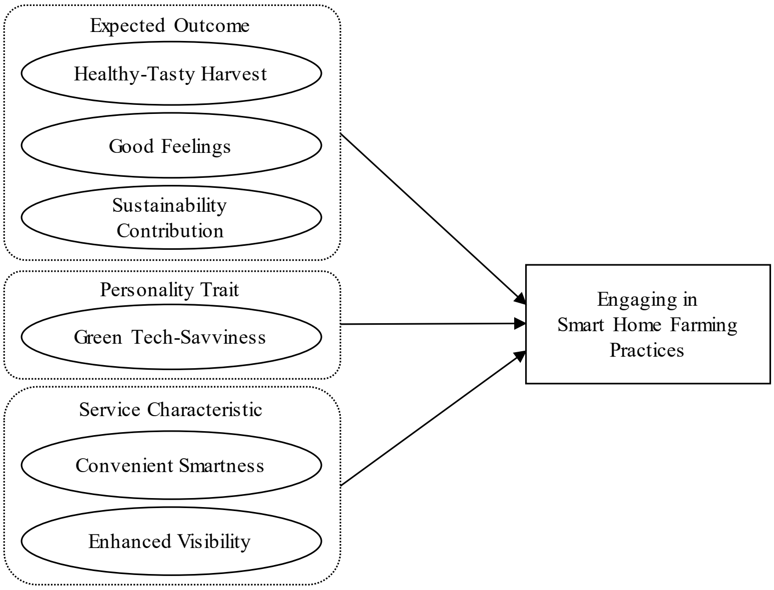

Figure 3. Antecedents of Smart Home Farming.

4.1 Expected Outcome

We identified three major themes related to what smart home farming activities can deliver to the individual. The salient outcomes individuals expect from a specific behavior have demonstrated high predictive power in social psychology (c.f., Bandura 1986) or the IS discipline (e.g., Venkatesh et al. 2003).

The construct of a healthy and tasty harvest refers to expectations about the material outcome of farming activities – the produce – in terms of quality, freshness, taste, healthiness. This is exemplarily emphasized by the following quote "*[..]a reduced quantity is better off than a sluggish mountain [lettuce], thus, rather than a few leaves with a very intense and very aromatic taste"* (Interviewee 4). Another stated that *"it's mainly about the quality and freshness and, if I do not grow myself, I just make sure that it is regional and organic"* (Interviewee 2). This relates to umbrella constructs observed in various smart home technology-related studies, usefulness, or utility (Hubert et al. 2019; Marikyan et al. 2021), but given the unique linkage of food, it deserves particular attention.

Expected good feelings refer to positive emotions about smart farming, with participants reporting happiness, hope, joy, pride. For instance, a participant reported that *"[..] it is also fun being able to farm by myself"* (Interviewee 3). Such emotions appear to positively increase the frequency as one stated to be *"very happy with it and also plant two three times a week"* (Interviewee 10). Previous studies in related SHT context found established constructs like hedonic value to be applicable (Marikyan et al. 2021). However, besides focusing on the fun factor, emotions appear to play a crucial role that received only little attention in respective research (Burton-Jones and Stein 2021; Pinsonneault and Beaudry 2010).

The sustainability contribution can be described as technology's current and future potential to decrease the personal footprint and save resources. Intertwined with the previous two factors, a smart home farmer stated that *"the basic motivation was certainly to plant something yourself and that was the, that was the healthy thing to have, that is sustainable"* (Interviewee 8). Another stated that the farming would be *"less, the concern for my health itself, but increasingly [...] the effect on our environment, which for a long time was neglected [...] here the SHF makes a great contribution"* (Interviewee 1). The construct of sustainability contribution linked by the same participant to the good feelings as the following quote emphasizes, *"this hope alone, that I make a positive contribution, already gives me a good feeling"* (Interviewee 2). In this vein, other scholars found the anticipated feel-good effect to be a relevant factor

– however, not for high-priced contexts as it is with the SHF (van der Linden 2018). But for SHFs our findings reveal that the sustainability aspect seems to endure the adoption decision (Jürkenbeck et al. 2019).

4.2 Personality Trait

Green Tech-Savviness refers to the affinity or personal preferences for sustainable novel technologies. In fact, one key aspect when researching within private households is to reflect on individual differences (e.g., Brown and Venkatesh 2005). Besides the focus on demographical aspects, also traits play an important role. Here, we found a unique combination of individuals prone to novel and green technologies, which characterizes some sort of conscious early adopters (Arkesteijn and Oerlemans 2005; Rogers 1983). One participant elaborated on that by mentioning *"what we are doing here on the planet is falling on everyone's feet again [...] here it is really the green spirit that is kind of hovering around [the farm] [...] and also a bit of the affinity for technology"* (Interviewee 3). In literature, established constructs refer to one's innovativeness (e.g., Wunderlich et al. 2019) or the environmental consciousness (e.g., Schill et al. 2019).

4.3 Service Characteristic

The construct of enhanced visibility refers to the instance that the service is recognized by multiple groups of persons while delivery and through the tangible artifact: Oneself, children, and peers. Several notions of the service's presence are subsumed under this characteristic, including touchpoints in personal leisure or in children's education, and with peers – holding a signaling function. Besides the previous elaboration on the good feeling factor, the two following statements underline the specific SHF ability to purposefully interact with the children or be of a visual appeal *"because for us it is important that the children have a positive approach to it and try it out"* (Interviewee 8); *"I also shared my SHF on Instagram as soon as it was installed and I got insanely amazed feedback"* (Interviewee 7). The visibility of smart services is a typical distinction feature (Wünderlich et al. 2015). Some well-known constructs, which have also been applied in the smart home context, are demonstrability (e.g., Hubert et al. 2019) or smart leisure (Marikyan et al. 2019). But very little attention received the educational aspect smart home farming may have for children.

Another reason to engage in smart home farming is the convenient smartness that the service offers. This refers to perceptions about operating the SHF in terms of little time and effort, autonomy and automation, and rich interaction possibilities. As of eleven participants, six have not engaged in farming activities previously - this factor appeared to play a crucial role. For instance, one elaborated that the main reason was that it is "*a machine where virtually everything works by itself, only every two months we have to clean it once in a while"* (Interviewee 6). Another participant emphasized the minimal care smart home farming requires due to the *"the high degree of automation ... the system improves itself and when it needs something, e.g. nutrients, there is direct feedback - it doesn't need much attention in the end and the most important thing"* (Interviewee 8). Similarly, in the field of smart home technology, previous studies demonstrated the advantage that respective systems are convenient (e.g., Baudier et al. 2020) or automate daily routines refers to the automation of daily routines (e.g., Marikyan et al. 2019). Therefore, convenient smartness can be seen as another specific factor influencing individuals' behavior.

5 Interim Conclusion and Outlook

Smart home farming is an emerging phenomenon comprising individuals' engagement in novel practices by utilizing smart technologies to co-create food at home. This exploratory study identified various themes that drive individuals´ engagement. We address the limited understanding of individuals' reasons for domestic, digitally mediated crop cultivation. The revealed insights, though, are contextually and theoretically exciting, as they provide a preliminary understanding of smart services that combine hedonic, utilitarian, and altruistic purposes. Following the idea of context-specific theorizing (Hong et al. 2014), our qualitatively identified antecedents can be seen as a starting point for ensuing theorizing on similar phenomena (Lehnhoff et al. 2021). The presented findings suggest six constructs to be of salient importance: expected outcomes in terms of harvest, good feelings, and sustainability, personality traits consisting of an affinity for green and novel technologies, and the level of smartness and visibility of the service.

While prior work on novel food technologies mainly focused on commercial applications and their adoption (e.g., Siegrist and Hartmann 2020), our research on SHF addresses *consumers´ engagement in technology-related food production practices*. Instead of following the tradition of household technology-related studies (see Brown et al. 2015, for a multi-model comparison), this paper follows an inductive approach to capture fine-granularly what drives individuals in their natural settings within a specific smart service environment (i.e., food-related). The results expand our understanding of consumers' farming practices and smart technologies that configure to enhanced smartness (i.e., reduced burden and higher quality of life, Wessel et al. 2019). Presented salient antecedents can also help designers to ensure that smartness does not result in unintended consequences, since it "cannot be taken for granted as desirable state" (Wessel et al. 2019, p. 1285). By outlining a real-world case of tangible co-creation at home, we also contribute to the notion of smartness in the private realm. Unlike smart home assistants, where smartness was recently identified to serve only personalized user experiences and expanded cooperation among devices and businesses (Kim et al. 2019), SHFs alter practices that expand individuals' capabilities. This transformation includes large potential in food production and novel a combination of hobby and sustainability aspects while engaging in service-related practices.

For the convenience and sustainability-related constructs, our data pointed to particularly interesting patterns. For instance, our respondents repeatedly emphasized how important it is that the technology does everything by itself, and they do not have to worry about anything. At the same time, many emphasized that they recognize the service-related practices as a kind of sustainability contribution. Because extant literature could not sufficiently help to determine their role and relevance, we seek to investigate these factors more closely within our second phase. In order to identify the outstanding influences, we intend to conduct experimental research (Dennis and Valacich 2001; Karahanna et al. 2018). We believe that by manipulating the service characteristics and service outcomes, we will be able to deeply explore the still poorly understood relations between convenience and sustainability. In addition, we anticipate exciting insights into interacting factors related to individual differences and emotional rewards of the service-related practices.

Through our experimental research, we also aim to address some of the limitations of this still progressing work. In developing the research design, we try to identify clear and delineable measures from existing literature that represent a suitable approximation of our identified major themes. This will ensure construct clarity for the further course of research. While we have been able to identify general tendencies in our sample, we will address the current lack of representativeness of our findings as part of the quantitative experiment.

Providers of such smart technologies can use the salient influences to make their products' benefits more tangible and convey them accordingly. The findings can also help to identify more specifically potential target groups (i.e., 'eco-techies' and/ or people who care about a healthy, high-quality diet). To leverage influences like the good feeling, gamification features appear to be a fruitful avenue, e.g., rewarding the customer for a certain amount of harvest or, as prior work suggests, setting ecological goals (e.g., Seidler et al. 2020).

While most food will still come from conventional agriculture in the next years, innovations in smart farming may increasingly shift certain food supplies into private households. Instead of standing on the sidelines of the respective research field, IS researchers could look more closely at the new phenomena surrounding smart farming to ultimately better understand human behavior. This research in progress represents an early attempt to do so.

References

Ajzen, I. 1985. "From Intentions to Actions: A Theory of Planned Behavior," in *Action Control*, J. Kuhl and J. Beckmann (eds.), Berlin, Heidelberg: Springer, pp. 11–39.

Andraschko, L., Wunderlich, P., Veit, D. J., and Sarker, S. 2021. "Towards a Taxonomy of Smart Home Technology: A Preliminary Understanding," in *ICIS 2021 Proceedings*, Austin, TX.

Arkesteijn, K., and Oerlemans, L. 2005. "The early adoption of green power by Dutch households," *Fuel and Energy Abstracts* (46:3), pp. 183–196.

Bandura, A. 1986. *Social foundations of thought and action: a social cognitive theory*, Englewood Cliffs, N.J: Prentice-Hall.

Baudier, P., Ammi, C., and Deboeuf-Rouchon, M. 2020. "Smart home: Highly-educated students' acceptance," *Technological Forecasting and Social Change* (153:119355).

Benke, K., and Tomkins, B. 2017. "Future food-production systems: vertical farming and controlled-environment agriculture," *Sustainability: Science, Practice, and Policy* (13:1), pp. 13–26.

Beverungen, D., Breidbach, C. F., Poeppelbuss, J., and Tuunainen, V. K. 2019a. "Smart service systems: An interdisciplinary perspective," *Information Systems Journal* (29:6), pp. 1201–1206.

Beverungen, D., Müller, O., Matzner, M., Mendling, J., and vom Brocke, J. 2019b. "Conceptualizing smart service systems," *Electronic Markets* (29:1), pp. 7–18.

Brown, S., and Venkatesh, V. 2005. "Model of Adoption of Technology in Households: A Baseline Model Test and Extension Incorporating Household Life Cycle," *MIS Quarterly* (29:3), pp. 399–426.

Burton-Jones, A., and Stein, M.-K. 2021. "Towards Scholarly Flourishing in the IS Field: Stories, Reflection, and Actions in an Emotional Time," *MIS Quarterly* (45:3), pp. ii–xvi.

Charmaz, K. 2006. *Constructing grounded theory*, London ; Thousand Oaks, Calif: Sage Publications.

Corbin, J., and Strauss, A. 1990. "Grounded theory research: Procedures, canons, and evaluative criteria," *Qualitative Sociology* (13:1), pp. 3–21.

Cram, W. A., Proudfoot, J. G., and D'Arcy, J. 2021. "When enough is enough: Investigating the antecedents and consequences of information security fatigue," *Information Systems Journal* (31:4), pp. 521–549.

Davis, F. D. 1989. "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly* (13:3), pp. 319–340.

Dennis, A. R., and Valacich, J. S. 2001. "Conducting Experimental Research in Information Systems," *Communications of the Association for Information Systems* (7:5).

Despommier, D. D. 2011. *The vertical farm: feeding the world in the 21st century*, 1st Picador ed., New York: Picador.

Hubert, M., Blut, M., Brock, C., Zhang, R. W., Koch, V., and Riedl, R. 2019. "The influence of acceptance and adoption drivers on smart home usage," *European Journal of Marketing* (53:6), pp. 1073–1098.

IPCC 2018. *Global Warming of 1.5°C: A Special Report*, Intergovernmental Panel on Climate Change.

Jürkenbeck, K., Heumann, A., and Spiller, A. 2019. "Sustainability Matters: Consumer Acceptance of Different Vertical Farming Systems," *Sustainability* (11:15.4052).

Kalantari, F., Tahir, O. M., Joni, R. A., and Fatemi, E. 2018. "Opportunities and Challenges in Sustainability of Vertical Farming: A Review," *Journal of Landscape Ecology* (11:1), pp. 35–60.

Kaplan, B., and Maxwell, J. A. 2005. "Qualitative Research Methods for Evaluating Computer Information Systems," in *Evaluating the Organizational Impact of Healthcare Information Systems*, J.G. Anderson and C.E. Aydin (eds.), New York: Springer, pp. 30–55.

Karahanna, E., Benbasat, I., Bapna, R., and Rai, A. 2018. "Opportunities and Challenges for Different Types of Online Experiments," *MIS Quarterly* (42:4), pp. ii–x.

Kim, S., Christiaans, H., and Baek, J. S. 2019. "Smart Homes as Product-Service Systems: Two Focal Areas for Developing Competitive Smart Home Appliances," *Service Science* (11:4), pp. 292–310.

Kim, Y., Park, Y., and Choi, J. 2017. "A study on the adoption of IoT smart home service: using Value-based Adoption Model," *Total Quality Management & Business Excellence* (28:9–10), pp. 1149–1165.

Klein, H. K., and Myers, M. D. 1999. "A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems," *MIS Quarterly* (23:1), pp. 67–93.

Kozai, T. 2019. "Towards sustainable plant factories with artificial lighting (PFALs) for achieving SDGs," *Biol Eng* (12), pp. 28–37.

Lehnhoff, S., Staudt, P., and Watson, R. T. 2021. "Changing the Climate in Information Systems Research," *Business & Information Systems Engineering* (63:3), pp. 219–222.

Li, W., Yigitcanlar, T., Erol, I., and Liu, A. 2021. "Motivations, barriers and risks of smart home adoption: From systematic literature review to conceptual framework," *Energy Research & Social Science* (80:102211).

Madushanki, A. R., Halgamuge, M., Surangi Wirasagoda, W., and Syed, A. 2019. "Adoption of the Internet of Things (IoT) in Agriculture and Smart Farming towards Urban Greening: A Review," *International Journal of Advanced Computer Science and Applications* (10:4), pp. 11–28.
Maglio, P. P., Vargo, S. L., Caswell, N., and Spohrer, J. 2009. "The service system is the basic abstraction of service science," *Information Systems and e-Business Management* (7:4), pp. 395–406.
Marikyan, D., Papagiannidis, S., and Alamanos, E. 2019. "A systematic review of the smart home literature: A user perspective," *Technological Forecasting and Social Change* (138), pp. 139–154.
Marikyan, D., Papagiannidis, S., and Alamanos, E. 2021. "'Smart Home Sweet Smart Home': An Examination of Smart Home Acceptance," *International Journal of E-Business Research* (17:2), pp. 1–23.
Myers, M. D. 2019. *Qualitative research in business and management*, 3rd edition., Thousand Oaks, CA: SAGE Publications.
O'Sullivan, C. A., McIntyre, C. L., Dry, I. B., Hani, S. M., Hochman, Z., and Bonnett, G. D. 2020. "Vertical farms bear fruit," *Nature Biotechnology* (38:2), pp. 160–162.
Pinsonneault, A., and Beaudry, A. 2010. "The Other Side of Acceptance: Studying the Direct and Indirect Effects of Emotions on Information Technology Use," *Management Information Systems Quarterly* (34:4), pp. 689–710.
Rogers, E. M. 1983. *Diffusion of innovations*, 3rd ed., New York : London: Free Press ; Collier Macmillan.
Sarker, S., Xiao, X., Beaulieu, T., and Lee, A. S. 2018. "Learning from First-Generation Qualitative Approaches in the IS Discipline: An Evolutionary View and Some Implications for Authors and Evaluators (PART 1/2)," *Journal of the Association for Information Systems* (19), pp. 752–774.
Schill, M., Godefroit-Winkel, D., Diallo, M. F., and Barbarossa, C. 2019. "Consumers' intentions to purchase smart home objects: Do environmental issues matter?," *Ecological Economics* (161), pp. 176–185.
Seidel, S., Bharati, P., Fridgen, G., Watson, R. T., Albizri, A., Boudreau, M.-C., et al. 2017. "The Sustainability Imperative in Information Systems Research," *Communications of the Association for Information Systems* (40:3), pp. 40–52.
Seidel, S., vom Brocke, J., and Recker, J. 2013. "Sensemaking and Sustainable Practicing: Functional Affordances of Information Systems in Green Transformations," *MIS Quarterly* (37:4), pp. 1275–1299.
Seidler, A.-R., Henkel, C., Fiedler, M., Kranz, J., Ixmeier, A., and Strunk, K. S. 2020. "Promoting Eco-Sustainable Behavior with Gamification: An Experimental Study on the Alignment of Competing Goals," in *ICIS 2020 Proceedings*, online.
Siegrist, M., and Hartmann, C. 2020. "Consumer acceptance of novel food technologies," *Nature Food* (1:6), pp. 343–350.
Strobel, G. 2020. "Agriculture in the Era of Internet of Things - An Information System Architecture for Smart Agriculture," *ECIS 2020 Proceedings*.
Swaminathan, M. S., and Kesavan, P. C. 2012. "Agricultural Research in an Era of Climate Change," *Agricultural Research* (1:1), pp. 3–11.
UN 2019. *World urbanization prospects: the 2018 revision*, NY: United Nations.
UN 2020. *United Nations - Sustainable Development Goals*. Retrieved 12. May, 2020, from https://sustainabledevelopment.un.org/?menu=1300.
UNDP and University of Oxford 2021. *Peoples' Climate Vote (Special Report)*.
van der Linden, S. 2018. "Warm glow is associated with low- but not high-cost sustainable behaviour," *Nature Sustainability* (1:1), pp. 28–30.
Venkatesh, V., Brown, S., and Sullivan, Y. 2016. "Guidelines for Conducting Mixed-methods Research: An Extension and Illustration," *Journal of the Association for Information Systems* (17:7), pp. 435–494.
Venkatesh, V., Morris, M., Davis, G., and Davis, F. D. 2003. "User Acceptance of Information Technology: Toward a Unified View," *MIS Quarterly* (27:3), pp. 425–478.
Walsham, G. 2006. "Doing interpretive research," *European Journal of Information Systems* (15:3), pp. 320–330.
Warkentin, M., Goel, S., and Menard, P. 2017. "Shared Benefits and Information Privacy: What Determines Smart Meter Technology Adoption?," *Journal of the Association for Information Systems* (18:11), pp. 758–786.
Wessel, L., Davidson, E., Barquet, A. P., Rothe, H., Peters, O., and Megges, H. 2019. "Configuration in smart service systems: A practice-based inquiry," *Information Systems Journal* (29:6), pp. 1256–1292.
Wünderlich, N. V., Heinonen, K., Ostrom, A. L., Patricio, L., Sousa, R., Voss, C., et al. 2015. "'Futurizing' smart service: implications for service researchers and managers," *Journal of Services Marketing* (29:6/7), pp. 442–447.
Wunderlich, P., Veit, D. J., and Sarker, S. 2019. "Adoption of Sustainable Technologies: A Mixed-Methods Study of German Households," *MIS Quarterly* (43:2), pp. 673–691.