

The dynamics of the adoption process of innovative technology: A collective perspective.

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Abstract

This study aims to understand the dynamics related to collective technology adoption within smart home environments using a qualitative approach. 24 interviews were conducted with twelve smart households, represented by two participants in each household fulfilling different roles. Within each household, one participant served as the primary decision-maker, while the other served as the non-decision-maker about the smart home technology they were adopting. This approach captured a holistic understanding of collective adoption experiences within households, acknowledging the diverse perspectives and roles individuals play in their collective adoption journey. The study illuminates the role of innovation characteristics, including technology complexity, compatibility, observability, triallability, and relative advantages, in shaping group valence towards the adoption of novel smart home technologies in collective settings.

Keywords: Collective technology adoption, innovation characteristics, valence theory, smart home technology

1 Introduction

As technology evolves, there is an increasing number of technologies for which adoption involves multiple users. For example, digital subscription services to online streaming platforms such as Netflix and Spotify are usually shared between family members in the home environment (Haapoja et al., 2021). Similarly, smart home technologies are collectively utilised by multiple users in residential settings (Park and Lim, 2020). In such instances trying to understand technology adoption solely from an individual's perspective can be limited and camouflage the more involved consideration users go through in the adoption journey. Not surprisingly, established theories used to explain human behaviour and attitudes in technology adoption and acceptance, such as the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT), are focused on individual perspectives (Taherdoost, 2018, Park et al., 2022, Hsu and Lin, 2021, Fussell and Truong, 2022, Ahn and Park, 2022, Zhu and Zhang, 2022, Salloum et al., 2019, Kamal et al., 2020, Rafique et al., 2020, Sohn and Kwon, 2020). Although such models have served us well, they may not fully explain the adoption journey when multiple users are involved.

The above points towards an important gap in the literature, namely the need to study how users collectively adopt, utilise, and confirm adoption choices. Typically, the adoption process can be considered as three phases, i.e. pre-adoption, in-adoption, and post-adoption (Damanpour and Schneider, 2006). Although there may be parallels with how this process works when comparing individual vs. collective adoption, what happens in each phase due to group dynamics and interactions can be rather different. Considering the above, there is a need to extend our understanding of technology adoption from a collective perspective as this could have significant theoretical and practical implications. This study understands the collective perspectives from different roles, i.e., (i) those who make the decision (the decision-makers) and (ii) those who follow the decision (the non-decision-makers). To this end, this study has two main objectives. The first is to understand the complex dynamics related to the process of collective technology adoption (CTA) in the pre-adoption phase. The second objective is to understand the cognitive and behavioural patterns users exhibit following CTA concerning adoption decisions influenced and/or determined by others. To address these objectives, this work aims to answer the following questions:

RQ1. How does the user journey process unfold in collective adoption?

RQ2. How does the adoption (usage) occur, and how is the voluntariness of use perceived?

RQ3. How does collective usage affect individual user experience and adoption outcomes?

RQ4. How do users demonstrate cognitive and behavioural patterns following adoption decisions influenced and/or determined by others?

2 Study background

This work adopts the Diffusion of Innovation (DOI) Theory as a theoretical basis to analyse the factors that revolve around the CTA process within the diffusion of innovation. Innovation characteristics play a significant role in forming group valence (Sarker and Valacich, 2010, Sarker et al., 2005). Roger's (2003) Diffusion of Innovation theory underlined five characteristics of innovation, i.e., relative advantage, compatibility, complexity, observability, and triallability. Those innovation characteristics are relevant at all technology adoption levels, either individual or collective (Sarker et al., 2005). What distinguishes both adoption levels are how the innovation characteristics are considered. When it comes to collective adoption, such characteristics will be discussed or deliberated on the basis of togetherness to reach a group consensus, rather than on the basis of individualism. The three phases of the adoption process, i.e., pre-adoption, in-adoption and post-adoption, occur within the five innovation diffusion stages (Doyle et al., 2014, Li, 2020).

Generally, technology adoption at the collective level differs from individual adoption due to its group-oriented nature. The process involves group dynamics, such as group valence, discussion, and negotiation, where conflicting preferences may sometimes arise. Studies argue that a collective orientation involves a process that goes through a group valence (Sarker and Valacich, 2010, Sarker et al., 2005). Group valence refers to "*the positive or negative orientation of a group toward each option*" (Hoffman and Kleinman, 1994, Hoffman and Maier, 1964). The empirical work on group valence theory in the study of technology adoption should consider influential factors, including innovation-related variables, to provide a comprehensive understanding of group/social dynamics and their association with group valence formation (Sarker and Valacich, 2010, Sarker et al., 2005). When it comes to collectively used technology, group valence is considered a key variable in analysing technology adoption from collective perspectives, underlying the process of group decision-making towards collective adoption (Ozturk et al., 2017, Sarker and Valacich, 2010, Sarker et al., 2005). The application of the group valence factor based on the valence theories helps explain the CTA process and how the final decision is taken (Sarker and Valacich, 2010, Sarker et al., 2005).

Smart home adoption has grown over the past few years. The global market for smart home services/products shows an increasing trend over time based on market revenue statistics and it is forecast to hit more users in the coming years (Statista, 2018). However, smart home experts believe that the smart home market is currently in a chasm and is yet to cross the early adopter stage and enter the mass-market adoption stage (Greenough, 2016). Such a chasm indicates that there is a need to analyse the smart home from the users' perspective. This includes how the smart home is adopted by users, especially when its adoption involves the engagement of multiple individuals in a group, i.e., household members. Previous smart home research focused on the smart home technology/technical perspective with little emphasis on the users' perspective (Shin et al., 2018). However, current studies of the smart home from users' perspectives are only considering individual users, yet it is important to consider the

multi-user smart home scenario. Therefore, this research will contextualise the model from a smart home context to fill that gap.

3 Methodology

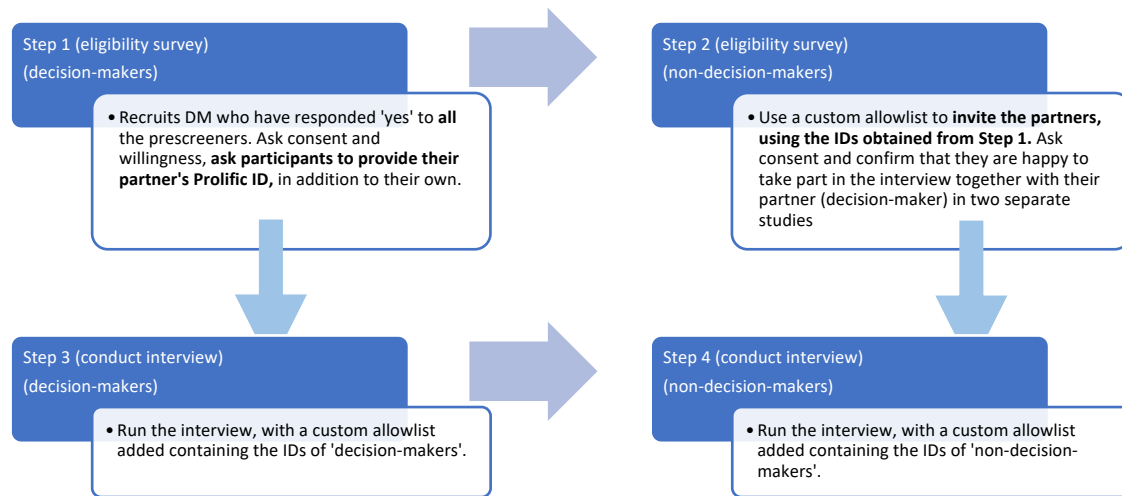
The dynamics related to the adoption of innovative technology from a collective perspective, particularly within the household, are still unclear. The inadequate empirical data on the user's journey in technology adoption from a collective perspective led this research to apply a qualitative approach through interviews to explore and gain an in-depth understanding of what happened in the journey. Interviews have been recommended as an appropriate methodology for conducting explorative studies (Mallat, 2007). In particular, the preliminary study of this research utilised a semi-structured interview approach, considering the argument of Renaud and Van Biljon (2008) that this method enables participants to freely contribute to the discussion to gain a comprehensive understanding of the research phenomenon. As articulated by Castillo-Montoya (2016), *“Interviews provide researchers with rich and detailed qualitative data for understanding participants’ experiences, how they describe those experiences and the meaning they make of those experiences”*. On top of that, research suggests that a qualitative approach helps provide strong evidence, especially when the research is considered a less-researched area with less evidence about the study context in the literature (Molina-Azorin, 2016).

3.1 Sample selection

The ideal samples for the study are the adopters of smart home technology who used it collectively. In particular, the sample involved two individuals from one household with different roles in their adoption, i.e., the primary decision-maker and the non-decision-maker. The perspectives from different roles in a household allow this study to gather an in-depth understanding of a collective adoption process and how cognitive dissonance works when it comes to decisions influenced and/or determined by others in a group. A non-probability purposive sampling technique was employed in selecting the study sample. Research suggests that a purposive sampling technique is helpful in gathering in-depth data regarding a studied phenomenon from samples with specified characteristics representing the investigated phenomenon (Lopez and Whitehead, 2013). The specified criteria include 1) smart home users who collectively used smart home technology and 2) the decision-makers and the non-decision-makers of the smart home technology they are collectively adopting. The criteria set-out are intended to ensure that data is collected from samples appropriately representing the investigated research phenomenon and deemed important to address the research objectives.

Potential households were located with the use of an online market research intelligence platform through a Uniform Resource Locator (URL) to target qualifying households. The URL was distributed to a general UK population sample. The URL consists of filtering questions that asked whether the eligibility is met to participate in the interview. The filtering questions asked whether the participants collectively used any smart home technologies and what their roles were in the smart home technology they are adopting. Only those who met the filtering criteria and who agreed to participate in interviews with their household members were eligible to participate in the interviews. Figure 1 shows the steps in recruiting participants through the market research intelligence platform.

Figure 1 The steps involved in recruiting qualifying participants from a household for interviews.



3.2 Preliminary data collection

The preliminary study of this research commenced at the end of December 2023 and continued until early January 2024. An additional 10 interviews were conducted in May 2024. 24 interviews were completed in total after reaching saturation—the strategy used to assess saturation is code frequency counts with a stopping criterion. Data were gathered from 12 households, represented by 2 participants in each household fulfilling different roles. Within each household, one participant served as the primary decision maker, while the other served as the non-decision-maker in relation to the smart home technology they are adopting. This approach captured a holistic understanding of collective adoption experiences within households, acknowledging the diverse perspectives and roles individuals play in their collective adoption journey. By engaging both the one who made the decision and the one who followed the decision, the study gained valuable insights into the intricacies of users' journeys from both perspectives, hence shedding light on how various factors revolve around the dynamics related to collective adoption in smart home settings. Table 1 shows the participants' role and the length of each interview.

Table 1 Participants' role and the length of the interviews

Household and SHTs used	Participant	Role	Interview time
1 Smart security camera	#1	Primary decision-maker	22 min
	#2	Non-decision-maker	23min
2 Smart light	#3	Primary decision-maker	37 min
	#4	Non-decision-maker	35 min
3 Smart home assistants	#5	Primary decision-maker	24 min
	#6	Non-decision-maker	48 min
4 Smart security cameras	#7	Primary decision-maker	47 min
	#8	Non-decision-maker	24 min
5 Home assistant	#9	Primary decision-maker	39 min
	#10	Non-decision-maker	31 min
6 Smart doorbell	#11	Primary decision-maker	35 min
	#12	Non-decision-maker	35 min
7 Smart thermostat	#13	Primary decision-maker	38 min

	#14	Non-decision-maker	37 min
8 Smart thermostat	#15	Primary decision-maker	37 min
	#16	Non-decision-maker	40 min
9 Smart home assistants	#17	Primary decision-maker	32 min
	#18	Non-decision-maker	38 min
10 Smart kitchen appliances	#19	Primary decision-maker	38 min
	#20	Non-decision-maker	21 min
11 Smart thermostat	#21	Primary decision-maker	26 min
	#22	Non-decision-maker	21 min
12 Smart plugs	#23	Primary decision-maker	29 min
	#24	Non-decision-maker	26 min

The interview questions were self-developed and comprised three main sections. The first section inquired about the participants' journey leading up to adoption. The second section focused on their collective usage experiences, and the third section sought their evaluations regarding collective adoption. All participants were asked the same set of interview questions. To ensure the validity and reliability of the interview questions, they were reviewed by the research team and pre-tested with a small sample of participants prior to the main data collection. This pre-testing aimed to confirm that participants understood the questions and that the questions effectively addressed the research objectives.

The interviews were conducted separately on a one-to-one basis between participants from the same household. Before the interviews, participants were asked to complete a short demographic survey that included some questions on what smart home technologies they used and the frequency of their engagement with the technologies. The responses received were used to understand the participants' roles and the smart home technologies were used to help formulate individual interview questions. The responses received from the surveys were not intended for statistical analysis.

Prior to each interview, participants were given a brief introduction via the online market research intelligence platform's messaging system to establish their understanding of the study purposes. At the start of each interview, participants were briefed about the interview outlines and encouraged to contribute any additional information they deemed pertinent. The interviews were structured around open-ended questions, fostering dynamic discussions, where interviewees could tailor their responses based on the flow of the conversation. This approach not only allowed for a deeper exploration of the topics but also encouraged participants to offer valuable insights beyond the predetermined questions. Specifically, participants were prompted to reflect on their experiences before adopting smart technologies, during the collective adoption, and offer an evaluation of the collective adoption. The discussions were split into three primary focuses:

1. The initial user's journey since the intention to adopt SHTs in the household was initiated, as well as the decision-making process up to the adoption.
2. The experience of collective usage of smart home technology.
3. The evaluation of collective smart home technology adoption and how cognitive dissonance works concerning the collective adoption experience.

The interviews were conducted virtually via the Zoom platform and audio-recorded for research purposes with participants' consent, ensuring the integrity of the data collection

process. The average duration of each interview session was approximately 34 minutes, providing ample opportunity for participants to articulate their perspectives and insights. The discussions yielded an insightful exploration of the topics at hand, ultimately enhancing the depth and breadth of the research findings. The recorded audios were transcribed and gone through manually in a verbatim approach to ensure the text corresponds precisely with the audio.

3.3 Data analysis

The interviews were transcribed verbatim to accurately capture the participants' perspectives (Rutakumwa et al., 2020). The transcribed data were then analysed using Nvivo software to identify initial codes and themes related to the research questions following Braun and Clarke's reflexive thematic analysis (RTA) approach (Braun and Clarke, 2006, Braun and Clarke, 2019, Byrne, 2021). Coding was an essential step in the data analysis process to identify key concepts and patterns (Byrne, 2021). The coding process involved familiarising oneself with the interview transcripts, assigning meaningful labels to segments of the data, and refining the codes to arrive at the final set of themes (Braun and Clarke, 2006, Byrne, 2021). Table 2 shows the initial codes derived from the data. The initial codes were then reviewed and grouped into meaningful themes and sub-themes related to the study, as shown in Figures 2, 3 and 4.

Table 2 Initial codes identified in pre-adoption, in-adoption and post-adoption phases.

Adoption Phases	Initial Codes
Pre-adoption	• Adoption intention (theme: mutual intention) ○ I-intention to We-intention (sub-theme) ○ Other's intention to We-intention (merged with I-intention to we-intention) • Agree to disagree (communication and conflict resolution) • Being involved (mutual involvement) • Consider others (mutual consideration of requirements and preferences) • Other's requirements (mutual consideration of requirements and preferences) • Disagreement and differing opinions (communication and conflict resolution) • Discuss (communication and conflict resolution) • Innovation characteristics (innovation characteristics as perceived collectively) ○ Advantages ○ Compatible with others ○ Easy to use for all ○ No issue and working fine ○ Obvious benefits ○ Serving its purpose ○ Test before adopting • Mutual agreement (communication and conflict resolution) • Other's involvement (mutual involvement) • Other's influence (mutual involvement) • Requirements considered by others (rename: considered) (mutual consideration of requirements and preferences) • Talk to and consult others (communication and conflict resolution)
In-adoption	• Collective usage experience (theme: collective usage) • Individual user control (collective usage experience) • Different time (collective usage experience)

	• Different purpose (collective usage experience) • Just have to use it (usage voluntariness) • Usage voluntariness- free will (usage voluntariness)
Post-adoption	• Collective adoption outcomes (theme) • Satisfied with the technology (cognitive consonance) • Cognitive dissonance (sub-theme) ○ Behaviour ○ Frustrated ○ Annoyed • Consult and discuss solution (communication and cognitive dissonance resolution) • Mutually agree on solution [consensus] (communication and cognitive dissonance resolution) • Other's reaction to solution (communication and cognitive dissonance resolution) • Solution (cognitive dissonance solutions) • Repair (cognitive dissonance solutions) • Replace (cognitive dissonance solutions) • Contact manufacturer (cognitive dissonance solutions)

Figure 2 Pre-adoption's themes and sub-themes

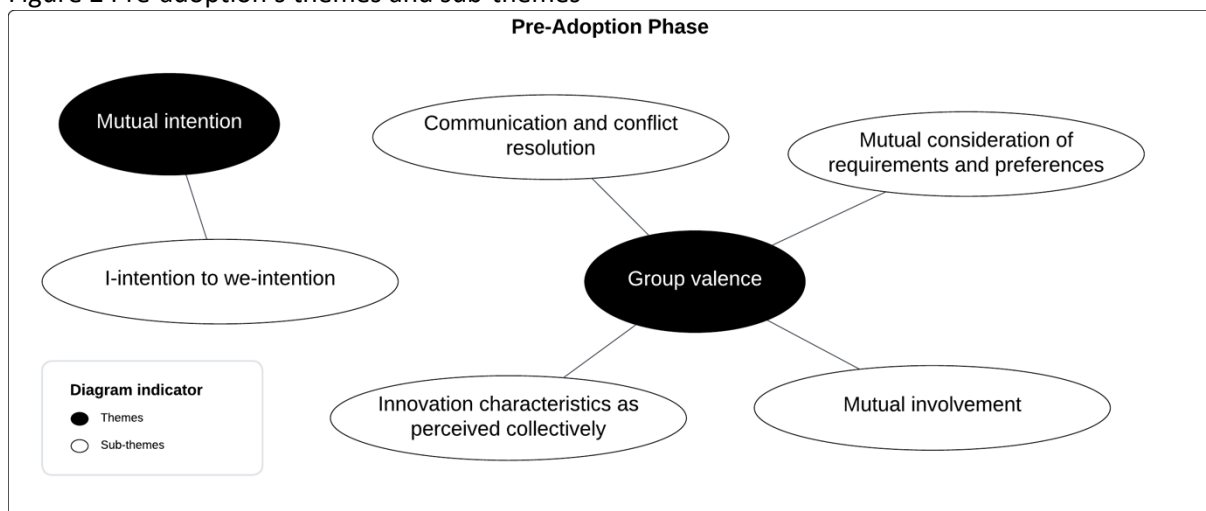


Figure 3 In-adoption's theme and sub-themes

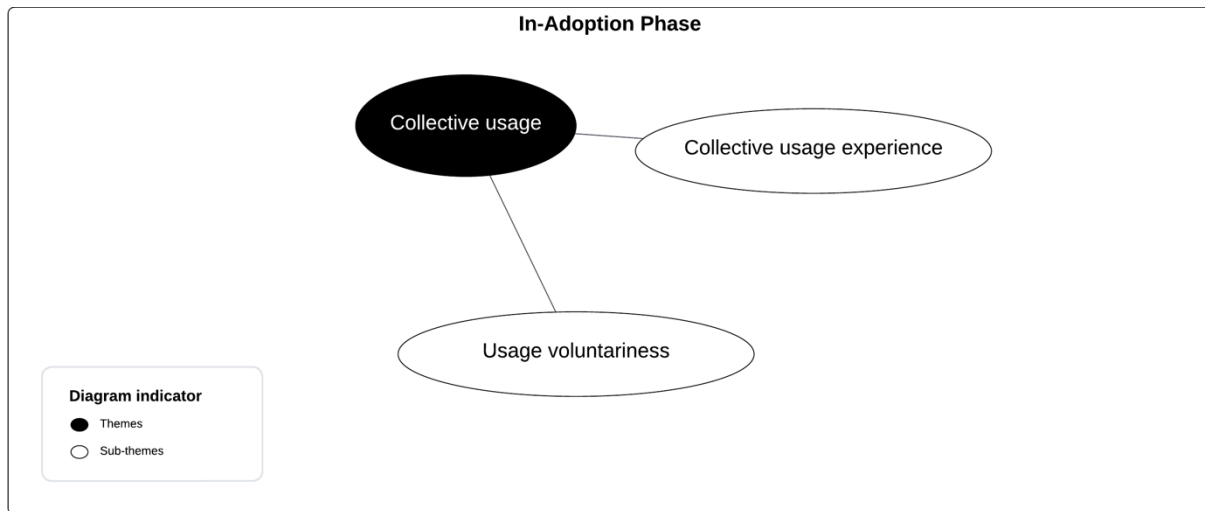
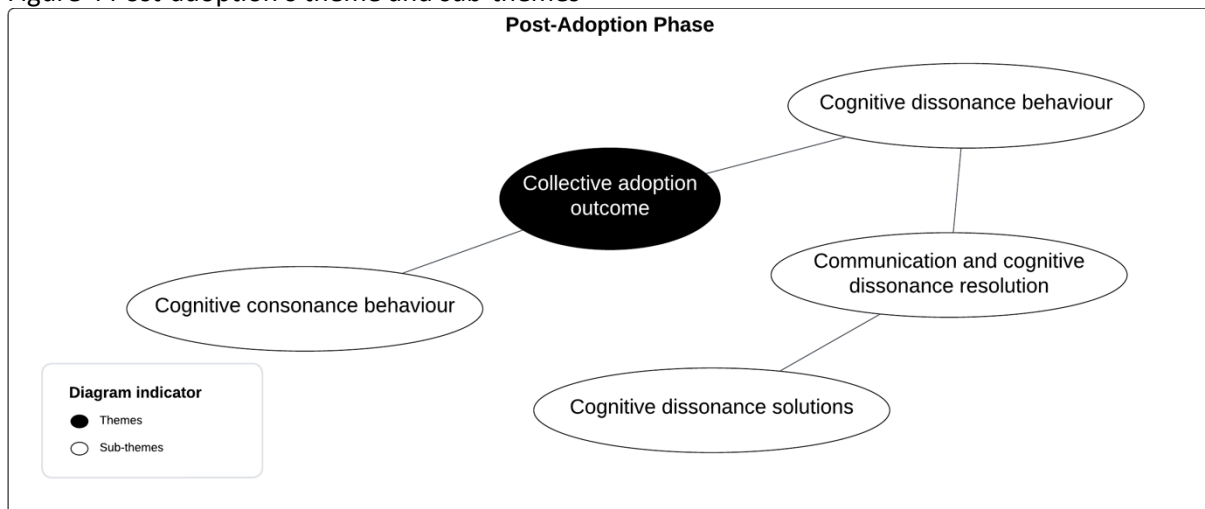


Figure 4 Post-adoption's theme and sub-themes



3.4 Initial findings

The initial findings from the interviews provide valuable insights into the dynamics related to the process of technology adoption from a collective perspective. The main themes that emerged from the interview data are mutual intention, group valence, collective usage and collective adoption. The central sub-theme identified is the consideration of innovation characteristics as part of the decision-making process that influences group valence, either positive or negative, towards the SHTs for collective use. The innovation characteristics were seen from group perspectives. In general, households had discussions about the smart home technology before the decision-makers had the final say about the decision. The decision-makers consider the innovation characteristics not only for themselves, but also for the others in the household who follow the decision. If all households have a positive orientation in relation to the smart home technology they are considering adopting, only then will the decision-makers have the final say to adopt it. One interviewee (decision-maker) said, *"I asked my partner if she agreed before I made the final say because we live in this house together"*. The SHTs characteristics have to tick all the boxes for household adoption, which both the decision-makers and non-decision-makers agreed to. As said by one interviewee (decision-maker), *"I am not the only one living in the house so whatever decision I make, I make sure my wife likes it as she will be the one at home the most and using it the most"*. Another interviewee (decision-maker) noted, *"Even though I am the primary decision-maker, before I make a*

decision, I make sure the SHT is compatible with my family". Furthermore, the decision-making process is not mainly done independently by the primary decision-makers. The involvement of the partners is crucial to help the decision-making to ensure the partner who follows the decision is happy with the decision and to avoid arguments in the future. When it comes to the adoption of household technology, the process is mainly involves communication between the primary decision-makers and the non-decision-makers. The adoption usage is voluntary, even for the one who followed the decision as they were involved in the decision-making process. If the non-decision-makers had low involvement in the process, the usage is voluntary and leads to satisfied adoption due to the characteristics offered by the SHTs. One non-decision-maker said "I used it (the SHT) on my own freewill. Because later on, I found out that this thing actually makes a lot of sense and makes my life easier. I am very satisfied with it (SHT)". The process is cyclical if the SHTs do not work as expected, e.g., broken. In such instances, households would engage in discussions to determine the best course of action, whether it be repairing the technology or replacing it altogether.

4 Conclusion

In summary, this study adopts Roger's Diffusion of Innovation theory and emphasises the significance of group valence in the collective technology adoption (CTA) process, particularly in the context of smart homes. By considering innovation characteristics and collective dynamics, the research elucidates the user's journey when it comes to collectively used technology. That includes how decisions are made within groups, the collective utilisation, and evaluation from collective adoption. The study unravels the users' journey before, during, and after collective adoption from smart home perspectives. As the smart home market continues to grow, a deeper understanding of user perspectives, especially in multi-user settings is desirable. This research contributes to bridging the gap in the existing literature by contextualising the collective adoption model within the realm of smart homes and the process behind using a qualitative approach.

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