

Unraveling Connected Lives: Exploring Individual Perceptions of Smart Homes

Argenis Ramirez Gomez
University of Portsmouth
argenis.ramirez-gomez@port.ac.uk

Kim Sauvé
University of the West of England
Bristol, UK
kim.sauve@uwe.ac.uk

Carolina Fuentes
Cardiff University
fuentestoroc@cardiff.ac.uk

Nervo Verdezoto
Cardiff University
verdezotodiasn@cardiff.ac.uk

In our data-driven world, smart devices are seamlessly integrated into our daily lives, offering convenient and user-friendly interactions based on user data. Human-Data Interaction (HDI) provides holistic frameworks to explore how individuals interact with their digital data. However, these are limited in revealing the entanglement of smart technology in everyday home experiences that inherently include multiple individuals. To this end, we conducted an exploratory survey (n=49) on smart home devices that revealed the synergies between smart technology, data, and individuals within different households. The results show people view smart technology in complex ways, recognising both pragmatic and (an)hedonic qualities, which in turn might influence their adoption of smart devices, as well as how they handle personal and shared data. We call for future work that considers data practices beyond the individual to advocate for a holistic social perspective on human-data interactions in the smart home.

Smart Home, Smart Technology, Human-Data Interaction

1. INTRODUCTION

Smart devices have become increasingly ubiquitous in our lives, entering our homes in various forms, including home appliances, game consoles, wearables, and voice assistants. These devices act as gateways to otherwise intangible information, enabling us to create, share, and consume vast amounts of data about ourselves, others, and our surroundings. This makes data accessible not only to ourselves but also to other individuals and third parties. Therefore, this rapid rise of data as a consumable good through these smart devices raises significant concerns regarding privacy, ethics, surveillance, and other related issues that users might not be aware of.

Human-Data Interaction (HDI) explores how individuals engage with their data (Mortier et al. 2014; Sailaja et al. 2021), with a primary focus on the data itself – emphasising technical aspects of data handling and the clarity of data systems. Moreover, research on smart home technologies to date has focused predominantly on individual use, looking at the home as “*an individual self-motivated decision-making entity*” (Dahlgren et al. 2021) without actively considering shared experiences in home environments (Trajkova and Martin-Hammond 2020). In contrast, Shin et al. (2019) has demonstrated that

households approach ownership and sharing in the domestic space in diverse ways, necessitating careful consideration of the different ‘collectives’ – such as multiple occupants with competing demands, relationships, or social dynamics – that influence the households’ decision-making around data.

Although previous research has focused on individuals’ data-centric ethical concerns of smart technology in the home (Seymour et al. 2020), the understanding of smart technology use in households with multiple occupants is limited (Shin et al. 2019). In line with research aiming to further understand the complex socio-material dimensions of the smart home (Yao et al. 2023), this paper explores perceptions of smart technology to understand individual experiences in the home context. We conducted an exploratory online survey involving 49 participants, revealing how individuals from different living arrangements understand and use smart technology and how their perception might influence the willingness to share different types of data.

The findings contribute empirical evidence of commonalities and differences in the adoption of smart technology and data practices in the home setting. Specifically, the results show (i) people use complex semantics to describe smart technology; (ii) there is a dissonance between the actual and

perceived ‘smartness’ of their home; and (iii) there are intricacies in data-sharing strategies. Therefore, we call for future work that reflects on the social and collective experiences of interacting with data rather than solely focusing on the perspective of an individual. By developing a deeper understanding of the domestic factors that shape how people use and interact with smart technology, we can inform frameworks and design principles that support more responsible and transparent data-driven systems that reflect the complexities of human experience.

2. RELATED WORK

As smart devices increasingly mediate our interactions with the world, questions around data access, privacy, and agency have become central. In particular, the domestic space introduces unique challenges: smart devices do not just support individual use but exist within shared, dynamic social environments. This section reviews work on Human-Data Interaction (HDI), data implications in domestic settings, and the social dynamics of collective data use in the home. These strands are interlinked, as foundational principles in HDI frame individual interactions with data, which become more complex when situated within the relational and negotiated practices of smart home use.

HDI provides a useful lens to understand how people make sense of and interact with their digital data (Crabtree and Mortier 2015). Central to this work are the three core principles of *legibility* (making data and its use understandable), *agency* (enabling control over data), and *negotiability* (supporting re-evaluation of decisions and contexts change) (Mortier et al. 2014). Recent work has extended these principles to explore their applicability for specific audiences and contexts. For instance, Black et al. (2019) investigated how contextual integrity—where data sharing depends on attributes, roles, and norms—shapes children’s privacy perceptions. Sun et al. (2021) focused on children’s mental models of privacy risks, highlighting how visual cues can support reasoning and strengthen agency and legibility. Meanwhile, Sauvé and Houben (2021) proposed an ecological framing, viewing users and the different physical/digital elements they use as interconnected components in a broader eco-system of data interactions. Still, much of this research focuses on individual data interactions, with limited attention to the social and relational dynamics that shape collective data practices (e.g., in the home).

2.1. Data Practices in Smart Homes

Building on these foundations, smart home technologies make traditional data relationships more

complex. Studies have shown that people often trade privacy for convenience or perceived benefit, such as in loyalty programs (Hupfeld and Speed 2017) or app permissions (James et al. 2021).

Within households, data can acquire new meanings as individuals infer or negotiate around shared use. For instance, data about electricity or water consumption can be interpreted as behavioural evidence (Kwon et al. 2018), and combined with situated knowledge leads to ‘educated guesses’ (Kurze et al. 2020). These inferences are not limited to internal dynamics: data generated in one home may carry implications for others, such as neighbours or institutions (Snow et al. 2021).

Studies have begun to surface these relational complexities. Research on family data sharing (Worthy et al. 2016) reveals tensions between autonomy and oversight, such as family members living independently desiring privacy for their own data but expecting access to their older relative’s data for surveillance purposes. Similarly, concerns around tech-enabled abuse and social accountability have led to design guidelines for protecting vulnerable users in shared settings (Parkin et al. 2020).

2.2. Collective Use and Social Dynamics

Recognising the home as a shared, socially constructed space, research has explored how smart technologies mediate collective experiences. Shin et al. (2019) and Trajkova and Martin-Hammond (2020) challenge the notion of the home as an individual decision-making unit, highlighting the need to account for diverse occupants, relationships, and power dynamics. Concepts such as the “data-hungry home” (Lee-Smith et al. 2019) and civic data Bowyer et al. (2018) offer frameworks for thinking about shared data ecologies, where decisions are influenced by both interpersonal relationships and broader social infrastructures. These studies show that trust, transparency, and perceived control are often negotiated between household members. For example, users may be more willing to share consumption data with households they trust, but resist sharing it with strangers Jakobi et al. (2019). Their work also highlights how user misconceptions about how the system works accentuate concerns about risk and trusted relationships, requiring better user literacy to make informed decisions. Despite increasing recognition of these collective dynamics, there is still limited understanding of how people from different living arrangements perceive and engage with smart technologies. Our work contributes to this growing area by investigating how individuals make sense of domestic smart devices and how their perceptions

shape and are shaped by household practices, social relationships, and data-sharing strategies.

3. METHODOLOGY

We conducted an exploratory study using an online survey to understand perceptions towards smart technology in the household context and how individual decisions affect the collective interest in participants' home configurations, in line with previous work exploring the use of smart devices in the home (Hasan et al. 2020). Following the guidelines provided by Müller et al. (2014), participants responded anonymously to minimise social desirability bias and grouped related questions in sections and presented them on different pages to reduce context switching and minimise cognitive processing. The survey consisted of four sections of questions: (i) demographic information; (ii) individual's understanding of smart-home technology; (iii) usage of smart devices in participants' households; and (iv) the willingness to share smart-home-related data. The full list of questions is available in the Appendix.

We used the Qualtrics Survey Platform Qualtrics (2005) to host a survey between May and June 2021. We recruited 72 participants via ad-hoc opportunistic sampling through posts on social media and word of mouth (in line with previous sample sizes reported in HCI research, e.g., (Ramirez Gomez and Stawarz 2022; Langlois and Kriglstein 2023)). The survey took approx. 25 minutes to complete, and participants had the option to enter a raffle to win one of three £20 shopping vouchers. The study received a favourable ethical opinion from the authors' institution.

In the survey, we asked participants to disclose their gender; age; maximum education level achieved; their employment status; employment's field of work; and their household occupancy information including the number of inhabitants of the house and a description of their relationship. Qualtrics Survey Platform registered the status of completion and duration of the survey (used to filter incomplete answers) and the location (country) from where participants answered the survey.

Regarding the individual's perceptions and opinions, we asked participants to indicate their level of comfort with the use of technology; how smart their home is; the importance of smart technology in their everyday life, and to select why based on predefined statements drawing on previous research (Nikou 2019; Ashraf et al. 2020). Moreover, we asked participants to describe smart technology in their own words, and once the question was completed, the survey showed them a definition (see Appendix

A.3) to facilitate reflection on all the types of devices that the definition could include.

Furthermore, to gather participants' attitudes towards the smart devices they own in their household, we generated a list of potential smart technologies homed within a household and the corresponding data these might generate about the individual user and other inhabitants. In the survey, the list was used to ask participants to identify how many smart devices they own and use, and their visceral reaction/opinion on data-sharing practices. We utilised a collaborative virtual whiteboard application to generate both lists. Two members of the team individually brainstormed a list of all smart devices that could be homed in every room in a hypothetical "super-smart" house using a floor plan's drawing of a popular cartoon's TV show (Aliste Lizarralde and E. Fischer 2023) and other external resources listing smart devices and categories of personal informatics (Enterprivacy 2018; Foundation 2022) to guide the task. The individual results were put together, discussed between the research team, and summarised by removing duplicates to generate a single list of 82 devices and a complementary list of the potential data types they generate. Then, the final list of devices was clustered in families of technology by their utility (e.g., personal devices, entertainment, home management, furniture). Similarly, the list of data types was refined and organised by affinity in related clusters. This process resulted in 28 different groups of smart devices and 54 data types.

Finally, we asked participants to select from a predefined list what categories of devices they owned. Moreover, participants were asked to describe the positive and the negative aspects of the smart technology they own/use, with three words for each. Finally, we divided the list of 54 data types into two subsets of 27 items each, so they would include a mix of data items about the individual (self) and others (relatives/offspring) - divided pragmatically in half to reduce participants' cognitive processing and the risk of participants dropping out with an excessively long list (Langlois and Kriglstein 2023). In the survey, we asked participants to indicate what 10 data items from each sub-set list they would "never be willing to share (under any circumstances) with third parties". We designed this question as a provocation to elicit a visceral reaction from participants, as provocations can challenge participants to reflect on current practices Jensen et al. (2018). As such, the prioritisation of items by selecting a maximum of 10 was not intended as a ranking exercise but a mechanism to facilitate participants' reflection and capture their visceral response about types of data they might already be sharing by owning/using smart devices in their home.

Data Analysis. We used descriptive statistics to summarise close-ended survey responses to provide insights into participants' demographics and their attitudes towards the use and ownership of smart technology in their household. We also conducted an exploratory thematic analysis (Braun and Clarke 2006) of the free-text responses for the descriptions of what participants considered smart technology to be. The format of the responses was of varying lengths (words, short sentences, and long paragraphs), ranging from adjectives/adverbs, pragmatic descriptions, or accounts of personal experiences and opinions. The analysis was performed in two iterations. First, we familiarised ourselves with the data and identified four provisional themes using a collaborative virtual whiteboard. Second, we used a deductive approach to label each response with one or more themes and grouped participants' descriptions according to different configurations of combined themes. Moreover, we analysed the answers from the positive and negative aspects of smart technology by summarising terms by affinity and quantifying their repetition.

4. RESULTS

4.1. Participant demographics, household types, and division of responsibility

Out of 72 respondents, only 49 participants (68% response rate) completed the survey; 18 self-identifying as male (36.7%), and 31 as female (63.3%). Most participants were 26-35 years old (49%); ten were aged 18-25 (20.4%); eleven were aged 36-45 (22.4%); four aged 46-55 (8.2%). Moreover, participants had different levels of education and occupation. Qualtrics' participants' registered location reported 33 participants answered the survey from the United Kingdom (67.3%), 13 from eight other countries in Europe (26.5%), two from the United States, and one from China.

We grouped participants' answers to the number of people they live with and the description of their relationship (e.g., who they are and their demographics) to explore how individual data practices around smart technology affect other people in their home environment. This exploratory analysis of the participants' demographics was not intended to create categories that can be compared, but to understand participants' living arrangements and add granularity to the information about the participant population. Hereinafter, we report descriptive statistics of the results (i.e., frequency distribution as f) and use the categorisation of participant household types derived from our analysis for illustration purposes only. We identified five types of household relationships:

- *Couple*: 19 participants cohabiting with a partner or spouse (38.8%).
- *Familiar*: 13 participants cohabiting with intergenerational family members (26.5%), including parents ($f = 6$) or children ($f = 7$), in households of two ($f = 1$), three ($f = 10$), or four ($f = 2$) people.
- *Individual*: 12 participants living alone (24.5%).
- *Acquaintance*: 3 participants cohabited with other individuals with whom they have no family bonds (6.1%), in households of two to six people.
- *Other mixed co-residence*: 2 participants cohabiting with a combination of a parent and a partner, or a spouse and an acquaintance (4.1%), creating a household of three people.

Within these types of households (some revealing non-traditional living arrangements), we identified a varied division of responsibility when managing smart technology in the home. Of all participants, 25 deemed themselves as the responsible individual (51%), 10 participants placed the responsibility on another member of the household (20.4%, of which 6 couple households, and 4 familiar); 9 participants indicated a shared responsibility with another person in their household (18.4%, of which 4 familiar, 4 couple, and 1 acquaintance), and 5 participants reported someone else not living with them (e.g., landlord, partner, or parents) was responsible (10.2%, of which 3 individual, 1 couple, and 1 familiar) for these practices.

4.2. Descriptions of Smart Technology

We asked how participants would describe 'smart technology' in their own words and collected 49 unique individual answers. From the analysis of all the answers, we observed 4 main categories:

- *Pragmatic Capabilities* ($f = 29$): descriptions that emphasize the practical properties such as (i) functional and non-functional capabilities (e.g. interactions, app control, remote control, sensing capabilities, or Natural User Interfaces such as voice-operated systems); (ii) system composition (e.g. what components it is made of, the type of systems that are integrated within, or the network of devices); and (iii) autonomous systems and the use of AI (e.g. notions of decision making, or data-driven aspects, context-awareness, or environmental adaptability). An example of pragmatic capabilities was provided by Participant 7 (P7): "Smart technology is the technology that has artificial intelligence and/or the ability to monitor and report its activity".
- *Perceived value* ($f = 24$): descriptions of the perceived positive outcomes rather than describing

the systems or functionalities, including (i) general indications of need satisfaction; (ii) specific features related to personalization, adaptation, and/or learning of the system about the user; and (iii) pinpointing the added value of smart systems to make their life easier (through extrinsic motivations such as providing comfort, convenience, efficiency, assistance, facilitation, utility, or simplicity). For example, *"Smart Technology is creating technological solutions for real-life problems. It makes our lives easier and more convenient"* (P45).

- *Symbiotic Relationship* ($f = 18$): descriptions that emphasize the different relations that can exist between the user, system, and/or the surrounding physical space. For instance, descriptions of (i) the location of the technology and places where you can find them (e.g., public spaces, work, or the home environment), (ii) the ubiquitous presence and integration of technology in everyday life, or (iii) different forms of input-output coupling between the user and a system (e.g., feedback, communication, responsiveness, or transhumanism). Example descriptions of a symbiotic relationship are *"Part of everyday life"* (P30) or *"Smart technology is the technology that adjusts to our needs or even the needs of the environment it is included in"* (P22).
- *Perception of risk or potential consequences* ($f = 13$): descriptions highlighting perceived negative outcomes, either presented through (i) exclamatory sentences (e.g., statements that express (strong) feelings), (ii) negative connotations of technology (e.g., intrusive, obsessive, addictive, worrying, or scary), or (iii) more pragmatic descriptions of ineffective or unnecessary capabilities. For instance, participants wrote *"Smart technology is not smart"* (P19) and *"An assistance to everyday tasks, such as communicating and finding information. Also can be a hindrance to the above, as people become obsessed and disconnected, even if they will not admit it"* (P39).

Beyond these four main categories, we observed specific compounds of two or more to describe smart technologies, of which the most occurring ones were:

- *Pragmatic Capabilities and Symbiotic Relationship* ($f = 7$): declarative statements on what the smart technology does and how that relates to the user experience. For instance, a participant wrote *"Technology that responds to you & can do things on its own"* (P10).
- *Perceived Values and Risks* ($f = 6$): exclamatory statements juxtaposing the positive outcomes from smart technology and the negative consequences. For example, a participant wrote, *"Invasive technology which can be useful"* (P48).

- *Perceived Values because of Capabilities and Relationships* ($f = 5$): compound-complex statements relating and/or justifying the perceived value through the ascribed capabilities and relationships. For instance, *"Lifestyle based, proactive technology that facilitates improvements to how we can work and live"* (P9).

Finally, we collected a total of 129 terms based on participants' descriptions of the positive aspects of smart technology using three words. We found 60 unique phrases, and only 25 of them were used by more than one participant. The most repeated words or phrases focused on the pragmatic qualities of smart technology ("convenience", $f = 23$; "ease of use", $f = 8$; and "efficient", $f = 5$) or hedonic qualities of using smart devices ("entertaining", $f = 5$). Moreover, we collected a total of 120 terms based on participants' three words to refer to negative aspects of smart technology. We found 55 unique phrases, and only 17 of them were used by more than one participant. Similarly, the most repeated phrases focused on either pragmatic qualities ("expensive", $f = 17$; "connected", $f = 5$; "malfunctioning", $f = 5$; "upkeep", $f = 5$) or (an)hedonic qualities ("privacy", $f = 8$; "invasive", $f = 7$).

4.3. Importance and Perception of Smart Technology in People's Life

The majority of participants reported being extremely ($f = 26$, 53%) or somewhat ($f = 21$, 43%) comfortable with smart technology, whereas one was unsure (2%), and one was somewhat uncomfortable (2%). Moreover, the reported importance of smart technology in participants' lives was evenly divided across household relationships. Overall, when asked to choose the reasons why technology is important, participants picked between one and five items (out of 11), indicating convenience ($f = 33$), the assistance to save time ($f = 16$), stay connected ($f = 14$), keep track/reach personal goals ($f = 11$) and help them be more productive ($f = 11$) as the most relevant reasons for adopting smart technology in their personal life.

Beyond the general ascribed importance, 24 participants indicated smart devices to be only slightly important (49%), highlighting some of the values they get, such as technology's convenience, and its use to help them save time or track and reach their goals. Although two participants responded technology is extremely important for them (4.1%) and three participants indicated it is very important (6.1%), 11 considered technology moderately important (22.4%) because it is convenient, helps them to be productive, stay connected, and save time. On the other hand, nine participants reported technology to not be at all important for them (18.4%), as they

did not perceive needing it and reported no trust or concerns about its reliability despite considering smart devices convenient.

The majority of participants ($f = 35$; 71.4%) rated their household to be 'a little bit smart' (with 1 to 5 devices installed); six participants indicated their household to be 'not smart at all'; five participants 'somewhat smart' (5 to 10 devices); and only three participants 'very smart' (more than 10 devices). Across household relationship types, participants indicated owning an average of 6 different types of devices ($\sigma = 3.2$), including personal computing devices, streaming devices, game consoles, wearables, small electronics, and voice assistants. Moreover, the results suggest specific types of households are more likely to own particular types of devices. For instance, *individual* households are more likely to own voice assistant devices (6 out of 12 households), *couple* households are akin with sound appliances (10 out of 19), and *familiar* households own more office related devices (5 out of 13). Cross-referencing the perceived smartness of participants' homes with the number and kind of devices owned, the results show a slight dissonance in participants' answers to the two questions. Whereas they indicated their household to be 'a little bit smart' (1-5 devices installed), participants listed at least 6 (on average) kinds of devices owned. Thus, this dissonance suggests they either underestimate the number of smart devices in their homes, misunderstand the 'smartness' of their devices, or forget about their prominence and capabilities as devices blend into their environment.

4.4. Preferences for Sharing Data about Oneself and/or Others

To extract participants' preferences for sharing data, we presented them with two lists of prospective data collected by their smart devices (*List A* and *List B*; see Appendix) that they needed to reflect on to choose the most relevant to them. From each list, participants were instructed to select a maximum of 10 data items to indicate which information about themselves and/or others (which they might be sharing already) they would never be willing to share under any circumstances.

Overall, participants chose a median of 8 items for the first subset of data types (*List A*) with only 18 participants (36.7%) indicating a total of 10 data items they would never share with third parties. Three of the participants indicated 'Other' as their only option to indicate they would be willing to share all the data items listed because, for instance, "*would or have shared all of these things [already]*" (P46). Similarly, participants selected a median of 7 items for the second subset of data types (*List B*) with only

19 (38.8%) choosing the maximum of 10 data items they would not share. Moreover, only 2 participants indicated with the 'Other' option that "*[third parties] have probably got all that [data] already from usage habits*" (P8) or that they "*just assume smart devices have all this information anyway*" (P29).

Figure 1 shows the (cumulative) top 10 data items in *List A* and *B* that participants (grouped by household relationship type) would never be willing to share with third parties under any circumstances. Overall, data related to *the location of offspring and relatives*, *snippets of voice data during conversations*, and *sexual history* were selected by more than 50% of the participants. Besides, across both lists, all items were chosen once except one item in *List B*: (*Favourite Foods*).

Participants gave equal priority in excluding data items about themselves or others, with a 50% split, in both *List A* and *B*. These lists contained data items pertaining to the participant as well as other individuals, either implicitly or explicitly, and can interact differently with each household relationship type, leading to distinct insights or implications. Some data items explicitly refer to the participant (e.g., their location or biometric data), or solely other individuals (i.e., relatives and/or offspring). In contrast, other items implicitly involve multiple parties (e.g., snippets of voice conversations) or might involve other people depending on the participant's household type (e.g., home occupancy or browser history). For instance, in shared households, home occupancy data is a collective representation of multiple individuals, whereas for individual households, home occupancy data provides a snapshot of a single person.

In the analysis, we explored the adoption of different selection/curation strategies when excluding data items depending on their type of household relationship, which shows slight variations in the prioritization of data items compared to the aggregated result. For example, people living on their own prioritised excluding the sharing of sexual history data over the location of relatives (position 1 and 2 in *List A*). On the other hand, participants from a couple household showed more concern in sharing biometric data and video images of themselves (position 9 and 10 in *List A*); text chats and emails, internet browser history, and criminal history (position 4, 6, and 7 in *List B*). In contrast, participants in a familiar household were more inclined to exclude data items on political views and life history and events (position 5 and 9 in *List B*) than other data items ranked higher in the aggregated list.

The results of the survey explore and highlight the ways in which people living in different types

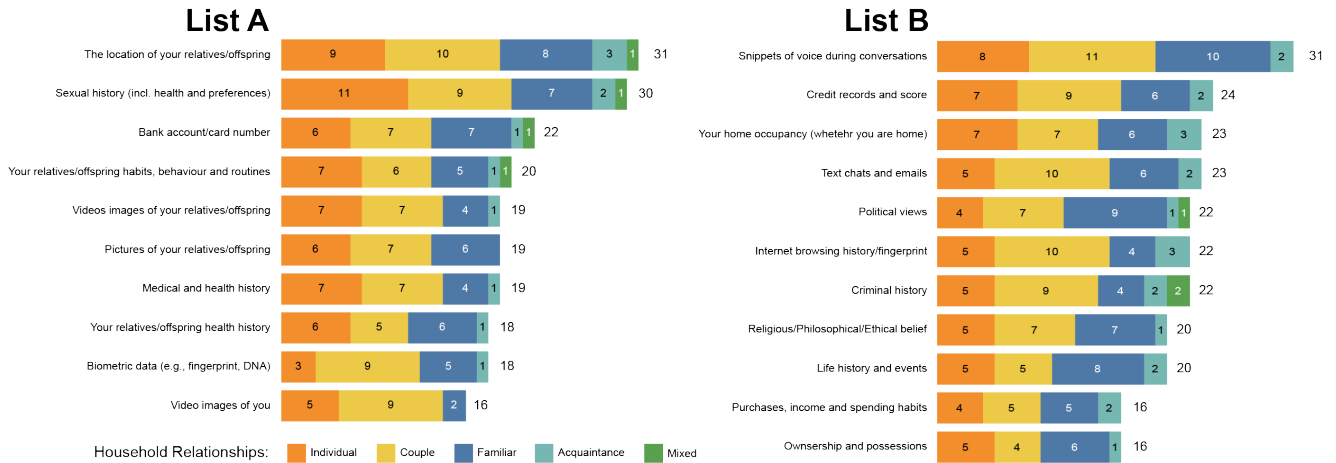


Figure 1: Stacked bar charts showing the 10 most voted items in Lists A and B per household relationship type.

of households describe smart technologies through pragmatic or functional qualities, their perceived value, symbiotic relationships, their perceptions of risks and their potential consequences, and how they might have influenced their use and behaviour. We use these findings to motivate our discussion on understanding data interactions in the smart home in line with the complexity of the human experience.

5. DISCUSSION

The design of smart homes has been largely shaped by a technology-driven perspective, emphasising what smart systems can do and the potential benefits they offer for daily living (Marikyan et al. 2019). This perspective often excludes users who “do not fit the model of the smart household” (Lupton et al. 2021), and hence overlooks the diversity of people’s experiences and their multifaceted relationships with smart technology in the complexity of everyday life (Dahlgren et al. 2021). While there is a shift to more user-centric approaches to the design of smart homes, research has focused mostly on understanding the factors that influence individuals’ perceptions of smart technology (Trajkova and Martin-Hammond 2020). Here, we have presented an exploratory study that contributes to understanding how different configurations of the home could influence individual experiences, perceptions, preferences, usage, and engagement with smart devices.

Our findings suggest that participants’ living arrangements influence decisions about data practices based on the relationships and responsibilities within the household, in line with research on entanglements between everyday relationships and IoT data in the home (Desjardins et al. 2020; Cheng et al. 2019). Although our individually-administered survey might hide complex social dynamics with smart

home devices and the data (e.g., (Helms and Fernaeus 2021)), the results indicate the need to move beyond viewing demographics as individual traits or individual use, and instead explore the multifaceted relationships of smart technology with others.

Moreover, the results indicate participants utilised complex semantics to describe ‘smart technology’ encompassing a combination of pragmatic qualities and the emphasis on juxtaposed mixed-affect concepts from (an)hedonic value, location (space and within users’ lives), and associated risks. As such, they acknowledged its multifaceted nature, understanding that smart technology has trade-offs and recognising its impact on their lives and broader societal implications. This illustrates how there is no simplistic way of making sense of smart technology and confirms prior interpretations of folk theory studies in HCI (Seymour et al. 2020; Wash 2010; Rader and Slaker 2017). Most notably, participants highlighted the importance of smart technology, but results indicate the extent to which the adoption of smart devices in the home is not well understood. Participants reported a dissonance between the number of devices they owned and their perception of how ‘smart’ their household was. This confirms prior interpretations on data privacy and the privacy paradox phenomenon (Kokolakis 2017), which observes the disparity between stated attitudes about privacy and actual behaviours. Nevertheless, this discrepancy suggests a need for a holistic understanding of the user experience with smart systems, considering the quantity as well as the qualitative nature of devices and their’ integration into the dynamics of users’ lives.

Moreover, results suggest participants adopted different strategies to select which data about themselves or others (not) to share. This might have been influenced by the relationships within their

household configuration, which illustrates how data-sharing strategies should not be seen as merely data management, but as a reflection of complex interpersonal dynamics. While confirming previous work on individual data practices and use of smart technologies within the home (Marikyan et al. 2019), one of the major contributions of our results lies in highlighting how the dynamics of collective settings might shape individual's experiences with smart technology, their data practices and interactions, suggesting new viewpoints and nuances to the adoption of smart technologies.

The results call for better transparency and design of data interactions that take into account the myriad of different "household choreographies" (i.e., division of responsibilities and data-sharing strategies) that might influence the perception, adoption, and use of smart technology in the home. We use them to motivate the reflection on prior work and provide several design opportunities for smart home technology considering the complexity of the human experience: when designing for individual lived experiences, and designing for collective experiences and shared understanding in the home.

5.1. Limitations & Future Work

While opportunistic sampling provides certain advantages for exploratory research (Etikan et al. 2016), our study does have some limitations. First, our study was prone to self-selection bias as a consequence and the results might not be generalizable. While we acknowledge that the richness of a qualitative in-depth household analysis (such as that provided by ethnomethodological studies) and the use of purposeful sampling (recruiting specific household types) could have provided deeper insights, our exploratory study was designed to achieve a breadth of understanding rather than to generalise through statistical comparisons between groups (Etikan et al. 2016; Patton 2002). Yet, our approach revealed important insights that are meant to be inferred as indicative and should be investigated further in future work using qualitative methods and targeted sampling, leveraging the five types of household relationships presented in this study.

Second, another limitation associated with the sampling method was the geographical location and age of the participants (results predominantly young Western-centric); thus, our findings are by no means exhaustive but might be seen as partial evidence of the diversity of household relationships around the world. Future work should consider investigating the similarities and/or differences in people's perceptions and household relationships in other socio-cultural contexts and geographical regions (e.g., (Chidziwisano and Jalakasi 2023)).

Finally, out of 72 participants, only 68% completed the questionnaire, resulting in 49 valid responses. This aligns with previous work that reported removing between 40% and 70% of their sample data from crowdsourced surveys when participants respond too quickly, fail to respond, or fail to complete the questionnaire (Alallah et al. 2018; Hasan et al. 2020). However, we argue this initial exploration contributes to a broader understanding of people's practices, highlighting how the dynamics of domestic settings might shape individual and collective experiences with smart technology.

6. CONCLUSION

We live in a world where ubiquitous and data-driven technologies have become gateways to transform raw data into a consumable commodity and populate our everyday lives. However, there is ambiguity in the risks that accompany these intangible data-driven systems and how people perceive and are aware of the trade-offs of using smart devices. Previous research efforts have adopted the perspective/lens of an individual user interacting with data rather than understanding data practices as part of a complex ecosystem that is everyday life. As such, social and domestic factors (like non-traditional or complex living arrangements) should be considered when reflecting on the future of data interactions.

In this paper, we conducted an exploratory survey to investigate people's perceptions and practices with smart devices across different households. We asked participants to indicate ownership of devices and willingness to share specific data (of different nature) with others. The results highlight that participants describe data-driven systems by juxtaposing (an)hedonic factors, benefits and risks, whilst indicating a dissonance between the prevalence and understanding of smart devices in their lives. Moreover, the findings suggest participants' intricate perception of smart devices and strategies with data-driven practices are influenced by the social context and complex relationships within (and beyond) their homes.

In summary, the findings are intricately tied to the HDI tenets (Mortier et al. 2014; Sailaja et al. 2021), emphasising the need for a human perspective that goes beyond a purely data-centric approach. This approach aligns with the nuanced understanding that individuals have regarding the complex interplay between technology and their lived experiences within the context of smart technology and HDI. We aim to inspire the adoption of a collective lens in the future of human-data interaction research that acknowledges the complexities of social and power dynamics in everyday life.

REFERENCES

- Alallah, F., A. Neshati, N. Sheibani, Y. Sakamoto, A. Bunt, P. Irani, and K. Hasan (2018). Crowdsourcing vs laboratory-style social acceptability studies? examining the social acceptability of spatial user interactions for head-worn displays. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, pp. 1–7.
- Aliste Lizaralde, I. and N. E. Fischer (2023). *Behind the Screens: Illustrated Floor Plans and Scenes from All of Your Favorite TV Shows*. Chronicle Books.
- Ashraf, A., J. H. Liu, and Q. Rauf (2020). Aging population perception and post adoption behavior about the usability of smart home technology of pakistani culture. In *Proceedings of 2020 the 6th International Conference on Computing and Data Engineering*, pp. 179–188.
- Black, S., R. Joshaghani, D. k. Ratakonda, H. Mehrpouyan, and J. A. Fails (2019). Anon what what? children's understanding of the language of privacy. In *Proceedings of the 18th ACM International Conference on Interaction Design and Children*, IDC '19, New York, NY, USA, pp. 439–445. Association for Computing Machinery.
- Bowyer, A., K. Montague, S. Wheeler, R. McGovern, R. Lingam, and M. Balaam (2018). Understanding the family perspective on the storage, sharing and handling of family civic data. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, CHI '18, New York, NY, USA, pp. 1–13. ACM.
- Braun, V. and V. Clarke (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology* 3(2), 77–101.
- Cheng, Y.-T., M. Funk, W.-C. Tsai, and L.-L. Chen (2019). Peekaboo cam: Designing an observational camera for home ecologies concerning privacy. In *Proceedings of the 2019 on Designing Interactive Systems Conference*, pp. 823–836.
- Chidziwisano, G. H. and M. Jalakasi (2023). Understanding women's perspectives on smart home security systems in patriarchal societies of malawi. In *Proceedings of the 2023 ACM Designing Interactive Systems Conference*, pp. 1078–1092.
- Crabtree, A. and R. Mortier (2015). Human data interaction: Historical lessons from social studies and cscw. In N. Boulus-Rødje, G. Ellingsen, T. Bratteteig, M. Aanestad, and P. Bjørn (Eds.), *ECSCW 2015: Proceedings of the 14th European Conference on Computer Supported Cooperative Work*, 19–23 September 2015, Oslo, Norway, Cham, pp. 3–21. Springer International Publishing.
- Dahlgren, K., S. Pink, Y. Strengers, L. Nicholls, and J. Sadowski (2021). Personalization and the smart home: questioning techno-hedonist imaginaries. *Convergence* 27(5), 1155–1169.
- Desjardins, A., H. R. Biggs, C. Key, and J. E. Viny (2020). IoT data in the home: Observing entanglements and drawing new encounters. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, pp. 1–13.
- Enterprivacy (2018). Enterprivacy: Categories of personal informatics.
- Etikan, I., S. A. Musa, R. S. Alkassim, et al. (2016). Comparison of convenience sampling and purposive sampling. *American journal of theoretical and applied statistics* 5(1), 1–4.
- Foundation, M. (2022). *privacy not included: A buyer's guide for connected products.
- Hasan, K., D. Mondal, D. Ahlström, and C. Neustaedter (2020). An exploration of rules and tools for family members to limit co-located smartphone usage. In *Proceedings of the 11th Augmented Human International Conference*, AH '20, New York, NY, USA. ACM.
- Helms, K. and Y. Fernaeus (2021). Troubling care: four orientations for wickedness in design. In *Proceedings of the 2021 ACM Designing Interactive Systems Conference*, pp. 789–801.
- Hupfeld, A. and C. Speed (2017). Getting something for nothing? a user-centric perspective on loyalty card schemes. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, CHI '17, New York, NY, USA, pp. 4443–4453. ACM.
- Jakobi, T., S. Patil, D. Randall, G. Stevens, and V. Wulf (2019). It is about what they could do with the data: A user perspective on privacy in smart metering. *ACM Transactions on Computer-Human Interaction (TOCHI)* 26(1), 1–44.
- James, T. L., J. L. Ziegelmayer, A. Schuler Scott, and G. Fox (2021). A multiple-motive heuristic-systematic model for examining how users process android data and service access notifications. *ACM SIGMIS Database: the DATABASE for Advances in Information Systems* 52(1), 91–122.
- Jensen, R. H., D. Raptis, J. Kjeldskov, and M. B. Skov (2018). Washing with the wind: A study of scripting towards sustainability. In *Proceedings of the 2018*

- Designing Interactive Systems Conference*, pp. 1387–1400.
- Kokolakis, S. (2017). Privacy attitudes and privacy behaviour: A review of current research on the privacy paradox phenomenon. *Computers & security* 64, 122–134.
- Kurze, A., A. Bischof, S. Totzauer, M. Storz, M. Eibl, M. Brereton, and A. Berger (2020). Guess the data: data work to understand how people make sense of and use simple sensor data from homes. In *Proceedings of the 2020 CHI conference on human factors in computing systems*, pp. 1–12.
- Kwon, H., J. E. Fischer, M. Flinham, and J. Colley (2018, dec). The connected shower: Studying intimate data in everyday life. *Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.* 2(4).
- Langlois, D. K. and S. Kriglstein (2023). Do you have time for a survey? challenges and lessons learned from the recruitment process for an online survey. In *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems*, CHI EA '23, New York, NY, USA. Association for Computing Machinery.
- Lee-Smith, M., T. Ross, M. Maguire, F. Po Tso, J. Morley, and S. Cavazzi (2019). The data hungry home. In *Proceedings of the Halfway to the Future Symposium 2019*, HTTF 2019, New York, NY, USA. ACM.
- Lupton, D., S. Pink, and H. Horst (2021). Living in, with and beyond the 'smart home': Introduction to the special issue. *Convergence* 27(5), 1147–1154.
- Marikeyan, D., S. Papagiannidis, and E. Alamanos (2019). A systematic review of the smart home literature: A user perspective. *Technological Forecasting and Social Change* 138, 139–154.
- Mortier, R., H. Haddadi, T. Henderson, D. McAuley, and J. Crowcroft (2014). Human-data interaction: The human face of the data-driven society. *CoRR abs/1412.6159*.
- Müller, H., A. Sedley, and E. Ferrall-Nunge (2014). Survey research in hci. *Ways of Knowing in HCI*, 229–266.
- Nikou, S. (2019). Factors driving the adoption of smart home technology: An empirical assessment. *Telematics and Informatics* 45, 101283.
- Parkin, S., T. Patel, I. Lopez-Neira, and L. Tanczer (2020). Usability analysis of shared device ecosystem security: Informing support for survivors of iot-facilitated tech-abuse. In *Proceedings of the New Security Paradigms Workshop*, NSPW '19, New York, NY, USA, pp. 1–15. ACM.
- Patton, M. Q. (2002). Qualitative research and evaluation methods. thousand oaks. Cal.: Sage Publications 4.
- Qualtrics (2005). Online survey software. Retrieved July 17, 2023, from <https://www.qualtrics.com>.
- Rader, E. and J. Slaker (2017). The importance of visibility for folk theories of sensor data. In *Thirteenth Symposium on Usable Privacy and Security (SOUPS 2017)*, pp. 257–270.
- Ramirez Gomez, A. and K. Stawarz (2022). Socially distanced games: Exploring the future opportunities of remote play. In *Extended Abstracts of the 2022 Annual Symposium on Computer-Human Interaction in Play*, CHI PLAY '22, New York, NY, USA, pp. 93–102. Association for Computing Machinery.
- Sailaja, N., R. Jones, and D. McAuley (2021). Designing for human data interaction in data-driven media experiences. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*, CHI EA '21, New York, NY, USA. Association for Computing Machinery.
- Sauvé, K. and S. Houben (2021). Towards an ecology of interconnected data devices. In *CHI'21 Workshop Human-Data Interaction through Design*.
- Seymour, W., R. Binns, P. Slovak, M. Van Kleek, and N. Shadbolt (2020). Strangers in the room: unpacking perceptions of 'smartness' and related ethical concerns in the home. In *Proceedings of the 2020 ACM designing interactive systems conference*, pp. 841–854.
- Shin, J., G. Aceves Sepúlveda, and W. Odom (2019). "collective wisdom": Inquiring into collective homes as a site for hci design. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, CHI '19, New York, NY, USA, pp. 1–14. Association for Computing Machinery.
- Snow, S., A. H. Khan, M. Glencross, and N. Horrocks (2021). Neighbourhood wattch: Using speculative design to explore values around curtailment and consent in household energy interactions. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, CHI '21, New York, NY, USA. Association for Computing Machinery.
- Sun, K., C. Sugatan, T. Afnan, H. Simon, S. A. Gelman, J. Radesky, and F. Schaub (2021). "they see you're a girl if you pick a pink robot with a skirt": A qualitative study of how children conceptualize data processing and digital privacy risks. In *Proceedings of the 2021 CHI Conference*

on Human Factors in Computing Systems, CHI '21, New York, NY, USA. Association for Computing Machinery.

Trajkova, M. and A. Martin-Hammond (2020). “alexa is a toy”: Exploring older adults’ reasons for using, limiting, and abandoning echo. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, CHI '20, New York, NY, USA, pp. 1–13. ACM.

Wash, R. (2010). Folk models of home computer security. In *Proceedings of the Sixth Symposium on Usable Privacy and Security*, pp. 1–16.

Worthy, P., B. Matthews, and S. Viller (2016). Trust me: Doubts and concerns living with the internet of things. In *Proceedings of the 2016 ACM Conference on Designing Interactive Systems*, DIS '16, New York, NY, USA, pp. 427–434. ACM.

Yao, Y., L. Huang, Y. He, Z. Ma, X. Xu, and H. Mi (2023). Reviewing and reflecting on smart home research from the human-centered perspective. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, pp. 1–21.

A. APPENDIX

A.1. Survey questions

A.1.1. Participant Demographics

1. What gender do you identify as? [Male; Female; Non-binary / third gender; Prefer to self-describe; Prefer not to answer]
2. What is your age? [18-25; 26-35; 36-45; 46-55; 56-65; 65+]
3. Counting yourself, how many people live in your household? [Just me; 2; 3; 4; 5; 6+]
4. Could you please tell us who are the members of your household? (For example, "I live with my husband/wife/partner and two children (age 4 and 7)"; or "I live with 3 flatmates") [Open question]
5. What is the highest degree or level of education you have completed? [Primary school; Secondary school up to 16 years; Higher or secondary or further education; College degree; Undergraduate degree; Post-graduate degree; PhD degree; Prefer not to answer]
6. Which of the following categories best describes your employment status? [Employed Full-time (35 or more hours per week); Employed Part-time (less than 35 hours per week); Stay at home parent; Home duties; Student; Not employed; Retired; Disabled, not able to work; Prefer not to answer]
7. What would best describe your current/previous occupation, or the general area that you work(ed) in? (For example, Medical Doctor, Factory worker, Teacher, Management, Scientist, Baker, ...) [Open question]

A.1.2. Views on Smart Technology

1. How comfortable are you with technology? [Extremely comfortable; Somewhat comfortable; Neither comfortable nor uncomfortable; Somewhat uncomfortable; Extremely uncomfortable]
2. How would you describe Smart Technology in your own words? (No wrong answers) [Open question]
3. How smart is your home? [Very smart (10+ smart devices are installed); Somewhat smart (5-10 devices are installed); A little bit smart (1-5 smart devices are installed); Not smart at all]
4. How important is it for you to have smart technology in your everyday life? [Extremely important; Very important; Moderately important; Slightly important; Not at all important]
5. Could you please elaborate on why? (Select all that apply)

- I like to own the latest gadgets
- They help me stay healthy
- They help me be more productive
- They help me save time
- They help me keep track/reach personal goals
- They offer me convenience
- They help me stay connected
- They provide safety
- They keep me up to date
- They help me explore the world
- Other (please write)

6. Who is the main responsible for installing or configuring the technology within the household? [Me; My partner; My housemate; My landlord/landlady; My parents; My children; Other relatives; Shared responsibility; Other]

A.1.3. Smart Technology in the home

We are interested in the number and type of smart technology you currently own or have access to on a daily basis in your household. Please consider smart technology as those electronic devices that you wear, carry with you, or are placed in your household, generally connected to other devices or networks via different wireless protocols such as Bluetooth, NFC, Wi-Fi, 5G, etc., and that can operate to some extent interactively and autonomously. If you are unsure if your device is a smart device, for example, think of those that can be controlled with an app on your smartphone.

1. Thinking about smart technology, could you please select any of the following smart devices you currently own or have access to daily? [Select all that apply]
 - Computing devices (laptops, smartphones, tablets, eReaders, ...)
 - Smart Kitchen Appliances (e.g. Smart Fridge, Alpowered Microwave, pressure cook, cooking robot, BBQ, induction hob, coffee maker, smart Thermo) [InstantPot, Smarter Coffee, Bosch smart oven, Withings Thermo, ...]
 - Game Consoles [Playstation, XBox, Nintendo Switch, Stadia, ...]
 - Smart Fitness appliances and devices (Bike, treadmill, chestband) [Tempo Studio, Peloton Bike+, NordiTrack, Fight Camp, ...]
 - Wearables (smartwatch, smart glasses, mood bands, smart jewellery, activity/fitness tracker, chest band...) [Fitbit, AppleWatch, Garmin Vivo, Amazon Halo, Snapchat Spectacle, GoogleGlass, Oura Ring, ...]

- Children wellbeing and Monitoring Smart devices (Baby monitor, Rocking chair, safety location tracker, smart sock...) [Nanit Plus, Smart Voyager Swing, Xiaomi Ronbei, Vodafone Neo, Wellue BabyO", Chipolo ONE, Owlet, ...]
 - Voice Assistant Device [Alexa, Google Nest mini, Apple HomePod, ...]
 - Smart Location tracking devices (Key fob) [Chipolo One, Yale, Tile Mate, ...]
 - Video and Sound Appliances (Smart TV, Sound System, projector...) [Nest Audio, WiFi-enabled TV, Band & Olufsen, Bose Soundbar, Sonos Beam, Apple Homepod, ...]
 - Health-related Smart Gadgets (Meditation, Thermometer, glucose biosensor, posture corrector, menstruation tools, fertility/pregnancy tracker, blood pressure monitor, SAD lamp) [iQ, UprightGO, MuseTM, Mira Fertility Tracker, Kinsa Thermometers, ...]
 - Streaming Device [Google Chrome, Amazon Fire Stick, AppleTV, ...]
 - Smart Wellbeing and Beauty (massage device, hair removal, scale feet water massager, sex toys, ...)
 - Smart video calling Device [Nest Hub, Facebook Portal, Logitech MeetUp, Echo Show, ...]
 - Smart Garden Appliances (lawn mower, sprinkler) [Eve Aqua, Rachio Sprinkler, Worx Landroid, ...]
 - Smart Camera (wearable and hand-held) [Go Pro, Google Clips, Somfy, Netatmo, ...]
 - Bathroom smart appliances (smart toilet, smart showerhead, smart mirror) [Salter Scale, Fitbit Aria, FitTrack, Numi Toilet, Kohler Verdara Mirror, Garmin Index Scale, ...]
 - Smart Entertainment devices and Toys (VR/AR headset, drone, robots,...) [Oculus VR, Hololens, LEGO AR, Sphero, Vuzix, Myo, Yoto Player, Kano Coding Kits, Hot Wheels TechMods, ...]
 - Smart Furniture (Bed, Sofa, chair, ...)
 - Pet wellbeing and Monitoring Smart Devices (Monitor, feeders, trackers) [Sure Petcare, PetSafe Smart Feeder, PETKIT, Furbo Treat Tossing, Furbo Camera, Findster Duo, Felix Pet Companion, Fitbark, ...]
 - Office-related devices (Printer, webcam, pens) [Canon Pixma HP Envy, HP Tango, Livescribe Smartpen, ...]
 - Smart indoor/outdoor Lightning [Philip Hue, Wireless LED, ...]
 - Small Electronic smart devices (Wakeup Alarm, Headphones, earphones, bluetooth speaker, selfie stick, portable music players, ...)
 - Smart Security Device, incl. alarm systems/sensors and door locks [Nest Protect, Nest Cam, Nest X Yale Lock, Aqara Smart Lock, Mi Smart Lock, Eve Motion, Arlo Security Cam, ...]
 - Smart clothing (shoes, jacket, socks,...) [Levis Jacquard, ...]
 - Home management devices (smart plug/switch, WiFi hub/extender, smart button, smart doorbell, garage door, window blinds control, ...) [Belkin WeMo, Samsung SmartThings, Amazon Dash, Amazon Ring, Nest Hello, Logitech Circle, Nest WiFi, ConnectSense Smart Outlet, ...]
 - Smart Car / Car devices, incl. GPS and Insurance Black Box
 - Smart Cleaning Appliances (vacuum, mop, washing machine, dryer, ...) [iRobot Roomba, Vileda VR, ...]
 - Home Climate-control systems (Thermostat, fan, air conditioners, purifiers, humidifier) [Google Nest Learning Thermostat, 10+Air, De'Longhi AriaDry Pure, Blueair, Dyson Pure, ...]
 - None of these
 - Other (please write)
2. How long have you been using those smart devices? (Think of the oldest one) [Less than a year; Between 1-2 years; Between 3-4 years; 5 years or more]
 3. Could you provide three words that best describe the positive aspects of smart technology you own or use? [Open question]
 4. Could you provide three words that best describe the negative aspects of smart technology? [Open question]
- A.1.4. Data Sharing Reflection*
1. Please think about all the devices you currently own and use which collect data about you in exchange for their services. Select a maximum of 10 types of information (about you) that you would NEVER be willing to share with the providers under any circumstances:
 - Full Name
 - Demographic information (age, gender, ...)
 - Ethnicity

- Physical Characteristics (height, weight, ...)
- Biometric Data
- Physiologic Data
- Knowledge and Education Level
- Family Structure and history
- Medical and Health History
- Your relatives/offspring's health history
- Sexual History (incl. health and preferences)
- Your fertility and menstrual cycle
- Your contact information (phone number and email address)
- Your postal address
- Bank account/card number
- Your current location
- The location of your relatives/offspring
- Personality traits
- Your habits and routine
- Your relatives/offspring's habits and behaviour
- Pictures of you
- Pictures of your relatives/offspring
- Video images of you
- Video images of your relatives/offspring
- Your drinking behaviour
- Social network and contacts
- Your pet's identity, location and wellbeing
- Other (please write)
- Content Consumption (listen/watch)
- Internet Browser history/fingerprint
- Your devices' IP addresses
- Your home occupancy (whether you are home)
- Driving history
- Your home deliveries frequency
- Snippets of voice data during conversations
- Destinations/location history
- Home floorplan
- Text chats and emails
- Energy and water consumption
- Your home temperature
- Your schedule/calendar
- App usage and screen time
- Other (please write)

2. Similar to the previous question, please think about all the devices you currently own and use. Select a maximum of 10 types of information (about you) that you would NEVER be willing to share with the providers under any circumstances:

- Interests and Hobbies
- Religious/Philosophical/Ethic belief
- Life History and events
- Political views
- Public and Social Life
- Purchases, income and spending habits
- Credit records and score
- Professional Occupation history
- Ownership and possessions
- Dietary Requirements
- Favourite Foods
- Criminal history
- Device usage and Interaction