7-18-2022

Factors Influencing the Adoption of Smart-home Appliances: Users' Perspectives

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A Dissertation submitted to the Graduate School at the University of Missouri-St. Louis,

in partial fulfillment of the requirements for the degree

Doctor of Business Administration with an emphasis on Strategic Management

December 2022

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Abstract

Smart appliances will be a significant part of the annual $300 billion smart-home market by 2025. Their use is expected to grow at a compounded annual growth rate of 31% for the foreseeable future. Currently, 12-16% of households use smart-home products in the U.S., including thermostats, TVs, refrigerators, coffee machines, garage door openers, and vision-equipped doorbells. Smart appliances provide significant benefits to us over traditional appliances. Smart appliances simplify our lives by automating various tasks in our homes and allowing us to monitor and control them remotely from our offices, grocery stores, and wherever we may be.

Despite the usefulness and popularity of some smart appliances, recent research has shown that their adoption rate may not be increasing as expected. Every day, manufacturers rush to make appliances smarter through increased automation and connectivity without paying attention to consumers' concerns about their use. However, if the manufacturers do not address consumers' concerns about their smart appliances, they may not readily be adopted solely based on their features.

Scholars have explored technology adoption through various sociology, psychology, and information science theories. The universal theory of acceptance and use of technology (UTAUT) combines these widely researched theories into a framework that can be used to explore the technology adoption process. This research qualitatively explores the critical factors antecedent to consumers' adoption behavior of smart appliances using the UTAUT framework.

The findings from this research have expanded the application of UTAUT to address the adoption of smart-home appliances. Further, to aid the adoption process, this research makes important suggestions to practitioners involved in developing, manufacturing, and marketing smart appliances: the need to focus on interoperability, the need to lower the consumers’ effort, and the need to handle consumers' data ethically. Finally, the research also offers remedies to counteract consumers’ resistance to adopting smart appliances: providing an acceptable level of automation and connectivity in appliances.

Keywords: Smart-home, Smart Appliance, Technology Adoption, Privacy and Security, Automation, Internet of Things (IoT), Artificial Intelligence, Autonomy

Acknowledgments

I express sincere gratitude to the Dissertation Committee Chair, Dr. Joseph Rottman, and committee members, Dr. Dinesh Mirchandani and Dr. Douglas Smith, for providing valuable guidance throughout this research process. I am also thankful to the dissertation community members Dr. Ekin Pellegrini, Denish Gangasingh, and Mike Seals for their suggestions and support throughout our multiple residencies.

I am indebted to all the participants who shared their time and answers to my questions. This research would not have been possible without their openness and honesty in the interviews.

I am grateful to my parents, Prithvi and Devi Shahi, and my siblings, Kiran, Naresh, Rajan, and Tara for unconditionally being there. Without your love and encouragement, I would not have dreamt of pursuing a doctoral program.

Finally, I dedicate this dissertation to my wife, Chasity Shahi, and our children, Priya and Cruz. Without your love, patience, understanding, and support, I could not have completed this study and this dissertation.

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Chapter 1: Introduction

Background

Imagine that you are flying home with the family from a recent vacation. As the plane lands, your phone automatically sets the air conditioner in your home to a comfortable 72 degrees. As you get close to your neighborhood from the airport, it knows to turn on your coffee machine to brew your favorite java and to command your bathtub to fill up with lukewarm water. When Uber drops you in your driveway, your neighbor is surprised to see that the entire family had been away for two weeks. However, this is not surprising to you because the smart-home appliances in your home were using their capabilities to give your neighbor the impression that your home was occupied. They were able to draw curtains open in the morning and close them in the evening, play music in the living room and turn selected lights off and on in different rooms at different times mimicking a normal day in the household. On top of that, when the vision-equipped doorbells suggested potential intruders, the smart speaker could bark like a bulldog and send notification to you and to your security provider. These intelligent smart appliance through the incorporation of Internet of things (IoT) technology that use sensors, software, connectivity, computing, and artificial intelligence (AI), were able to give the impression that your home was occupied, all while your family was enjoying their time on a beach in the Bahamas.

This hypothetical smart-home that uses technology to automate and simplify our life is not too far from reality. Already, appliances in our homes are automating various tasks for us using the latest technologies including varying levels of artificial intelligence. For example, Amazon's Echo, a voice interaction-capable smart speaker, can have voice conversations with users and learn from them. Another product recently announced by Amazon, aptly named *Always Home Cam*, can autonomously fly around in the home and alert the homeowners of anything unusual (Ring.com). In the future, as manufacturers significantly increase the use of newer technologies, such as artificial intelligence and machine learning, our homes will become even more intelligent (Augusto & Nugent, 2006).

The growing manufacturer and consumer interest in smart-home products has created a big market and is expected to create even bigger business opportunities in the future. According to the marketing research firm Mordor Intelligence (2020), worldwide consumer spending in smart-home market was US$79.13 billion in 2020 and is expected to grow at a CAGR of 25.3% to US$313.95 billion by 2025. Statistics from McKinsey & Co (2021) show that 12 to 16 percent of current U.S. households already use smart-home products. Furthermore, their use is expected to increase at the compounded annual growth rate of 31% for the foreseeable future (McKinsey & Co., 2021). Similar data, published in a white paper by Cisco (2020), reveals that manufacturers expect to sell over 7 billion devices in 2023 to enable various smart-home applications such as home automation, home security and video surveillance, and connected appliances.

Smart-home appliances and the number of homes with them have been steadily increasing over the last decade, as seen by the popularity of appliances such as internet-connected TVs, smart thermostats, vision-equipped doorbells, and smart door locks. However, recent research also shows that the adoption rate of smart-home appliances may not be increasing as expected. For example, a longitudinal survey of first-time customers planning to purchase smart speakers within the next 12 months decreased in 2020 from

2019; privacy concerns were cited as the number one reason for not purchasing (Kinsella & Mutchler, 2020). Despite the usefulness of smart speakers, consumers concern for privacy is affecting their decisions to adopt them. Communicating the benefits to the consumers alone may not be sufficient enough to overcome other barriers to adoption (Wilson et al., 2017). This research aims to bridge this difference between what manufacturers and consumers find as important characteristics of smart-home appliances so that future products can address them to meet their consumers' expectations.

Smart-home Appliances

The rising popularity of some smart-home products, such as Amazon Echo, Ring doorbell, Nest thermostat, and others, have opened profound opportunities for manufacturers to add "smarts" to all appliances. Already, users have the option to replace many of their traditional appliances, like refrigerators, washers, and thermostats, with their "smarter" versions that are networked together and can be accessed and controlled through a remote phone or from a central system in the home to provide automatic energy management (AHAM, 2009). Smart appliances make our lives easier through their various use cases in homes, including entertainment, automation, health monitoring, energy management, and surveillance (Fabi et al., 2017). For example, through automation, you can set the ambient temperature of your home to your comfort or open your garage door for your kids remotely from your phone before leaving the office.

The opportunity for smart-home appliances to make our life simpler and efficient, as highlighted earlier, is endless. However, as manufacturers make our appliances smarter, they can introduce unintended negative consequences for the users. For example, these appliances can be intrusive to the users' data privacy and security. Appliances may need to sense their environment and collect user data and personal environment to make any beneficial decisions. However, consumers may be ignorant of the data collection process by the manufacturers or how they use the data. For example, many consumers were dismayed to find out from Bloomberg News that Amazon employees and contractors worldwide were listening in on private conversations recorded on Echo smart speakers (Day et al., 2019). Although it was necessary to use the recordings to make the voice recognition software better, it was revealed that Amazon did not explicitly let users know that the Echo speakers were recording their private conversations.

When appliances become smarter, they may also be intrusive to users' ability to make free choices. For example, using sensors, artificial intelligence, and machine learning, an intelligent HVAC system may adjust the temperature of each room independently in the home, based on the occupancy, to lower the energy consumptions. However, these decisions may not be what the consumers desire. Similarly, when a smart speaker recommends certain restaurants or products, the artificial intelligence-based algorithm used in making that recommendation may have been sponsored by a third party that does not account everyone's taste. These smart appliances' decisions and suggestions intended to provide value may seem intrusive to our autonomy and independence when we disagree with the choices.

Due to their many usefulness, smart-home appliances have a great potential to shape our future homes. However, consumers may not readily adopt them solely based on their usefulness. We have already suggested a few factors that may affect consumers' decisions to adopt smart-home appliances, but more work needs to be done to get a complete picture. According to Li et al. (2021), there is a need to understand the factors that influence households' adoption of smart-home technology, which is still an understudied area.

Research Gap

Research on the adoption of smart-home appliance has focused on testing various technology acceptance model constructs to see if they explain the adoption process. For example, Haglund and Flyden (2018) tested and found that constructs (perceived usefulness and perceived ease of use) of the Technology Acceptance Model (TAM) can shape consumers' adoption intention of smart-home ecosystems. Researchers have also tested constructs of TAM variations (Park et al., 2017) or TAM with other models (Liu & Chou, 2020; Hubert et al., 2019). However, research has not explored if the constructs of Unified Theory of Acceptance and Use of Technology (UTAUT) can explain the adoption of smart-home appliances. This may be because other models are parsimonious and easier to test quantitatively than UTAUT. Venkatesh et al. (2003) combined eight competing theories: Theory of Reasoned Action, Theory of Planned Behavior, Technology Acceptance Model, Combined TAM with Theory of Planned Behavior, Motivation Model, Model of PC Utilization, Innovation Diffusion Theory, and Social Cognitive Theory to formulate UTAUT unified model.

While testing adoption theories is essential, we believe that it is more important first to find out how the unique characteristics of smart-home appliances affect our adoption intentions. We agree with Fishbein and Ajzen's (1977) suggestion that researchers must first identify important factors that affect the new behavior under investigation. Thus, smart-home appliance adoption behavior needs to be explored. Since UTAUT is a unified model, we believe it will provide the best lens to explore the factors that affect consumers' smart-home appliance adoption behavior.

Understanding the factors that affect technology adoption are crucial to diffusing innovations. Our research has shown that smart-home appliances have a great potential to change the way we live in the future. There is also an immense interest from manufacturers and policymakers to increase the adoption of smart-home appliances that have many uses, from providing user health monitoring to reducing energy usage in the homes. Despite their usefulness, smart-home appliances adoption has not been as expected. We will use the lens of UTAUT to qualitatively explore the unique characteristics of smart-home appliances and their effect on individuals' smart-home appliance adoption behavior.

Research Questions

This research will address the following questions:

1. How do the unique characteristics of smart-home appliances affect adoption intentions?
2. How do the unique characteristics of smart-home appliances affect their adoption?

Expected Contributions

Smart appliances in various applications, such as energy management, security and surveillance, entertainment, medical, etc. are automating many of our tasks that used to require our physical intervention. In the future, the level of automation is expected to increase as manufacturers incorporate more artificial intelligence and machine learning to our appliances. This research explores the factors that affect consumer adoption behavior due to the increased level of automation in our appliances. This research will be beneficial to both academic researchers and practitioners involved in smart-home technologies and industries.

For researchers:

1. This research expands the application of UTAUT by using it to address the adoption of novel smart-home appliances.
2. Through in-depth interviews of users and non-users, this research decomposes core determinants of UTAUT into factors that affect the adoption of smart-home appliances.
3. This research adds additional determinants, internal values and risk expectancy, to UTAUT which will improve its explaining power when applied to novel technologies like smart-home appliance.

For practitioners, this research addresses the following:

4. Acceptable level of automation: It is important to address the acceptable level of automation in each application. Findings of this study can help manufactures find the level of automation that will best address consumers' perceived benefit versus acceptable level of risk from the smart appliances. Manufacturers may also want to allow varying level of automation to be set by the consumer. Similarly, manufactures may only want to include optimum level of features in their smart-home appliances.
5. Remedies for resistance to smart-home appliances: Manufacturers should find ways to address the reasons for consumers’ resistance to smart-home adoption that are highlighted by this research. In particular, some customers may want to manage the level of connectivity and control in the appliances. By adding the options to change

connectivity and control options, manufacturers will be able to reduce customers' perceived risks from the use of their appliances.

6. Addressing consumers internal values: When appliances can save energy, manufacturers should find ways to communicate that effectively to their "green" customers. Customers may not know about the environmental or social benefits from using the products.
7. Maintenance benefits: Practitioners should address not only the initial effort needed to install their appliances but also the maintenance efforts that is required from the owners. Appliances that can stay updated on their own or have a simple way to upgrade will be favored by consumers.

Summary

Smart-home appliances are expected to change the way we live in future. By incorporating software, hardware, connectivity, IoT, artificial intelligence, and machine learning, smart-home appliances can automate various tasks in our homes to make our lives easier. They can also enhance the quality of our lives through services that provide energy efficiency management, security and surveillance, and home-based healthcare. However, the pervasive use of novel technologies has also introduced several issues that negatively relate to consumers adoption decisions. These issues relate to the risks to the user from possible breach of data privacy and security as well as from ceding autonomy and independence due to increased automation. Research has shown that these perceived risks will slow consumers adoption to fall behind manufacturers as well as marketing and technology firms' growth expectations. This research aims to qualitatively explore consumer perspectives to find the factors that are important to their adoption decisions.

The finding of this research will help manufacturers find the right level of automation in the smart-home appliances that is needed to balance the factors that negatively affect consumers adoption decisions.

Chapter 2: Theoretical Framework and Propositions

Literature Review

The literature review will introduce three different streams of research. First, smart-home technology is introduced via smart-home appliances, and their unique characteristics are distinct from traditional appliances. In reviewing these characteristics, we will explicate themes that are important to users in their adoption decisions. By reviewing these unique characteristics, the limitations of UTAUT in explaining users' adoption of smart-home technology will be highlighted, and the need for including additional factors into UTAUT will be suggested. Second, the relevant theories of technology acceptance and use will be introduced. In particular, the eight theories that are foundational to the model of Unified Theory of Acceptance and Use of Technology (UTAUT), which forms the underlying framework of this research, will be reviewed. Determinants of UTAUT will be analyzed to see their relationship with the constructs of other related models. Third, a framework to study the user adoption of smart-home technologies based on UTAUT will be introduced, and several propositions will be postulated. Finally, through the review of the literature and the proposed propositions, this chapter will end by suggesting expected contributions from this research.

Smart-home and Smart-home Appliances

Smart-home is a term used to describe a residence that uses innovative technology to connect various appliances to the outside world. In a smart-home, these appliances can sense the occupants' needs, wherever they may be physically in the world, and respond to maintain and promote their comfort, convenience, security, and entertainment (Harper, 2006). For example, wireless thermostats already allow people to change their heating and cooling equipment remotely so that the home is comfortable when they arrive. Garage door openers and front door locks can be closed shut and opened remotely by parents when their children leave for school in the mornings and come home in the evenings. Vision-equipped wireless doorbells allow us to monitor our front doors and answer them remotely.

The concept of "smart" in smart-home keeps evolving as technology changes. Today's full-blown smart-home concept is the *acme of domestic technology we can envisage at present* (Harper, 2006). Recently, "smart" has evolved in the literature to describe innovative technologies that possess some degree of artificial intelligence (Marikyan et al., 2019). In a smart-home, connected appliances with artificial intelligence can monitor the environment and take appropriate action without any required intervention from the occupants. For example, smart electric meters can make smart-home energy-aware environments (Stojkoska & Trivodaliev, 2017). With artificial intelligence, smart-homes can monitor energy prices and schedule appliance demand to reduce the power use during peak hours: the running of washing machines and dishwashers may be postponed to the middle of the night when the electricity prices are the lowest (Yaghmaee & Hejazi, 2018).

Current literature has explored various practical uses of smart-home appliances, including security and health monitoring. By utilizing a network of cameras and sensors on doors, windows, and the surroundings, smart-homes can detect unwanted intrusion and protect the assets by alerting the homeowners and the police (Daramas et al., 2016). In addition, by equipping with technology that uses informatics to monitor the health as part of the home's infrastructure, older adults and those with chronic conditions can maintain independence in their own homes (Demiris & Hensel, 2008). The recent growth in the interest in utilizing data processing to improve elderly health has resulted in a new research field of "gerontechnology" - a cross-disciplinary field that focuses on research on technical applications, including in smart-homes, to promote quality of life for our elderly population (Bouma, 1998).

Smart-home Appliances' Unique Characteristics

A key aspect of smart-home appliances is the integration of Internet of Things (IoT) technology. The phrase "Internet of Things" is an amalgamation of two words. "Internet" refers to a global system of interconnected computer networks and "Things" refers to physical objects distinguishable in the real world. IoT is defined as "an open and comprehensive network on intelligent objects that have the capacity to auto-organize, share information, data and resources, reacting and acting in face of situations and changes in the environment" (Madakam et al., 2015).

IoT is an evolving technology. When it was first introduced in a presentation to the executives at Proctor and Gamble in 1999 by Kevin Ashton, it was limited to the technical possibilities of integrating radio frequency identification device (RFID) technology with the Internet to improve supply chain efficiencies (Ashton, 2009). Today, IoT can include a communicating network of everyday physical objects embedded with sensors, actuators, wireless communication, software, and other technologies (Atzori et al., 2010). In homes, the integration of IoT has enabled researchers to turn many technical possibilities into realities over the past two decades, as seen through the widespread use of wireless appliances such as thermostats, garage door openers, vision-equipped doorbells, and smart light bulbs. Still, researchers and manufacturers are focusing on novel technologies and applications of the Internet of Things to make our homes even more "smarter" by making the "things" in our homes more aware of their states and respond appropriately.

Patel and Patel (2016) describe five fundamental characteristics of the IoT:

1. Interconnectivity: IoT allows anything to be connected globally. In the smart-home context, any physical thing in and around our homes can be connected to the Internet by integrating IoT.
2. Things-related services: With IoT, manufacturers can provide services through their smart-home appliances beyond what traditional appliances can offer. For example, smart doorbells can be answered remotely from anywhere in the world.
3. Heterogeneity: Appliances in the IoT can have different hardware, software, and network platforms, but they may need to interact with each other. For example, a garage door opener may need to be connected through Amazon's Echo or Google Home.
4. Dynamic changes: The state of the appliances (on, off, sleeping) and the context of appliances (physical location) can change dynamically.
5. Enormous scale: The number of appliances that will need to be managed in a home will increase by an order of magnitude in the future.

These fundamental characteristics of IoT introduce both benefits and challenges to the users of smart-home appliances. From the user's perspective, smart-home technology can offer economic, social, health-related, emotional, sustainability, and security benefits (Marikyan et al., 2019). These benefits result from smart-home applications that provide various features, such as health condition monitoring, entertainment, security, and energy efficiency (Fabi et al., 2017; Li et al. 2021). Further, some authors have suggested managing energy efficiency as a significant benefit from the use of smart-home technology (Fabi et al., 2017; Wilson et al., 2017). For example, 5 to 15 percent of total energy consumption in a home can be lowered by continuously monitoring and understanding the energy usage of individual appliances within a building (Fabi et al., 2017).

The challenges arising from the fundamental characteristics of IoT in the smart-home can be divided into users' technological barriers, financial barriers, ethical and logical concerns, and knowledge gap and psychological concerns (Marikyan et al.,2019).

Research has mainly explored technical challenges to the adoption of smart-home appliances, including security, privacy, usability, reliability, and complexity (Abdi et al., 2019; Coskun, Kaner, & Bostan, 2018; Emami-Naeini et al., 2019; Fabi et al., 2017; Fu et al., 2017; Li e al., 2021; Marikyan et al., 2019; Patel and Patel, 2016; Schomakers et al., 2021). Non-technical challenges to smart-home adoption relate to costs and lack of government regulations (Fabi et al., 2017; Marikyan et al., 2019), trust factors (Li et al., 2021; Schomakers et al., 2021), and the users' lack of knowledge and their resistance to innovations (Li et al., 2021; Marikyan et al., 2019).

However, studies to explore smart-home characteristics that affect adoption of smart-home technology are not consistent in their findings. Yang et al. (2018) found that controllability, interconnectedness, and reliability significantly impacted users' intentions to adopt smart-home services, but automation did not have a significant impact. Conversely, a qualitative study involving 20 in-depth interviews of representative mainstream smart-home technology users found that offering flexible autonomy and remote controllability in smart-home appliances together with the ability to provide guidance are most important to them (Coskun, Kaner, & Bostan, 2018). Schomakers et al.

(2021) found that smart-home technology's most dominant adoption determinants are perceived reliability, followed by data security.

Our literature review has revealed several themes related to smart-home appliances that affect the user's adoption behavior, as shown in Table 1.

Themes	Smart-home appliances characteristics
Performance-technical	Interoperability, remote access, automation
Performance- economic	Saving energy, time, and money
Effort	Installation effort, use effort, and maintenance effort
Influence – external	Government policy and regulations, media, social network
Influence- internal	Environmental responsibility, innovativeness
Risks	Privacy risks, security risks, and autonomy risks

Table 1:Factors that affect the adoption of smart-home appliances

Theories on Technology Adoption

User acceptance has been widely explored in the information systems (IS) domain since the 1980s and has produced one of the most comprehensive streams of research that has enabled us to understand the determining factors that lead us to accept various new technologies. Research has borrowed theoretical underpinnings from vast academic fields, including information systems, sociology, and psychology, to produce several models explaining up to 40 percent variance in users' technology acceptance intentions. However, there is no clear trend in the research that suggests a particular model is better suited than others to study technology acceptance. Thus, as researchers face new technologies in their explorations, they have had to resort to their favorite model or combine it with constructs from multitudes of available models to increase their explaining power of the variance in user acceptance. In their highly cited research, Venkatesh et al. critically reviewed the constructs in 8 widely used technology acceptance models. As a result, they suggested the Unified Theory of Acceptance and Use (UTAUT) as a comprehensive model for future research (2003). The eight models included in the UTAUT are:

1. Theory of Reasoned Action (TRA)
2. Technology Acceptance Model (TAM)
3. Theory of Planned Behavior (TPB)
4. Decomposed Theory of Planned Behavior (DTPB)
5. Motivational Model (MM)
6. Model of PC Utilization (MPCU)
7. Innovation Diffusion Theory (IDT)
8. Social Cognitive Theory (SCT)

Theory of Reasoned Action

Martin Fishbein and Icek Ajzen proposed the Theory of Reasoned Action, which is shown in Figure 1. In their theoretical model, Fishbein and Ajzen explained the relationships between beliefs, attitudes, intentions, and people's behavior. First, people's beliefs influence their attitudes, leading to intentions, which guide their behavior (Fishbein & Ajzen, 1975).

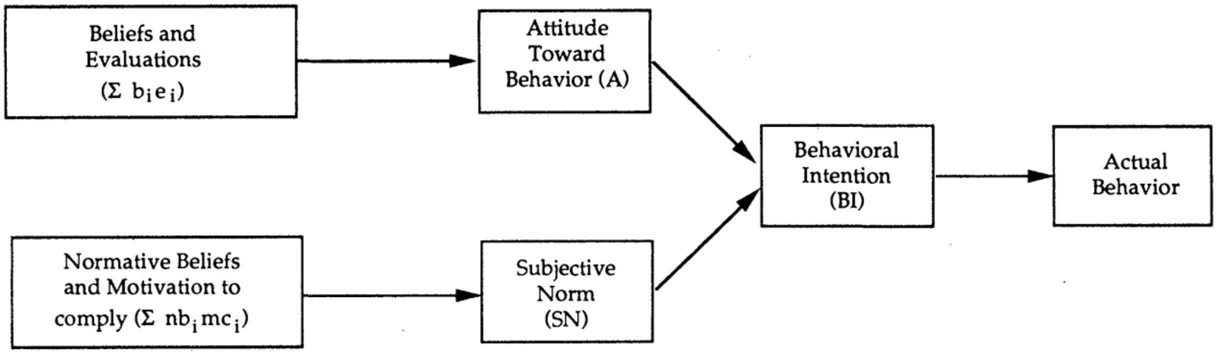

Figure 1: Fishbein and Ajzen's model of the Theory of Reasoned Action (Davis, Bagozzi, and Warshaw, 1989)

In their model, Fishbein and Ajzen refer to behavioral intention as a precursor to a person's actual behavior, which is a measure of one's intention to perform a behavior. The behavioral intentions are determined by:

a. a person's positive or negative feelings of performing that behavior, called attitude towards behavior (A), measured by summing the products of their salient beliefs on the consequences of performing that behavior (*bi)*, and an evaluation (*ei*) of those consequences, as given by the formula:

$$A = \sum_{i=0}^{n} b_i \, e_i$$

b. The perception of how a person values others feel about him or her performing that behavior is also called the subjective norm (SN) associated with that behavior. SN is determined by a person's perceived expectations of others, called normative beliefs (*nb*) and the motivation to comply (*mc*) with those external expectations. The formula gives subjective norm:

$$SN = \sum_{i=0}^{n} nb_i \, mc_i$$

Fishbein and Ajzen's model can be used to determine the actual behavior of an individual through the person's intentions to perform that behavior which is calculated as the sum of their attitude towards the behavior and the subjective norm. The formula shows this relationship:

$$BI = A + SN$$

Technology Acceptance Model

A decade after the proposal of the TRA by Fishbein and Ajzen, Fred Davis adapted it into the Technology Acceptance Model (TAM) to explain the user acceptance of information systems (Davis, 1989). TAM considers the actual use of an information system as behavior and, thus, can be modeled through TRA. However, Davis removed the subjective norm's relationship with the behavioral intention from the original model proposed by Fishbein and Ajzen. He proposed that the behavioral intentions are determined solely by a person's attitude towards the behavior. Further, to make TAM more meaningful to practitioners that are interested in evaluating new information systems prior to their implementation, Davis (1989), in his model, proposed limiting the users' salient beliefs to two fundamental determinants that could be measured: perceived usefulness (PU) and perceived ease of use (PEOU). Davis's original TAM proposed in his doctoral dissertation thesis is shown in Figure 2 which shows PU and PEOU being influenced by system design characteristics represented by X1, X2, and X3.

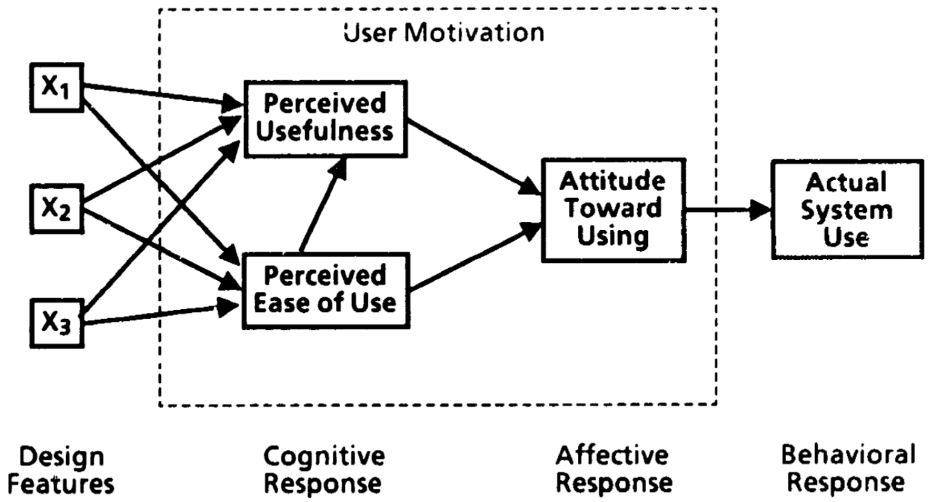

Figure 2: Technology Acceptance Model proposed by Fred Davis

In TAM, PU is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" and PEOU as "the degree to which a person believes that a particular system would be free of effort" (Davis, 1989). TAM has since become one of the most widely used models to explore user acceptance of technology, not only in the information systems domain but also in other domains, such as medicine (Hu et al., 1999), e-commerce (Klopping & McKinney, 2004), education (Gong et al., 2004; Agudo-Peregrina et al., 2014), and smart-home technologies (Liu and Chou, 2020; Haglund and Flyden, 2018). In a meta-analysis of 72 publications that studied TAM, Turner et al. (2010) found that behavioral intention (BI) is the most significant predictor of use, followed by PU and PEOU. However, the study also found that when objective measures are used instead of subjective measures, all the TAM variables' predictive power of actual use was lowered (Turner et al, 2010). In another meta-analysis of empirical research on TAM, the correlation between PU and acceptance and that between PU and PEOU was strong. However, the relationship between PEOU and acceptance was weak and not significant (Ma and Liu, 2004).

Theory of Planned Behavior

Theory of Planned Behavior (TPB) is an extension of TRA proposed by Icek Ajzen in 1985. TPB adds the construct of perceived behavioral control (PCB) to TRA. Perceived behavioral control is defined as the perception of one's control over the performance of a given behavior. Since resources and opportunities available to a person are limited and will dictate the likelihood of achieving a given behavior, the perception of behavioral control and its impact on intentions and actions are important (Ajzen, 1991). Thus, the theory suggests that a person who feels more strongly that they can successfully perform a behavior will more likely enact it than another who feels less strongly about the success of his or her behavior. TPB is shown in Figure 3 below.

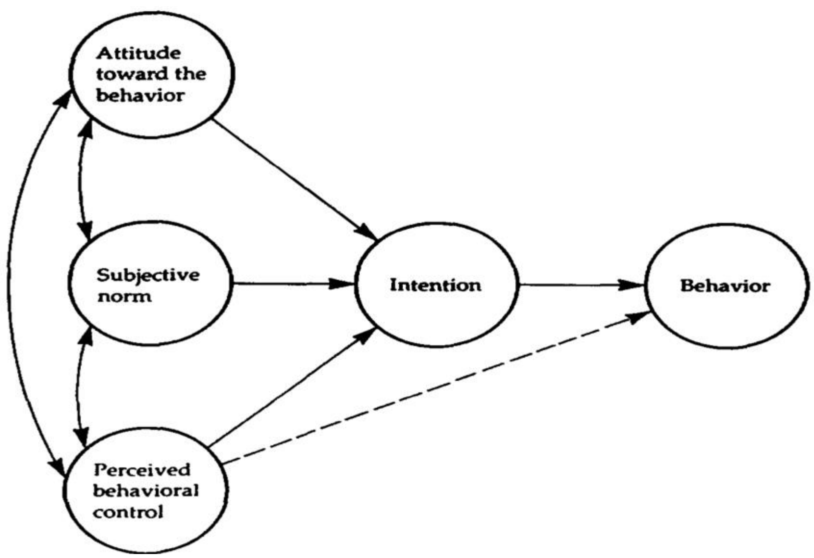

Figure 3: Theory of planned behavior (Ajzen, 1991)

Social Cognitive Theory

Social Cognitive Theory (SCT) was proposed by Albert Bandura (Bandura, 1986). It is one of the most influential theories of human behavior. It suggests a triadic reciprocal relationship between a person's behavior, environmental influences, and cognitive factors as shown below in Figure 4 (Compeau and Higgins, 1995).

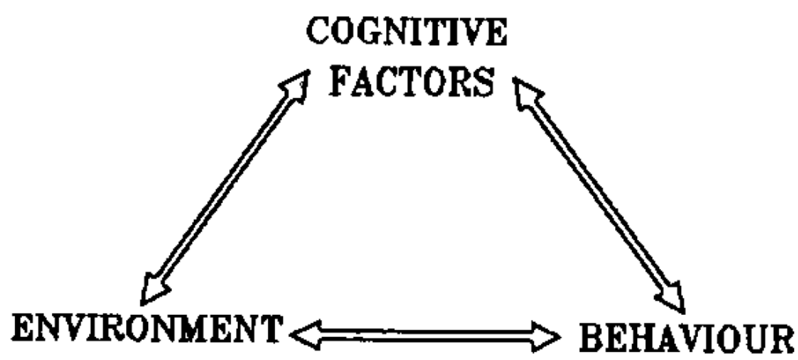

Figure 4: Social cognitive theory triadic reciprocal relationship (Compeau & Higgins, 1995)

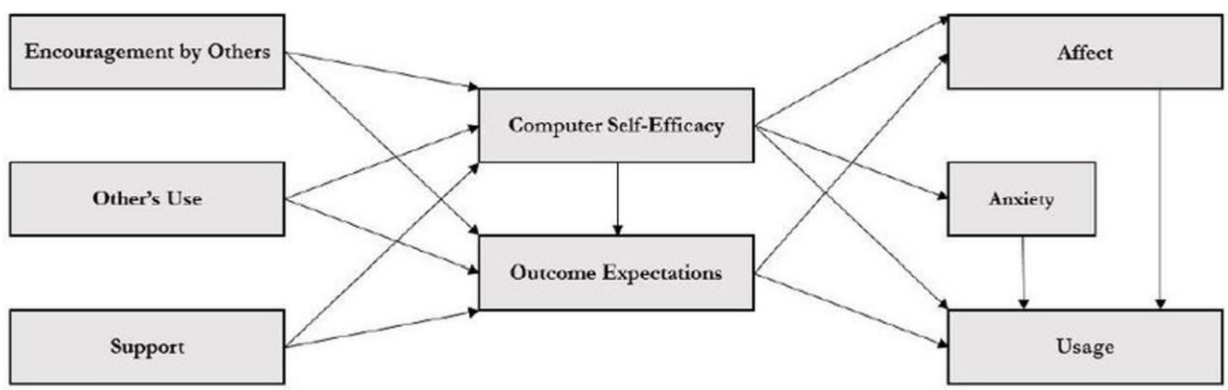

Figure 5: SCT theory of computer use

Based on Bandura's SCT, Compeau and Higgins (1985) proposed the SCT theory for computer use as shown in Figure 5. This theory suggests key influencers of computer use behavior: user's self-efficacy (SE) and outcome judgments, along with their emotional responses: affect and anxiety. Both affect and anxiety are dependent on computer self-efficacy and outcome expectations. Self-efficacy is defined as the judgement of one's ability to perform a particular behavior. Self-efficacy is like the perceived ease of use (PEOU) construct in TAM and relates to a person's judgment to execute courses of action to complete a particular job or task (Venkatesh et al., 2003). Outcome judgment suggests that individuals are most likely to undertake behaviors that will produce favorable outcomes (Compeau and Higgins, 1995). It is defined as "the extent to which a behavior once successfully executed is believed to be linked to valued outcomes" (Venkatesh et al., 2003) and is similar to the perceived usefulness (PU) construct in TAM. Both self-efficacy and outcome expectations are influenced by other factors, including encouragement from others, the available organizational support, and others actual use behavior.

Motivation Model

Motivational model suggests that a person's behavior is based upon both intrinsic and extrinsic motivations. Intrinsic motivation refers to the perceptions of pleasure and satisfaction from participation in the act itself. For example, a student may be intrinsically motivated to go to the class if they find the act of going exciting and the learning is pleasurable (Vallerand, 1997). Intrinsic motivation leads users to perform an activity "for no apparent reinforcement other than the process of performing the activity per se" (Davis et al., 1992). Extrinsic motivation, on the contrary, relates to a wide variety of behaviors that are performed not for the sake of oneself. It is defined as the perception that users want to perform an activity "because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself" (Davis et al., 1992). TAM constructs PU and PEOU and TRA predictor subjective norms are examples of extrinsic motivations.

Decomposed Theory of Planned Behavior

Taylor and Todd (1995) proposed a hybrid model, called the Decomposed Theory of Planned Behavior (DTPB), by combining the constructs PU and PEOU of TAM with TPB predictors. This model in Figure 6 shows the decomposition of belief structures. Attitudinal beliefs are decomposed into perceived usefulness, perceived ease of use, and compatibility. Subjective norm beliefs are decomposed into peer influence and superior's influence. Control beliefs are decomposed into self-efficacy, resource facilitating conditions, and technology facilitating conditions. DTPB has been applied to study the acceptance of various technologies and applications, including online tourism booking (Sahli and Legoherel, 2014), education (Hsiao and Tang, 2015), mobile banking (Kazemi et al., 2013; Yu, 2014), and e-commerce (Crespo and Bosque, 2010)

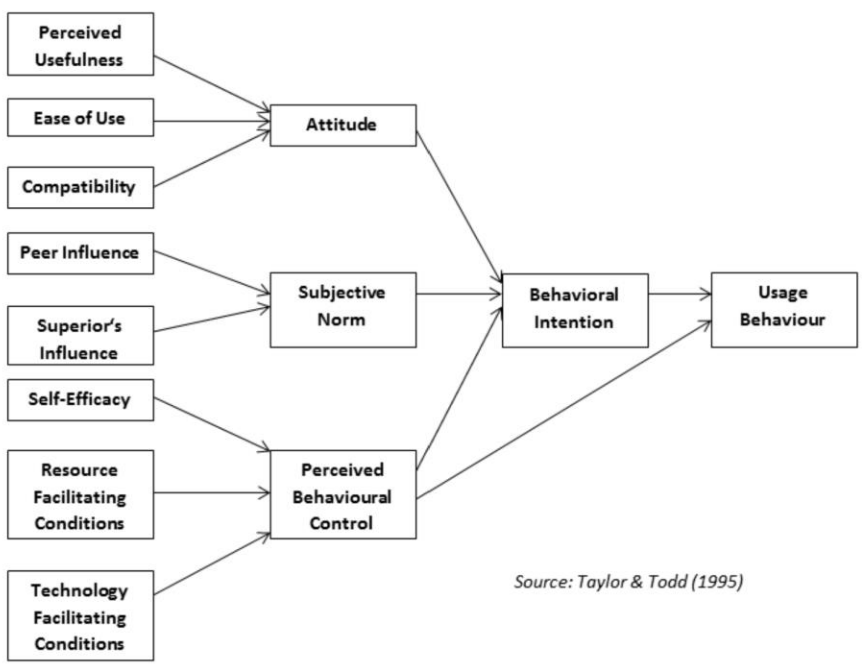

Figure 6: Combined TAM and TPB (Taylor and Todd, 1995)

Model of PC Utilization

Model of PC Utilization (MPCU) is mostly derived from Triandis' (1979) theory of human attitudes and behavior. Triandis argues that behavior is determined by attitudes (what people would like to do), social norms (what they think they should do), and habits (what they have usually done). Although MPCU incorporates similar constructs and concepts from TRA and TPB, it proposes a different perspective to human behavior by modifying and redefining them (Thomson et al., 1991). One of the key differences is that while Fishbein and Ajzen consider all beliefs a person has about an act or behavior collectively, Triandis distinguishes the beliefs that link emotions to the act and the beliefs that link the act to future consequences. In addition, Thomson et al. (1991) refined Triandis' model specifically to predict users' PC utilization behavior rather than intention, shown in Figure 7.

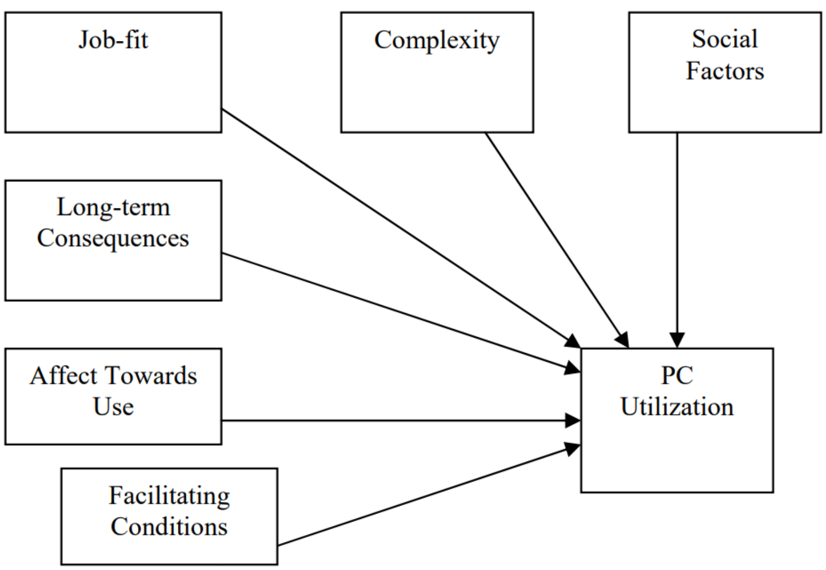

Figure 7: Model of PC Utilization (Thomson et al., 1991)

Innovation Diffusion Theory

Innovation Diffusion Theory (IDT) has been used in studying the diffusion of innovations in various sectors ranging from agricultural farms to organizations since the 1960s. In the book, *Diffusion of Innovations*, Everett Rogers (2010) identifies and defines five attributes of innovation that help in the diffusion of the innovation:

1. Relative advantage: the degree to which an innovation is perceived as being better than its precursor
2. Compatibility: the degree to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adoptors
3. Complexity: the degree to which an innovation is perceived as being difficult to use
4. Observability: the degree to which the results of an innovation are observable to others; and
5. Trialability: the degree to which an innovation may be experimented with before adoption

Moore and Benbasat (1991) refined some of Rogers' attributes and additionally made two additions that were thought to be important in the adoption decisions:

1. Image: the degree to which the use of an innovation is perceived to enhance one's image or status in one's social system
2. Voluntariness of Use: the degree to which use of the innovation is perceived as being voluntary or of free will

Universal Theory of Use and Acceptance of Technology

Universal Theory of Acceptance and Use of Technology (UTAUT) was formulated by Venkatesh et al. (2003) by empirically comparing the constructs from the eight theories and models described earlier. The empirical synthesis produced seven significant determinants of intention or usage in one or more models: performance expectancy, effort expectancy, social influence, facilitating conditions, behavioral attitude, self-efficacy, and anxiety. Behavioral attitude, self-efficacy, and anxiety are theorized not to be significant direct determinants of user acceptance or usage behavior. The UTAUT model is shown in Figure 8.

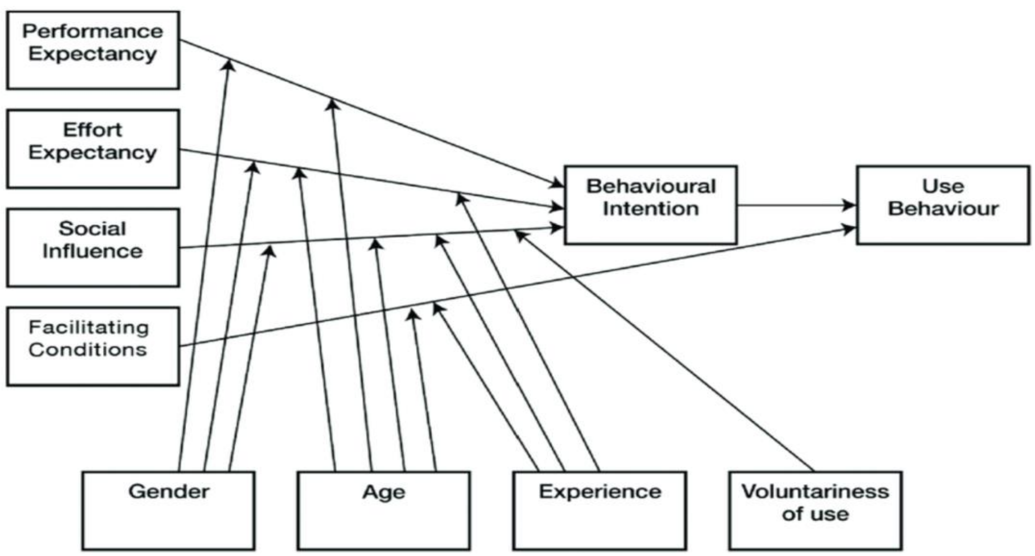

Figure 8: UTAUT based on Venkatesh et al. (2003)

As shown in Figure 8, UTAUT proposes facilitating conditions to be a direct determinant of use behavior of technology and performance expectancy, effort expectancy, and social influence to be direct determinants of use intention. Additionally, UTAUT also suggests the technology's voluntariness of use and the users' age, gender, and experience to play the moderating role in the relationships. In a longitudinal field study of employees' technology acceptance, Venkatesh et al. (2003) compared UTAUT against the eight models. They found that it outperformed them and explained about 70 percent of the variance in behavioral intention to use and about 50 percent of the variance in the usage of the technology.

Determinants of UTAUT

The four core constructs of UTAUT and their relationship to the constructs of each of the eight models used in forming UTAUT are shown below in Table 2. The next section will outline each of the constructs in the eight models that are similar to the root constructs of UTAUT.

	UTAUT Root Constructs				
Theories used in UTAUT	Performance Expectancy	Effort Expectancy	Social Influence	Facilitating Conditions	
TRA			Subjective Norm		Individual constructs that map to UTAUT determinants
TAM	Perceived Usefulness	Perceived Ease of Use			
TPB			Subjective Norm	Perceived Behavioral Control	
DTPB	Perceived Usefulness	Ease of Use	Subjective Norm	Perceived Behavioral Control	
MM	Extrinsic Motivation				
MPCU	Job-fit	Complexity	Social Factors	Facilitating Conditions	

IDT	Relative Advantage	Complexity	Image	Compatibility	
SCT	Outcome Expectations				

Table 2: Root constructs of UTAUT and their relation to other theories

Performance Expectancy

Performance expectancy is defined as "the degree to which an individual believes that using the system will help him or her to attain gains in job performance" (Venkatesh et al., 2003). As shown in Table 2, performance expectancy includes five root constructs from six different models: perceived usefulness (from TAM and DTPB), extrinsic motivation (from MM), job-fit (from MPCU), relative advantage (from IDT), and outcome expectations (from SCT).

Effort Expectancy

Effort expectancy is defined as "the degree of ease associated with the use of system" (Venkatesh et al., 2003). As shown in Table 2, effort expectancy includes three root constructs from three different models: perceived ease of use (from TAM and DTPB), complexity (from MPCU and IDT).

Social Influence

Social influence is defined as "the degree to which an individual perceives those important others believe he or she should use the new system" (Venkatesh et al., 2003). As shown in Table 2, social influence includes three different root constructs from five different models: subjective norm (from TRA, TPB, DTPB), social factors (from MPCU), and image (from IDT).

Facilitating Conditions

Facilitating conditions are defined as "the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system" (Venkatesh et al., 2003). As shown in Table 2, facilitating conditions include three different root constructs from four different models: perceived behavioral control (from TPB and DTPB), facilitating conditions (from MPCU), and compatibility (from IDT).

Theoretical Framework: Applying UTAUT in a Smart-home Context

Venkatesh et al. (2003) suggest that their study highlights the need to explore the contextual factors when analyzing technology implementation strategies. Although literature is abundant on the technology aspect of smart-home, research on contextual factors that determine the adoption of this technology is limited. Based on the literature review on smart-home appliances and their unique characteristics, several important themes to smart-home technology adoption have been identified in Table 1. Although this may not be an exhaustive list, and our own research and any other future research may reveal more, we believe these are important in the adoption of smart-home technology. Next, we will review these themes through the lens of UTAUT, categorize them within the constructs of UTAUT, and offer several research propositions guided by our literature review.

Performance Expectancy

Users' performance expectancy is shaped by the benefits they perceive from using smart-home technology. Venkatesh, Thong, and Xu (2012) have described performance expectancy as "the degree to which using a technology will provide benefits to consumers in performing certain activities." Based on our literature review, we propose two performance-based themes that are expected to affect our behavioral intention to adopt smart-home technology.

Technical Performance

The use of IoT technology in smart-homes has enabled many technical possibilities to become realities, as can be seen through the proliferation of smart appliances like vision-equipped doorbells, smart door locks, smart switches, and connected thermostats. When people purchase smart-home appliances, they expect seamless operation from wherever they are. For example, people with smart doorbells expect to get a notification when any person comes to the door, wherever they may be physically. At the same time, they do not want to be notified if a neighbor's pet cat or a squirrel sets off the motion detector in the doorbell sensor. Therefore, the doorbell needs to be able to interoperate with the home Wi-Fi router, provide remote access to the data it is collecting, and allow the users to interact with it to answer any rings. In addition, the doorbell needs to make a reliable decision on its own to interpret whether the motion sensor is activated by a human or something else. The level of interoperability, remote access, autonomy, and reliability are important factors influencing our technical performance expectancy of smart-home appliances. Thus:

Proposition 1: Perceived technical performance is related to an individual's behavioral intention to adopt smart-home appliances.

Economic Performance

Performance expectancy can also be described in terms of relative advantage of a technology. Moore and Benbasat (1991) describe relative advantage as the "degree to which using an innovation is perceived as being better than using its precursor." The literature review has revealed that people expect distinct advantages from the new technology over the previous. Fabi et al. (2017) suggested that energy efficiency is a major driver for choosing some smart-home appliances. For example, adding smarts to HVAC components can lower the overall energy usage by 5 to 15 percent which also saves money for the homeowners. Voice activated smart speakers, such as Amazon's Echo, save users time in many ways. For example, by connecting other appliances in your home to Echo, you can turn them off and on without physically having to go to the device. You can also ask Alexa on Echo products to find you today's sports results, news, weather, or play you a specific tune without the need to spend time to search them individually. The level of energy, time, and money that people can save by using smart-home technology are critical performance factors. Thus:

Proposition 2: Perceived economic performance is related to an individual's behavioral intention to adopt smart-home appliances.

Effort Expectancy

A smart-home user's effort expectancy is guided by his or her perception of how easy it is to use the technology. It is defined as "the degree of ease associated with the use of the system" (Venkatesh et al., 2003). With many smart-home technology appliances, the perception is that the users will self-install and manage them over the product's life. Our literature review proposes two effort-based themes that are expected to affect smart-home appliances adoption: installation effort and maintenance effort. Since maintenance effort is needed only after starting to use the system, we propose maintenance effort as a facilitating condition for the use adoption of smart-home technology. However, perceived installation effort will affect our behavioral intention to adopt smart-home technology.

Perceived Installation Effort, Use Effort, and Maintenance Effort

In using smart-home appliances, installation and maintenance efforts are also needed on top of the actual effort to use them. For example, many smart-home appliances are expected to be self-installed. Some of the most widely adopted smart-home appliances are sold as self-install kits, such as smart speakers. The self-installation process lowers the cost and inconvenience of having a technician come to the house. When users perceive a smart-home appliance is difficult to install, they will be discouraged to adopt it. Also, smart-home appliances may require updates during the life of the product to stay up to date with the technology. For example, smart televisions will update their software to update data from their content providers. When users perceive a smart-home appliance is not easy to update to stay on top of technology changes, they will be discouraged from adopting it. Thus:

Proposition 3: Perceived effort is related to an individual's behavioral intention to adopt smart-home appliances.

Social Influence

Social influence relates to how individuals' behavior is influenced by how they perceive others will view them because of their technology usage. Social influence affects an individual's behavioral intentions through compliance, internalization, and identification mechanisms (Venkatesh and Davis, 2000). The subjective norm construct in TPB and DTPB suggests that individuals tend to be compliant to the views of others that are important to them. In specific social situations, social factors, such as reference group's subjective culture, influence individual's behavioral intentions (Thomson et al., 1991). Moore and Benbasat (1991) suggested that when individuals perceive their behavior will enhance social standing, they will increase their intention towards that behavior.

In a smart-home context, the literature review reveals that individuals are influenced by external factors like government policy, media, and social networks. For example, a well-designed government policy that delineates privacy and security responsibilities of manufacturers of smart-home technology can lower individuals' perceived privacy and security risks, which will increase their behavioral intention to adopt (Wilson et al., 2017). At the same time, when individuals find favorable reviews of the technology through the media or their social network, they will be influenced to adopt it. Thus:

Proposition 4: Perceived government policy is related to an individual's behavioral intention to adopt smart-home appliances.

Proposition 5: Perceived media bias is related to an individual's behavioral intention to adopt smart-home appliances.

Proposition 6: Perceived social network bias is related to an individual's behavioral intention to adopt smart-home appliances.

Personal Norm (Internal Values)

UTAUT does not include any influences on adoption behavior intention that are internal to the individual. However, our literature review revealed two internal factors influential in individuals' technology adoption decisions: environmental responsibility and innovativeness. These are consistent with the personal norms suggested by Norm

Activation Theory (Schwartz, 1977). Norm Activation Theory (NAM) explains pro-social behavior through three variables. One of them is personal norms which influence an individual's smart-home adoption intention. Ji and Chan (2019), by using a case study based in Guangdong province in China, showed that personal norms affect adoption intentions. They suggested the following indicators of personal norm: social responsibility, environmental awareness, and innovativeness. Our research revealed that environmental responsibility awareness and innovativeness influenced individual's adoption intentions. Therefore, we add the personal norms construct into the UTAUT model and suggest that an individual's personal norm, including environmental responsibility and innovativeness, influences his or her behavioral intention to adopt technology. Thus:

Proposition 7: The level of environmental responsibility is related to an individual's behavioral intention to adopt smart-home appliances.

Proposition 8: The level of innovativeness is related to an individual's behavioral intention to adopt smart-home appliances.

Perceived Risks

The four significant core constructs and the three additional non-significant constructs in UTAUT do not address the role played by individuals' perceived risks to their smart-home adoption intentions. Our literature review has revealed three unique risks from smart-home appliances: privacy, security, and autonomy. Both privacy and security risks are related to personal data that is being collected by smart-home appliances. Risk of ceding autonomy is related to giving more control to the smart-home appliances, often through the use of artificial intelligence and machine learning, to take independent decision on our behalf.

Perceived Privacy and Security Risks Related to Data

Amazon discontinued its Echo Look, a standalone camera that used artificial intelligence and machine learning to give users fashion advice, in July of 2020. Although Echo Look was intended to help users choose the right outfit for the day, it generated privacy concerns that it sees and records users in their intimate setting since the day it was released (Gunaratna, 2017). Similarly, Bloomberg News reported in 2019 that, unbeknownst to the users, Amazon workers and contractors worldwide were listening in on their private conversations that were being recorded on the Echo smart speaker (Day et al., 2019). A related issue of security was also raised with Echo smart speakers. A related concept to privacy is the security of the information being collected and shared by smart-home appliances. In another incident involving Echo in 2018, a woman's private conversation was recorded and emailed to one of her contacts. The Amazon engineers revealed that was a result of a weird combination of events and keywords that Echo interpreted as an instruction (Siemaszko, 2018). Such privacy and security concerns can lower consumers' behavioral intentions to adopt new technologies. A survey by the consumer research firm Voicebot showed that the percentage of people citing privacy concerns as the number one reason for not purchasing smart speakers doubled in 2020 from 2018 (Kinsella &Mutchler, 2020). Thus:

Proposition 9: Perceived level of privacy and security concern is related to an individual's behavioral intention to adopt smart-home appliances.

Perceived Ceding of Autonomy and Independence Risk

As reviewed earlier, home automation is one of the main performance advantages of smart-home technology. The use of IoT technology allows manufacturers to automate many of the functions that required user intervention in traditional home appliances. For example, home HVAC systems can be automated to operate more efficiently by sensing the number of occupants in different areas of home, smart refrigerators and pantries can send alerts to let homeowners know of any shortages, and smart locks can be remotely opened when your kids return from school. However, this very idea of making appliances smarter can also lead to a conflict with homeowners who may not prefer the idea of giving up some of their routine tasks of switching lights off or adjusting thermostats. In a representative national survey of 1025 UK homeowners, Wilson et al. (2017) found that the main perceived risk from smart-home technologies was ceding autonomy and independence in the home for increased technological control. As artificial intelligence and machine learning become more pervasive, manufacturers' smart-home automation possibilities are unlimited. However, homeowners' intentions to adapt these automation technologies may adversely be affected. Thus:

Proposition 10: Perceived level of autonomy is related to an individual's behavioral intention to adopt smart-home appliances.

Facilitating Conditions

Thomson et al. (1991) define facilitating conditions as "objective factors in the environment that observers agree make an act easy to do." Facilitating conditions contribute to the actual use of a technology once the individual intends to adopt it.

Financial constraints

Based on our literature review, besides the initial cost of the smart-home appliance, the cost to upgrade to stay on top of the technology is also important. As technology is constantly changing, smart-home appliances need to stay up to date, otherwise, they can become obsolete. As a result, manufacturers need to make their products easier to install and make them easier to maintain by providing software updates and maintenance support (Georgiv and Schlog, 2018). For example, smart televisions will update their software to stay on top of the changes from content providers. When users perceive a smart-home appliance are expensive to upgrade and maintain to stay on top of technology changes, they will be discouraged from adopting it. Thus:

Proposition 11: Financial constraints acts as a facilitating condition that directly affects an individual's adoption of smart-home appliances.

Research Model and Propositions

Our research model is shown in Figure 9 and the research propositions are shown in Table 3.

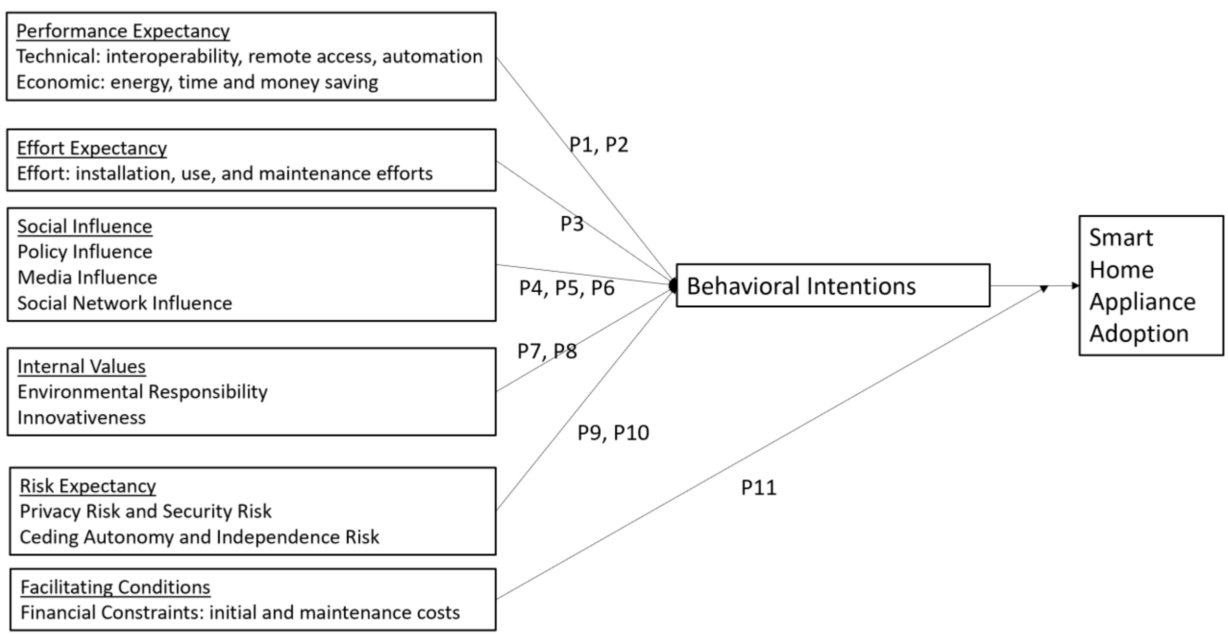

Figure 9: Smart-home Technology Adoption Research Model

	Research Propositions
P1	Perceived technical performance is related to an individual's behavioral intention to adopt smart-home appliances
P2	Perceived economic performance is related to an individual's behavioral intention to adopt smart-home appliances
P3	Perceived effort is related to an individual's behavioral intention to adopt smart-home appliances
P4	Perceived government policy is related to an individual's behavioral intention to adopt smart-home appliances
P5	Perceived media bias is related to an individual's behavioral intention to adopt smart-home appliances
P6	Perceived social network bias is related to an individual's behavioral intention to adopt smart-home appliances
P7	The level of environmental responsibility is related to an individual's behavioral intention to adopt smart-home appliances
P8	The level of innovativeness is related to an individual's behavioral intention to adopt smart-home appliances
P9	Perceived level of privacy and security concern is related to an individual's behavioral intention to adopt smart-home appliances
P10	Perceived level of autonomy concern is related to an individual's behavioral intention to adopt smart-home appliances
P11	Financial constraints act as a facilitating condition that directly affects an individual's adoption of smart-home appliances

Table 3: Research Propositions Related to Smart-home Technology Adoption

Chapter 3: Research Design and Method

Overview

Smart-home appliances are making our lives more efficient and enhancing the quality of our lives by automating many tasks in the home. Automation is possible through novel technologies, such as IoT that uses various sensors to collect data of households' environment, transmit over the Internet, and use artificial intelligence and machine learning to guide us and make decisions based on algorithms. However, our literature review has revealed that the novel applications of these technologies in homes lead to conflicts between the individual's perception of benefits and risks from using smart appliances. When manufacturers overtly focus on the benefits of using smart-home appliances and do not address their concerns, the consumer adoption of their smart-home appliances can be negatively affected.

The research aims to find the answers to the following questions that will help our understanding of the adoption process of smart-home appliances:

1. How do the unique characteristics of smart-home appliances affect users' adoption intentions?
2. How do the unique characteristics of smart-home affect their adoption?

As evident from the literature review, scholars have mainly focused on quantitative testing various technology acceptance model determinants in the smart-home context. In addition, the current qualitative research literature is limited to focus group studies and surveys on exploring essential features in smart-home appliances. However, there is no study to determine how these essential features in smart-home appliances affect adoption decisions. Therefore, this research will fill the literature void by exploring the reality of smart-home appliance adoption by exploring consumers' knowledge of smart-home appliances, their experiences, and their explanations and rationale for adopting them.

Research Method

Although various qualitative research methodologies are available, this research will use a case study methodology to explore individuals' perceptions, experiences, and expectations of smart-home appliances that can affect their adoption. As suggested by renowned social scientist and case study scholar Robert Yin (Yin, 2018), case study research methodology lends itself to answering research questions that ask "how" and "why" of contemporary phenomenon in their real-world context. In particular, when the underlying logic that explains such phenomenon is not known, researchers can make in-depth examinations of the "how" and "why" questions through the use of case studies (Yin, 2018). Our study seeks answers to "how" research questions that explore individuals' smart-home appliance adoption behaviors. Besides being a contemporary phenomenon, understanding adoption behavior is significant to stakeholders of smart-home appliances, including consumers, manufacturers, and policymakers. Thus, our case study methodology is best suited for this research.

Data Access and Collection Technique

Participants

This study includes interviews with 23 adoptors and 23 non-adoptors of smart-home appliances. For this research, adoptors are defined as current users of any appliance controlled remotely through a smartphone or a central controller, such as Amazon Echo or a home energy management system. Table 6 below lists some of the smart-home appliances that are currently available in the market.

Examples of Smart-home Appliances
• Clothes washers and dryers
• Coffee makers
• Diswashers
• Door locks
• Light bulbs
• Oven and microwaves
• Refrigerators
• Robotic vacuums
• Security cameras
• Televisions
• Thermostats

Table 4: Table showing a list of smart-home appliances available in the market

Participant Recruitment Process

After Institutional Review Board (IRB) approval from the University of Missouri - St. Louis (See Appendix K), we recruited potential candidates from within the researcher's professional network, including the UMSL DBA cohorts and social media sites, including Linkedin and Facebook, and Reddit. The initial potential list of candidates included 30 each of the adoptors and non-adoptors of smart-home appliances to allow for sufficient candidates if some declined during the process or were not available or suitable for the study. To encourage participants and to thank them for their time, a small honorarium was provided to the participants that completed the interview process.

The recruitment process consisted of two stages. First, we sent a recruitment email explaining the research topic, the research process, including informed consent and interview recording, and qualifications to be included as a participant. Second, we sent a follow-up email to participants that agreed and were qualified for the participation. This email included an informed consent (Appendix J) form and several timeslots for the participants to choose an interview time that worked with their schedule. The recruitment and the follow-up emails are attached in Appendix H.

Interview Protocol

The interviews took place either in person or through the Zoom video conferencing service. The interviews lasted about an hour and were recorded. The interviews were exploratory and included prepared semi-structured questions (Appendix I) to probe individuals' smart-home appliance adoption behavior and processes. The interview protocol process consisted of two parts: a non-recorded part and a recorded part, as shown in Table 5 below:

Non-recorded Interview Part: 5 minutes • Introduction (See Appendix L for the introductory script used during the non-recorded part of the interview) • Informed consent (See Appendix J for the informed consent that was distributed to the participants prior to the interview) Recorded Interview Part: 35 – 60 minutes

• Main questions (25-50 minutes) (See Appendix I for the list of semi-structured questions) • Demographic questions (0-5 minutes) (See Appendix I for the list of demographic questions) • Summary & wrap-up: 5 minutes

Table 5: Research interview protocol

Interview Questions

The main interview questions and their relationship to the determining factors and propositions are shown Table 6 below:

Determining Factors	Related Propositions	Exploratory Questions
Performance Expectancy	P1	1. What would you consider to be the main features that distinguish smart-home appliances from traditional appliances? 2. What would you consider to be the main benefits from smart-home appliances?
	P2	1. What features would you look for in your smart-home appliances? 2. What benefits would you expect from your smart-home appliances?
Effort Expectancy	P3	1. What would you expect the effort to be in installing smart-home appliances?

		2. What would you expect the effort to be in using smart-home appliances? 3. What would you expect the effort to be in upgrading smart-home appliances?
Social Influence	P4	1. How does government regulation affect your perception of smart-home appliances? 2. How does government regulation affect your decision to use smart-home appliances?
	P5	1. How do social media, including customer reviews, affect your perception of smart-home appliances? 2. How do social media, including customer reviews, affect your decision to use smart-home appliances?
	P6	1. How does your social network's (friends, families, co-workers, and acquaintances) experiences with smart-home appliances affect your perception of smart-home appliances? 2. How does your social network's (friends, families, co-workers, and acquaintances) experiences with smart-home appliances

		affect your decision to use smart-home appliances?
Internal Values	P7	1. What are the environmental impacts of using smart-home appliances? 2. What are the social impacts of using smart-home appliances?
	P8	1. Are you ahead or behind your friends, families, co-workers, and acquaintances in the adoption of smart-home appliances? 2. Do you consider yourself an early adopter of smart-home appliances?
Risk Expectancy	P9	1. What are the main risks to you and your family from using smart-home appliances? 2. What features and characteristics of smart-home appliance discourage you from using them? 3. What concerns of privacy and security do you have about using smart-home appliances?
	P10	1. Are you concerned about possibly ceding autonomy and independence when/if you use smart-home appliances?

Facilitating Conditions	P11	1. How does cost affect your decision to purchase smart-home appliances? 2. What do you think is the cost of keeping your smart-home appliance up to date?

Table 6: Exploratory interview question, determining factors, and propositions

Research Perspective: Paradigms and Ethics

This research involved interaction with human subjects through interviews conducted in-person or remotely via conferencing technology, such as Zoom. Interviews were also recorded and transcribed using a professional transcribing service. Thus, we followed a strict code of ethics to protect both the human subjects and the collected data.

Institutional Review Board Approval and CITI HSR Training

As guided by APA ethical standards, we received approval from the University of Missouri - St. Louis Institutional Review Board (IRB) before contacting any potential candidates for interviewing. In the IRB application, we asked for permission to interview up 60 participants which was more than the 46 that we interviewed for this research. In addition to the required IRB approval, the researcher also completed the CITI human subjects research training. We did not be interview anyone under the age of 18. Although, since our research topic is innocuous, disclosing responses should not harm the participants. However, we kept all collected data confidential. Our research project qualified for Exemption category # 2 according to the University of Missouri – St Louis IRB approval committee (See Appendix K).

Harm to Participants

This research did not cause any harm to the participants. The interview questions were carefully framed so that participants did not need to divulge any potentially sensitive information. We also reminded the participants before and during the interview that they have control of the interview process, and they can refuse to answer any questions or stop the interview at any point.

Integrity and Confidentiality

Our interview questions do not ask for any confidential information. However, to protect any unintentional disclosure of private information, we used fictitious names in the research to prevent any identifying personal information from becoming public. Additionally, the interview process and the data analysis were conducted professionally as suggested in the IRB, the informed consent form, and the interview protocol.

Dissemination of Research Findings

Since this research aims to publish the findings for others, the consent form informed the participants of this outcome. In addition, research participants will be offered a copy of the research findings.

Chapter 4: Results

This study explores the determining factors that are antecedents to the consumers' adoption of smart home appliances. Every day, manufacturers are integrating "smart" technology into our traditional appliances, such as refrigerators, ovens, and washing machines, to make them smarter or find new appliance applications, such as doorbells as security systems. However, the U.S. homeowners' level of adoption of smart appliances has not been as expected. Manufacturers can only reap the rewards of their smart appliances when homeowners widely adopt them. Consumers' adoption decisions are complex that involve other factors beyond the attractiveness of including new technology in an appliance. Understanding these determining factors is essential to the stakeholders involved in proliferating the adoption of smart home appliances, including the manufacturers, researchers, and policymakers, to enable the market for smart home appliances that the homeowners will readily adopt.

Our literature review has suggested that understanding technology adoption factors is integral to diffusing innovations. Further, research has highlighted that when technologies under consideration are nascent, as is the case with smart home appliances, the adoption behavior first needs to be investigated. Therefore, this study used the case-study research methodology to investigate consumers' adoption behavior of smart home appliances. In addition, case study research methodology has successfully been used in exploring "how" and "why" questions of the contemporary phenomenon in their real-world context and, thus, lends itself to exploring consumers' adoption behavior of smart home appliances in their residences.

Description of the research base

Adopter/ Rejector	Home Ownership	# househo	Age gro	Gende	Household income	Occupation	Education level	#smart appliance	Use
Rejector	Own	2	55-64	M	100-150K	Engineer	Bachelor	0	N
Adopter	Own	2	25-34	F	50 - 100 K	Engineer	Bachelor	1 to 5	Y
Rejector	Own	4	45-54	M	100K-150K	Software	Bachelor	0	N
Adopter	Own	3	45-54	M	NA	Director	Masters	6 to 10	Y
Rejector	Rent	1	55-64	M	50K - 100K	Technician	High schoo	1 to 5	N
Adopter	Own	4	25-34	M	150K-200K	Insurance Adjuster	Bachelor	6 to 10	Y
Adopter	Own	4	45-54	M	150K-200K	Manager	Masters	1 to 5	Y
Adopter	Own	3	25-34	M	100K-150K	Software	Bachelor	11 or more	Y
Adopter	Own	5 or more	45-54	F	200K higher	Graphic designer	Bachelor	6 to 10	Y
Adopter	Own	4	45-54	M	150K-200K	IT Management	Masters	6 to 10	Y
Rejector	Rent	3	45-54	M	50-100K	conflict managemen	Masters	1 to 5	N
Rejector	Rent	5	45-54	M	200K higher	Product Manager	Masters	1 to 5	N
Adopter	Own	2	25-34	F	200K higher	Engineer	Bachelor	1 to 5	Y
Adopter	Own	4	25-34	M	NA	Engineer	Bachelor	11 or more	Y
Adopter	Own	2	45-54	M	50-100K	PM	Bachelor	1 to 5	Y
Adopter	Own	6	45-54	M	200K higher	CTO	Masters	11 or more	Y
Adopter	Own	2	45-54	M	NA	Account Manager	Bachelor	6 to 10	Y
Adopter	Own	2	45-54	M	150K-200K	Engineer	Masters	1 to 5	Y
Rejector	Rent	1	25-34	F	50K-100K	Application E	Masters	0	N
Rejector	Own	2	NA	M	NA	Eng Manager	Masters	0	N
Rejector	Rent	2	25-34	F	50K-100K	Sr. Marketing Analy	Masters	0	N
Adopter	Own	4	45-54	M	200K higher	Finance	Masters	6 to 10	Y
Rejector	Own	4	45-54	M	200K higher	Security advisor	Masters	1 to 5	N
Adopter	Own	3	45-54	M	200K higher	Marketing	Masters	11 or more	Y
Adopter	Own	2	35-44	F	NA	Social worker	Masters	1 to 5	Y
Rejector	Rent	4	35-44	M	NA	Labor	High schoo	0	N
Rejector	Own	1	45-54	M	NA	Software	Masters	1 to 5	N
Adopter	Own	3	35-44	M	NA	Forecasting Manage	PhD	6 to 10	Y
Rejector	Rent	1	45-54	M	150K-200K	system analyst	Masters	0	N
Rejector	Own	3	55-64	M	100K-150K	Engineer	Masters	0	N
Adopter	Own	4	35-44	F	150K-200K	Analyst	Masters	1 to 5	Y
Adopter	Own	4	35-44	F	200K higher	Social worker	Masters	6 to 10	Y
Rejector	Own	2	45-54	F	50k less	office	college	0	N
Adopter	Own	2	55-64	M	150K-200K	IT	Masters	11 or more	Y
Adopter	Own	4	35-44	M	NA	Engineer	Masters	6 to 10	Y
Rejector	Own	2	55-64	M	50K-100K	Project Manager	Masters	1 to 5	N
Rejector	Own	4	55-64	M	100K-150K	Technician	High schoo	0	N
Rejector	Own	4	55-64	M	150K-200K	Engineer	Bachelor	0	N
Rejector	Own	1	45-54	M	50K-100K	Technician	Associate	0	N
Rejector	Own	1	25-34	M	50K-100K	Technician	Bachelor	0	N
Rejector	Own	2	35-44	F	NA	Banker	Bachelor	0	N
Adopter	Own	3	35-44	M	NA	Business Manager	Masters	6 to 10	Y
Rejector	Own	3	25-34	M	100K-150K	Project Manager	Masters	1 to 5	N
Rejector	Own	5 or more	NA	M	NA	Test engineer	Masters	0	N
Adopter	Own	4	25-34	M	100K-150K	Marketing	Masters	6 to 10	Y
Rejector	Own	4	55-64	F	150K-200K	Engineer	Bachelor	1 to 5	N

Table 7: Description of research participants

This study involved in-depth interviews with 46 individuals, including 23 adopters and 23 non-adopters of smart home appliances. Non-adopters also included nine rejectors of smart home appliances – individuals that stopped adopting their smart home appliances. The key demographic differences between the samples are shown below in Figure 10. Each interview was conducted over video conferencing software Zoom, which was also used for recording and transcribing. Individual interviews lasted between 30 minutes to an hour. They used semi-structured questions to explore the participant's perceptions, experiences, and expectations of smart home appliances that can affect their adoption decisions.

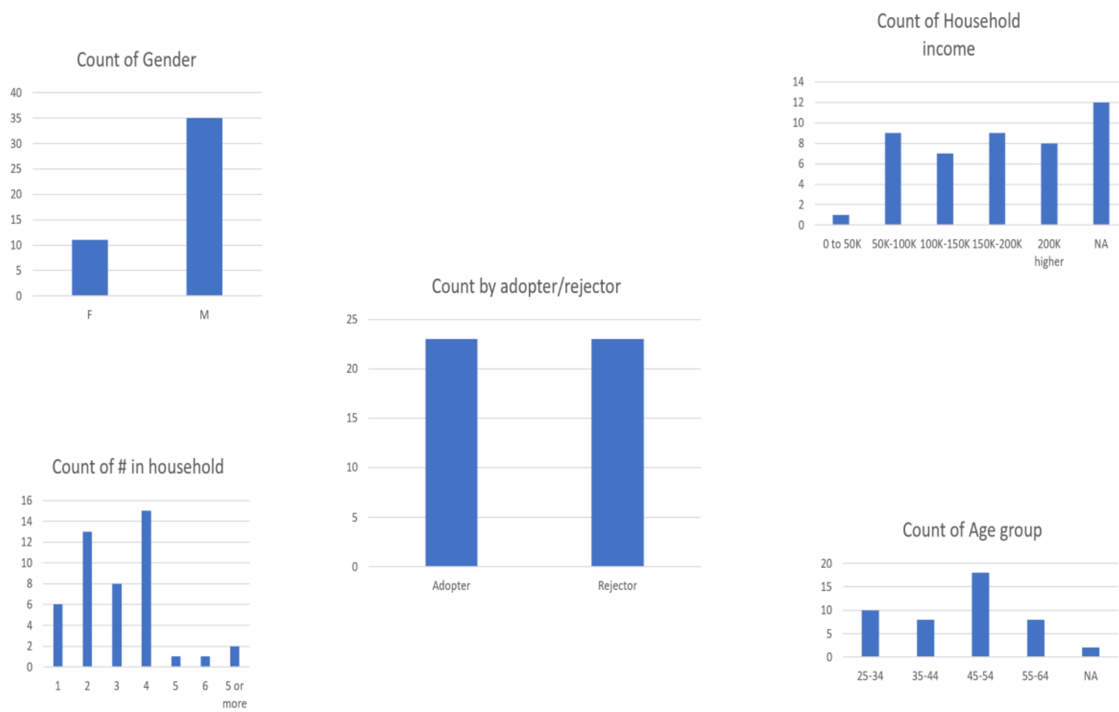

Figure 10: Key demographic differences in the data sample

Overall, 896 pages of transcripts were collected as part of the interview process. A qualitative data analysis computer software (QDACS) package from QSR International, NVivo, was used in organizing and analyzing the semi-structured interview data and the demographic and survey responses from the participants. NVivo was chosen as the data analysis package for its many advantages, and studies have suggested that it may significantly improve the quality of research (Hilal & Alabri, 2013). For example, NVivo significantly reduced the manual tasks of organizing 896 pages of interview transcripts together with demographic and survey responses. It also provided a more straightforward way to organize and group themes revealed when reviewing transcripts. In addition, we also used NVivo for its ability to query data. For example, Figure 11 shows a result of a query made in NVivo to find the top 100 words by their usage frequency. Besides “smart,” “home,” and “appliance,” some of the other most mentioned words were “cost,” “privacy,” “data,” “security,” and “ access.” This output helped with the coding process.

Figure 11: The output of word frequency search in NVivo

In addition, Nvivo was useful in visually displaying the hierarchical data. Using tree charts, NVivo can visualize all the discovered themes and sub-themes, called nodes, organized into rectangular boxes of varying sizes and colors. The size of the rectangles represents the relative amount of coding for each node. Sub-themes, grouped to form a descriptive theme, are shown as nested rectangles inside the outer rectangle that represent it. For example, Figure 12 below shows the hierarchy chart of all the themes and sub-themes that emerged during our data coding. The eight rectangles with nested rectangles of various shades of the same color represent our primary themes: adoption risks, outcome expectations, performance expectations, internal influences, external influences, individual constraints, risk mitigation, and personal effort expectancy. The relative sizes of the rectangles representing these themes show that adoption risks and outcome expectations are associated with the most amount of coding. Conversely, personal effort expectancy and risk mitigation themes have the least number of coding associated with them.

Figure 12: NVivo hierarchy chart for the overall data.

Another way to group and represent themes (called nodes in NVivo) is through the codebook output from NVivo. Codebook shows a complete list of all the thematic nodes, the number of references related to the node, and the number of files making the references. A complete codebook output for our data, showing eight themes and 83 sub-themes, is shown in Appendix B. Table 8 below shows the summary of the codebook output displaying only the main themes and the underlying sub-themes.

Themes	Sub-themes
1. Performance (technical) Expectations	• Automation • Interoperability • Remote access
2. Performance (Output) Expectations	• Energy and money-saving • Time saving & convenience
3. Personal Effort Expectations	• Installation effort • Use effort • Maintenance effort
4. External influences	• Policy influence • Media influence • Social network influence
5. Internal influences	• Social responsibility • Innovativeness – ahead of others • Innovativeness – same or behind others
6. Adoption risks	• Privacy and security • Ceding autonomy and independence risks • Health risks
7. Individual constraints	• Financial constraints • Technology constraints
8. Risk Mitigation	• Brand selection

	• Ethical use of data policy • Network access selection

Table 8: NVivo codebook output

Another valuable feature of NVivo is to compare data or responses between groups. For this research, comparing the responses of adopters vs. non-adopters was key to finding how the determining factors affected each group. For example, a query comparing the relative references of the discovered themes by adopters and non-adopters is shown as hierarchy charts in Appendix A. In addition, within each group of adopters and non-adopters, further comparisons between different groups can be made. For example, themes and the level of coding associated with them can be compared using demographics, such as age group, gender, income, and education level. For example, Appendix C shows how each participant's responses were coded across each of the sub-themes associated with the main themes. This was accomplished by transferring the NVivo data to Excel and assigning a value of one vote for any coded response to each theme per participant. A summary of Appendix 3, showing the relative importance of each of the sub-themes and themes in determining the adoption of smart home appliances, is shown in Table 9.

		Non-adopters		Adopters	
Emerged Themes	Sub-themes	Total Votes	% votes	Total Votes	% votes
Performance Expectations	Automation	7	30%	9	39%
	Interoperability	1	4%	3	13%
	remote access	21	91%	22	96%
Output Expectations	energy and money	5	22%	7	30%
	time and convenience	21	91%	21	91%
	physical safety	5	22%	7	30%
Personal Effort Expectations	installation effort	5	22%	7	30%
	maintenance effort	4	17%	6	26%

	use effort	11	48%	11	48%
External Influences	policy influence	11	48%	12	52%
	media influence	6	26%	8	35%
	social network influence	10	43%	11	48%
Internal Influences	ahead of social network	0	0%	2	9%
	same or behind social network	23	100%	23	100%
	social responsibillity	0	0%	2	9%
Adoption Risks	ceding autonomy & independence	9	39%	11	48%
	health risks	1	4%	3	13%
	privacy and security	22	96%	22	96%
Individual Constraints	financial constraints	17	74%	18	78%
	technology constraints	5	22%	6	26%
Risk Mitigation	brand selection	0	0%	2	9%
	ethical use of data policy	8	35%	10	43%
	network access selection	5	22%	7	30%

Table 9: Relative number of references per each theme

Next, we will review each of the main themes from our analysis and use quotes from the participants to show their relation to smart-home appliance adoption.

Technical Performance

Technical performance, in this research, is described in terms of the technology features that provide smart-home appliances a relative advantage over traditional appliances. Consistent with our literature review, our research shows that consumers expect smart appliances to possess technology features that differentiate them from traditional ones. In particular, data revealed remote access, automation, and interoperability as the distinguishing features in smart-home appliances that affect consumers' adoption behavior.

Our research showed that the appliance first needs to be integrated with the Internet of Things (IoT) to enable remote access and automation. IoT enables the appliances to be connected to the internet via wi-fi, cellular, and other technologies and allows remote access from phones and home automation systems. Smart appliances' remote access capability differentiates them from traditional ones that require a homeowner to be physically present next to the appliance to turn it on or off. Further, it allows the monitoring and controlling of appliances from anywhere in or outside the home, such as from the office or a vacation spot in a different country.

Integration of IoT also gives them intelligence. This intelligence further enables the automation of various tasks. For example, adopters can make their appliances operate in a specific predefined schedule through phone applications that connect to the appliances. For example, smart light bulbs and curtains can be set on a schedule to operate to give the impression that someone is at home when consumers are vacationing somewhere else.

Participant	Adopter/ Non-adopter	Selected Quote: Remote access and automation
A_Nineteen	Adopter	I would say the ability to connect and get more details from the object. For instance, I have a Nest (doorbell camera), and being able to see how often it is running, turned on, and information like that, to me, is what makes it smart.
A_Ten	Adopter	A smart-appliance runs on wi-fi. So it does not matter where you are, you can connect to it. Also, you can use a smartphone to access and control the appliances. That is what I think makes an appliance smart.
A_Eight	Adopter	Internet connectivity! Being able to access them remotely through another device adds convenience. For example, you can monitor the appliance without being physically present.
A_Fourteen	Adopter	Remote controllability, to me, is the key. I do not have to be there to turn on the light, and I do not have to be there to change the thermostat setting.

		So that is the main underlying feature of smart appliances: I do not need to be present; I can connect to it remotely.
A_Three	Adopter	I would say, for the most part, it is automation. Another would be that I can control it from anywhere. So I can automate, schedule, and control or monitor it from anywhere.
A_Twelve	Adopter	Connectivity: I have everything connected to my phone to access everything in the house!
A_Twenty	Adopter	It would be something (technology) that allows me to control without standing next to the thing (appliance).
A_TwentyOne	Adopter	It is a smart appliance if I can control it from my phone. I do not have to get up and go to it to make it do something. I can just stay seated and knock it out. Smart also means self-learning. An example is a thermostat that notes what temperatures you like and sets them by itself.
A_TwentyTwo	Adopter	From my point of view, the main thing would be the connectivity to the Internet, so that we can control it remotely. It can also provide notifications to us through phone or some other device. So the main thing I would consider to be a minimum requirement for any smart appliance is internet connectivity.
A_Five	Adopter	Smart means having access to the appliance from the phone that removes the need to go to the appliance to monitor and control it.

Table 10: Selected quotes by adopters – remote access and automation.

Our research showed that non-adopters identify the importance of remote access and automation and the value they can get from these features in appliances, as seen from the selected quotes in the table below.

Participant	Adopter/ Non-adopter	Selected Quote: Remote access and automation
N_Five	Non-adopter	Smart means having remote access capability and the ability to schedule tasks.
N_Eight	Non-adopter	I believe that smart appliances should have connectivity so that you can use your phone to turn it on, turn it off, or do whatever else you want.
N_Eighteen	Non-adopter	A smart appliance can be operated from far away (remotely) through a tablet or a smartphone.
N_Six	Non-adopter	Smart means having remote accessibility. The fact that you can access appliances with a phone or tablet makes using them trivial. For instance, I have seen refrigerators that allow you to look inside them from a store and check what groceries you need.
N_Sixteen	Non-adopter	The main differences (between smart and traditional appliances) are the interconnectivity and the ability to access them remotely.
N_Three	Non-adopter	To call them smart home appliances, I think they need at least two features- communication and accessibility.
N_Fifteen	Non-adopter	A traditional appliance has similar features to a smart appliance but is not connected. It is isolated from everything. You have your manual controls to do what you need to do to the appliance. It can be automated if connected. That is the main difference.
N_Four	Non-adopter	Smart means you can tell what is in the refrigerator by looking at the phone!
N_Nineteen	Non-adopter	The main feature of a smart appliance is the capability to be connected via an APP (phone application) so that it can be controlled remotely.
N_One	Non-adopter	I think the ability to either start them or change them (their state) from your phone or your computer makes appliances smart.

Table 11: Selected quotes by non-adopters – remote access and automation.

For the adopters, the interoperability of a new appliance was a key metric for measuring the performance of smart home appliances. In particular, interoperability of the smart home appliance with a home automation system the adopters already used or were inclined to use in the future was important. In contrast, interoperability was not significant in the non-adopters' decisions.

Our data shows that maintaining an ecosystem of products that work together was a significant decision for adopters to purchase and adopt new smart home appliances. For them, choosing an ecosystem of appliances that work together is vital to maintain a single or consistent interface instead of having multiple inconsistent interfaces that control different appliances. As the number of smart home appliances grows in the adopter's homes, some experience apps (phone applications) overload fatigue, reducing the usefulness of the smart home appliance. For example, using multiple apps to control multiple smart televisions in the home can be akin to dealing with multiple remotes that control multiple traditional televisions.

Our data also showed that the lack of interoperability between smart appliances drives some consumers to adopt a specific brand of appliances. For example, when choosing between various options of doorbell cameras in the market, consumers who already have an Amazon system may choose the Ring doorbell camera instead of the consumers with a Google system opting for Nest. However, consumers would prefer the option to be able to use appliances from any manufacturer if they would be compatible with their home automation system. This interoperability allows the most flexibility in choosing the right product at the lowest cost. Thus, for some adopters, lack of interoperability between appliances ranks high in their concerns when adding new smart appliances to their homes.

Participant	Adopter/ Non-adopter	Selected Quote: Interoperability
A_Eleven	Adopter	As for the camera, the primary focus was to have a connected device that could have cloud storage and video in two-way communication. So what drove me to Ring was the ecosphere (home automation) that I currently have. If I were not part of the Amazon ecosystem, maybe I would have rolled into more of a Nest (Google's doorbell camera) or some other brand. But, since I already have Amazon's other items, I wanted to stay within that ecosphere. So, I chose the Ring.
A_One	Adopter	The main feature that I look at is the interface. I want to ensure that everything is on a single interface capable of being driven by Amazon's Alexa. So I first look at whether it is Alexa capable. We already have three different Echos in our house. I want to ensure that I can control everything from one interface. I do not want to have multiple Apps or interfaces I am dealing with to control those devices.
A_Eighteen	Adopter	Having the same brand is something that I would look for because I would only have to add devices to an APP as opposed to adding more Apps to my phone that give me more mind-boggling things to have to deal. So having devices that all connect through one APP is helpful.
A_Four	Adopter	You cannot add a Google Nest camera to your Ring network and communicate today. Wyse camera does not work with your Ring seamlessly. With their products, everybody is still staying in their little walled garden. So, these are the three things I look for: How expensive it is, how easy it is to use, and if it works within the automation environment I have already created in my home?
A_Sixteen	Adopter	It is (apartment) controlled mainly by Alexa, which means you can connect everything with an Alexa APP. Like, the thermostat has an APP called Nest, but Alexa

		controls it. ButterflyMx runs the front door, and it is also connected to Alexa. I also have smart TVs connected to Alexa, and by using the speakers (Echo), you could play (control) them in the living room or the bedroom. I can also control the apartment's temperature using the phone even when I am outside, or I could just ask Alexa to turn the temperature up to whatever I want (when indoors).

Table 12: Selected quotes – interoperability

Outcome Expectations

Consumers' expectations of the benefits they receive from smart-home appliances play a critical role in their adoption behavior. Consistent with previous research, our data shows that consumers are more willing to adopt smart home appliances if they perceive smart-home appliances to have certain benefits over traditional appliances. In particular, our research identified consumers' three different expectations from adopting smart home appliances over traditional ones: saving energy and money, saving time, and providing home safety.

Appliances are a significant source of energy use in residences. Thus, it makes sense why consumers expect smart appliances to reduce their overall energy consumption, especially from their light fixtures and their HVAC (heating, ventilating, and air-conditioning) equipment. Our data revealed that adopters and non-adopters expect energy savings from adopting smart light bulbs, connected thermostats, and other high-energy appliances. For consumers, the energy savings help in their effort and need to conserve energy and directly save them money. Furthermore, our data showed that consumers expect smart appliances to save them money in the residential environment by reducing their energy and water usage.

Participant	Adopter/ Non-adopter	Selected Quotes: energy and money saving
A_Thirteen	Adopter	Sometimes it is (a smart appliance) valuable because it can save money. For example, I can have automation turn off lights independently; otherwise, I would forget to turn off lights. This can help conserve energy which directly impacts costs.
A_Seven	Adopter	I considered buying something like that almost seven or eight years ago when I owned a house with a big backyard in Illinois. You always over-water or under-water the lawn. I realized that I was always paying more money because I was not watching (the amount of water on the lawn). Some companies like Monsanto Syngenta have technologies that can determine the moisture level by just looking at the picture of the soil. You can achieve the same by having a small device stuck in the ground to collect moisture data. Water conservation is a big issue. There is a shortage of good quality drinking water in many parts of the country, not only in the US but also worldwide.
N_Six	Non-adopter	I have never thought about getting thermostats, but I could see where that could come in handy. For example, say if you were coming back home from work or a road trip, you can regulate your thermostat to keep you within a budget when you are away, but by the time you get home, set it to 72 degrees. That would be something I would look into.
A_TwentyThree	Adopter	I can see myself wanting to use one product over another if it uses less energy or can reduce how much energy my household will use.

Table 13: Selected quotes – energy and money-saving

Besides direct financial gain from adopting smart appliances, consumers expect to benefit from timesaving. Our research shows that adopters greatly benefit from the convenience of accessing their smart appliances remotely. For example, they do not need to come back to the house to close the garage door or shut off the oven when they are 20 miles down the road from their homes to their kids' baseball game. Similarly, they do not need to come home from the office to check their grocery supplies. Smart refrigerators can remind them they are running low on milk or juice as they enter the supermarket.

Participant	Adopter/ Non-adopter	Selected Quotes: time and convenience
A_Four	Adopter	You can get a return on the investment pretty quickly (from smart appliances). If you are at work and someone rings your doorbell, you can talk to that person, and that person will not know whether you are inside the house or at work, 30 miles away. This is a tremendous value equation for the end user.
A_Fourteen	Adopter	I do not have to be there to turn on the light. I do not have to be there to change the thermostat setting. I do not have to be present physically; I can do it remotely.
A_TwentyOne	Adopter	I do not have to get up and go to it to make it do something. I can just stay seated and knock it out.
A_Eleven	Adopter	Traditionally, when somebody knocks at the door, you do not know who is there unless you look out the window or open the door. Here (with smart doorbell), I can see who is there, especially if I am at a remote location or work and somebody is at my home. Not only can I bring up the camera (on the phone) and see who it is, but I also can have a conversation with them through two-way communication.
A_Seven	Adopter	I get convenience (from using smart appliances). It makes it easy and fun for me to track things. For example, if somebody is in front of my house, I can see who is there. Sometimes, I do not even open that door if I see salespeople. When I know my friends, my kids' friends, or somebody I know is at the door, I talk to them. I can even remotely control things if I am not there (at home). I have smart light bulbs, which I can turn on and off even when I am not there. So, I think that helps a lot.

Table 14: Selected quotes – time and convenience

Our research also highlighted the benefit of increasing physical safety for themselves and their families from the adoption of smart-home appliances. Their home security's remote accessibility and controllability, including door locks, garage door openers, and vision-equipped doorbells, increased the adopters' sense of physical security for themselves and their families. Data also revealed that non-adopters viewed physical security as necessary in their future decisions to adopt smart appliances.

Participant	Adopter/ Non-adopter	Selected Quote: physical safety
A_Two	Adopter	Suppose I realize that I have accidentally left the garage door open. I can check from work and close it. Conversely, if we have a delivery expectation from UPS or FedEx, I could have them pop it in the garage. I can watch when they come up the driveway, open the garage, and let them put the package right in it. When I am not home, it adds to the security of things.
A_Seven	Adopter	You can leave the house and suddenly realize that kitchen lights are on or the garage door is open. It has happened many times to me in the past. For example, my neighbor called me, “A_Seven, your garage door is open. Just want to make sure everything is okay.” I am glad I had a great neighbor who had my phone number, and they do not mind calling me, but when I am in a time crunch, it is difficult for me to come back, and I had to live with that in the past. Now, I do not have to. I press a button, and my security gets enabled.
A_Seventeen	Adopter	I think the most significant benefit is security when it comes to automation and smart homes. It gives me peace of mind.
A_Twelve	Adopter	I can drive down the road 10 miles without worrying if I close the garage door because my mind was elsewhere when I pulled out of the garage. I can quickly look on the phone and see if the garage doors are closed. If they are not, I can close them. That type of security and information is why I adopt them (smart appliances).
N_Thirteen	Non-adopter	I would want a smart appliance for the security features. For example, I may not know when somebody is in or

		trying to get into my property during the nighttime. In that case, a camera can send notifications to my phone when somebody is on the property.
N_Four	Non-adopter	There are some attractions, like the security features, just because of where we live. We often travel so it would be nice if somebody came over and we could see them remotely.
N_Six	Non-adopter	Security cameras, even though I do not have one, I have been thinking about getting them. From a security standpoint, you can monitor your home and see what is moving on around your house. I think those are absolutely great!
N_Ten	Non-adopter	Usually, kids walk in after school at 3:30, and most of the time, the parents are still at work. So it would be nice if after the kids can come inside the house, it (smart door) can help ensure to auto-lock so that you know the kids are safe in the house.

Table 15: Selected quotes – physical safety

Personal Effort Expectations

Literature reviews show that the use effort required is one of the significant determinants of technology adoption. Our research shows that when it comes to the adoption of smart appliances, there are three distinct efforts for consumers: installation, use, and maintenance. Installation effort is often required for the homeowners to install the smart appliances to save the cost of hiring a technician to do the same. Our data shows that the consumers' level of perceived installation effort affects their smart appliances adoption behavior.

Participant	Adopter/ Non-adopter	Selected Quote: installation effort
A_Fourteen	Adopter	The amount of effort and the attention needed are much more involved in installing it (a smart appliance). It just takes a lot more time. For example,

		you are done with the traditional thermostat after you do the mechanical work of wiring and mounting it to your wall. However, with the wifi thermostat, there is a lot more work even after you complete the traditional part of the work.
A_Nineteen	Adopter	Some of the appliance installations can get more complex and more difficult. For example, you must go through your router and make sure it connects properly. I have had some issues with appliances where if I was not tech savvy enough, I would get frustrated and probably send them back immediately.
A_Twelve	Adopter	There is a bit more setup time. I think, on my part, because I am a little more technical, it is not as difficult. However, for my wife or my kids, I pretty much have to set it up for them. They can not grasp what is required in doing the installation.
A_Two	Adopter	Some of these appliances do not connect to the current standards of wifi. So I find myself returning to a wifi unit from a router from 10 or 15 years ago, that is a pain in the neck, and it happens a lot more commonly than I would prefer. Another is the difference between 2.4G and 5G for radio waves. Some of these appliances still do not have the 5G capabilities. Again, that is a pain in the neck trying to get them set up. The other thing is the issues with the wifi-protected setup. You need to press a button, go back to the router, press another button, and then hope everything connects. It does not always work. So connectivity issues have prevented me from going all in on smart home technologies.
A_Twenty	Adopter	I would expect more setup work (with smart appliances) like connecting it to a router instead of just plugging it in. I have had a few experiences where you buy something and want to use them, but it suddenly needs a bunch of updates. That does become frustrating!
A_TwentyThree	Adopter	When I lived with my parents, I saw them put in one of those smart camera doorbells. It was an ordeal to put it in, which is the biggest reason why I have dragged my feet on getting one at my house!

N_Seven	Non-adopter	If it required more effort than connecting it to a wi-fi network, I would probably be inclined not to use it.
N_Three	Non-adopter	The effort to install is something I have to think about before I buy any appliance. Does it get cumbersome to set up, is it a cumbersome interface, and is it easy to use? I am not a big tech guy.
N_TwentyOne	Non-adopter	I think you need to know what you're doing. Otherwise, you need technicians to come and install it for you. If you try installing it yourself, you can easily do something wrong!

Table 16: Selected quotes – installation effort

Even when the appliances are successfully installed, consumers can face additional effort to use them. Unlike traditional appliances that may only require turning on and off a switch or a button, smart appliances require constant interaction, often through phone applications (apps). Our research shows that when consumers have to use complicated application interfaces, they can find it burdensome, especially if they are not technologically savvy. Also, when they have to use multiple application interfaces to interact with various appliances, it can negatively affect their adoption experience. The data also showed that consumers who experience high use effort become non-adopters after rejecting the use of smart appliances.

Participant	Adopter/ Non-adopter	Selected Quote: use effort
N_Nineteen	Non-adopter (rejector)	It is (stopped using smart appliances) because of the effort in managing the complexity of having different Apps to monitor. For example, I have a few smart TVs, and I am getting frustrated just managing these TVs alone. I have two right next to each other and never get them to work!

N_Three	Non-adopter (rejector)	I think it is (smart thermostat rejection) because I tried, and it was cumbersome. It is easier to just think about the temperature and set it manually. However, I could be wasting money, in a way, but I got frustrated with it when I was using it.
N_One	Non-adopter (rejector)	I think it is just because we have not taken the time to find out how to use and utilize them. Also, there is more than one person in the house that needs to learn how to use it, so getting everybody up to the same level of understanding is difficult.
N_Twelve	Non-adopter (rejector)	I stopped using them because of the lack of ease of use.

Table 17: Selected quotes – use effort

Further, our findings show that consumers face additional effort to maintain the technology and manage the smart appliance during its lifetime. For example, some smart battery-powered appliances need their batteries replaced periodically. Others may have security and firmware updates that need significant consumer interaction. Thus, the need for constant maintenance can reduce the consumers' positive adoption experience and perceptions.

Participant	Adopter/ Non-adopter	Selected Quote: maintenance effort
A_Eleven	Adopter	The Ring camera is battery-powered, at least the one that I have. I have to go out and swap a battery every couple of months. So I have to have a battery on charge. This is not hard to do, but that is extra maintenance beyond what a traditional doorbell requires.
A_Nineteen	Adopter	Most of the devices do it (updates) automatically. However, I have recently, with a security device, noticed that I had to do everything manually to tell it to update. And, in the middle of that process, it kept kicking me off from the wi-fi router. So, that kind of maintenance gets frustrating, especially when it is something that I want to be very reliable.

A_Four	Adopter	They all need updates. Sometimes they do not update automatically and sometimes have compatibility beef, for example, between version 1.0 of the Ring alarm system versus the Ring pro version 2.0 system.

Table 18: Selected quotes – maintenance effort

External Influences

Our literature review showed three external factors influencing consumers' smart home appliance adoption behavior: media, social network, and policy. To most adopters, social media channels, especially those that share customer reviews, were important sources of information at the initial stage of making queries to purchase appliances. However, the influence of this information on the actual purchase of smart appliances was not very strong for all consumers. Some consumers questioned the reliability of the available information from social media sites. However, most benefitted from reading social media to gain the first level of understanding of the availability of different appliances and to find out the pros and cons of the products based on others' experiences.

Participant	Adopter/ Non-adopter	Selected Quote: social media influence
A_Four	Adopter	I would probably say it is through technology media and technical websites such as CNet, PC magazine, or something similar.
A_Fourteen	Adopter	I do not use social media as the source of information for my decision-making.
A_Nine	Adopter	My decision is primarily based on the reviews I read on the website or the platform selling that device. So when I buy something on Amazon, I look at Amazon reviews, but if I buy something from Kickstarter, for example, then I would look at Reddit or some other platforms to understand more about what the product is or how it works.

A_Nineteen	Adopter	I use them to determine if I would like to look into something, but I would not say that they are 100% what dictates if I will purchase or use that product. When I look into some of the reviews, I see people going off on random tangents that do not make sense. Similar to social media, like TikTok and all those with advertisements, I tend to go away from those products because someone is getting paid to say how good it is versus just testing it out on their own.
A_Ten	Adopter	Before buying a smart appliance, I research by looking at the customer reviews. For example, how many stars it has. And then, once that is done, I will see which one has the best cost. I will choose the one that gives me a bigger bang for my buck
A_Thirteen	Adopter	Part of my research involves looking at what other people say, although I do not rely solely on what they say- just because somebody says this is good, I do not go and buy it. I use it to understand their perspective. Everything has context, and I try to understand how their perspective fits into mine. I take all this information in and then decide based on what I value most, not necessarily on what they value.
A_Three	Adopter	It affects big time. I would go to the review sites and read through them. I like to see good reviews on the products that I buy. I had good reviews on the Waze camera, and when I tested it, it was good.
A_Twenty	Adopter	I think reviews are a big impact in almost everything we buy. We tend to look at the reviews to see what people say about the product. It is a pretty huge influence.
A_TwentyOne	Adopter	If I am getting a one-off item on Amazon and do not know much about them, I just look for the item with the highest number of stars and the most reviews. I do not want the one with few reviews, even if it has five stars. I want the one with four stars but 3000 reviews. I think it is wildly impactful for what I buy!

A_TwentyThree	Adopter	I definitely read a lot of reviews before I buy things. They are a big influence on me.
A_TwentyTwo	Adopter	They are impactful. I look at the reviews not necessarily from the pros, but mainly from a cons point of view.
A_Two	Adopter	The only social media that I ever value is the ratings and consumer reports. I cannot value any social media reviews anymore because I think too many fake reviews exist. I have been burned in the past by those. Thus, I generally do not care about the star ranking on Amazon.
N_Seventeen	Non-adopter	I read the source first. I probably discard it if it is on Facebook or some dumb thing. I do not even bother reading garbage on social media. On the other hand, if it is a genuine guy talking real thing, and there is actual data, only then does it make sense.
N_TwentyThree	Non-adopter	I would say it probably does not.

Table 19: Selected quotes – social media influence

Our data showed that people trust and rely on the information from their personal network more than they trust the information available on social media. Some consumers give higher credibility and regard to what people from their social network say than random people who post on social media. Further, family members' experiences and perceptions were held with even higher regard and given more credibility than others in their social network. Therefore, positive word of mouth about the experiences of co-workers, friends, and families goes a long way in influencing consumers about smart appliances.

Participant	Adopter/ Non-adopter	Selected Quotes: social network influence
A_Eighteen	Adopter	I am more influenced when I hear from a friend or family member that have it (smart appliances).

A_Eleven	Adopter	Word of mouth from people I know directly holds a higher quality of review than just some random person on the Internet. Understanding the source of information goes a long way, so word of mouth holds some credence above just reading how many stars.
A_Fifteen	Adopter	How I go about buying is based on word of mouth. So if I have a friend who says they enjoy the product and I can talk to them firsthand about it, then that is a good way of going about it.
A_Five	Adopter	If the review is from somebody we know who has already used it and is very happy with the purchase, we will consider buying it versus being the first to buy it.
A_Nine	Adopter	Before buying, I think it is very important to know that it (smart appliance) has been tried and tested by people that you know and that they highly recommend it. This is a big factor in my purchasing decision when somebody I know has used, liked, and trusted it. Now to be clear, somebody's recommendation by itself is not enough for me to make my decision. However, if that recommendation comes when I am in the purchasing mood or during the purchasing cycle, it will sway my decision towards that particular item.
A_Nineteen	Adopter	If a family member were to recommend something, they would be more influential than social media like Twitter or Tech talks. Mostly, because I feel that my family and friends would be much more honest about the product or why they like it and give me enough details, even let me use it a little bit. It is hard to tell with social media nowadays if they are paid reviews. Are they honest, or are they hyping it up just because they have some stake in it?
A_Ten	Adopter	I get most influenced when I see my friends use them.

A_TwentyThree	Adopter	Almost every smart device I bought is because someone else I knew had it in their house. I do not think there is any better gold star for a product than somebody you know using it and liking it.
A_Two	Adopter	Because you get one-on-one interaction with people you trust, it is a significant influence when they tell you they had a really good experience with a product. That holds a lot more weight and value than online reviews. I would be much more willing to listen to recommendations from friends and co-workers than from any strange media site.
N_Fifteen	Non-adopter	I usually ask my friends if I am making some big appliance purchases, what they have and how they like them.
N_Four	Non-adopter	I do word of mouth more than anything.
N_One	Non-adopter	When I hear somebody giving their experience on how something works, I am more apt to try it.

Table 20: Selected quotes – social network influence

The literature review has shown that correct policies could mitigate perceived risks and promote the energy-management potential of smart-home appliances (Wilson et al., 2017). To explore the effect of government policies on consumers' smart home appliances adoption, we asked our participants the following questions:

How does government regulation affect your perception of smart-home appliances?

How does government regulation affect your decision to use smart-home appliances?

Our data shows that consumers have mixed opinions on how government policies influence their perception of smart-home appliances. Some participants expect government policies to limit their scope to ensure a fair and open marketplace that fosters innovation. However, most participants see the need for policies to protect them and their data from misuse by manufacturers. Although some participants are skeptical of how government policies will work when implemented, many think they will help them gain confidence in appliances that adhere to those regulations. Some participants pointed to policies already implemented in Europe as examples of what could be possible in the U.S.

Participant	Adopter/ Non-adopter	Selected Quotes: policy influence
A_Four	Adopter	Any government policy should ensure a fair and open marketplace that allows innovation and the introduction of new products so companies with exciting products can bring them to market.
A_Fourteen	Adopter	Anytime the government starts stepping in and regulating any industry, in any manner, it is a little bit of a red flag, and that is enough to cause people to dig deeper. It would probably cause me to dig deeper as well.
A_Seven	Adopter	I think there is an area where the law and the legal authorities can be more proactive. I think Europeans are more proactive about it: companies cannot collect data without asking. Google and Microsoft are taking different steps in Europe versus in the US.
A_Thirteen	Adopter	It is always, to me, a double-edged sword. Sometimes it is nice to say there is regulation because it gives a sense of protection and safety. However, you can see it every day. Any government regulation has loopholes. So it is a false sense of security.
A_Twelve	Adopter	Government policies and regulations cannot police every piece of data out there. It is just totally impossible!
A_Twenty	Adopter	If there were a choice between two devices: one that is compliant with the privacy standards and the other that is not compliant, I would choose the compliant

		one. It would definitely influence my buying decision.
A_TwentyTwo	Adopter	I watched a documentary on Netflix about how these big technology companies use AI. I know AI regulation of some kind is needed as soon as possible.
A_Ten	Adopter	There is always a risk, even when there are policies in place. Even if there is government regulation, if a bad actor wants to do wrong, there is no way for anyone to stop them. Government regulations do not keep away the bad actors. If a person has already set up their mind to do wrong, there is no stopping.
N_One	Non-adopter	There are already some European regulations based on my dealings with European companies, but I do not know how successful they are at it or if the rules are helping. There will always be hackers, no matter what the rules are.
N_Seven	Non-adopter	I believe European standards are much stricter regarding protecting a person's privacy and ensuring what is transmitted and recorded. However, I think the US is a little lagging. Probably, something similar needs to be done here.
N_Three	Non-adopter	I know that once you get the government involved, it can get sticky sometimes. But I would hope there would be some oversight into what data these companies are generating, the outcomes, and how they use people's information.
N_Twenty	Non-adopter	I do not see any effect or benefit of it (policy) because my main concern is security. If tomorrow the government wants to use it against me, they can use it, no matter what the policy is.
N_TwentyThree	Non-adopter	It would not change my perception because of what is happening right now with Ukraine and Russia. Russia has been able to take down some of the IT infrastructures in Ukraine, so if they can do that to government systems, they can certainly get through a home appliance.

Table 21: Selected quotes – policy influence

Internal Influences

Literature reviews show that people's behavior is affected by their values, which this research refers to as their internal influences. Further, our review specifically highlighted two internal values that can influence consumers' smart-home appliance adoption behavior: their perceived responsibility to the environment and society and their level of innovativeness.

Our data showed that consumers associated smart appliances with environmental and societal impacts. For example, our data also showed that security cameras were identified as smart-home appliances that can positively impact society. By sharing their security camera recording with law enforcement when any crime occurred in their neighborhood, consumers could benefit, which influenced the consumers' decisions to adopt them. Similarly, any smart appliance that reduced energy usage, in particular, positively influenced people. This is because consumers could satisfy their needs to be green and save money from lowered energy usage. However, our data also showed that most consumers do not want to be burdened with extra costs or inconvenienced in making a positive environmental impact.

Similarly, consumers were also concerned with the negative impact on the environment and society from their smart appliance adoption due to the unavailability of recycling options, leading to adding older items to the landfill. However, this concern is not unique to smart appliances since it applies to traditional appliances.

Participant	Adopter/ Non-adopter	Selected Quotes: social responsibility
A_Eight	Adopter	I have a smart dishwasher that automatically runs at one o'clock to save energy, which is good for me, because if I

		had to do it manually, I probably would not be running it that late.
A_Nine	Adopter	I will go a certain distance to contribute to the environmental benefit. However, that is something where, I guess, it is more of a consensus with my wife. So I might be willing to say, yes, I am more than happy to do that, but it may not be the most convenient for my wife.
A_Twenty	Adopter	Would the appliance's social impact be the absolute number one decider? No, but it could be a feature that I would look at. When I buy something, I look at its features' sum. So it might be one of the features that I would look at, but it would not be the absolute number one thing.
A_Nine	Adopter	I have handed over my camera footage twice in the last couple of years to law enforcement. There were a bunch of auto thefts in my neighborhood, and police were going around the neighborhood asking for neighbors to share. Fortunately, my camera captured at least two of those incidents. Although the image was unclear, it helped police establish a timeline. I have no problem sharing anything outside of my home, that is, capturing footage for the greater good.
A_Nineteen	Adopter	I would not like others to have direct access to my cameras all the time. However, if the police were to ask me when we had an incidence of neighborhood crime, I would probably agree and appreciate that.

Table 22: Selected quotes – social responsibility

The literature review suggested the consumers' perceived innovativeness as another internal factor that influences smart appliance adoption. Our data showed that this was true with our participants as well. Our non-adopters, in general, perceived themselves as less innovative than the adopters. On the other hand, most adopters perceived themselves as technologically savvy. Additionally, adopters who rated themselves more innovative than their social network of acquaintances, including friends, family, and coworkers, adopted more smart home appliances than others. In addition, less innovative adopters tended to be later adopters of smart home appliances and were more cost-conscious.

Participant	Adopter/ Non-adopter	Selected Quote: internal influence - innovativeness
A_Fifteen	Adopter	I am not necessarily an early beta adopter of anything now. I would say that I usually want to see the product set out there and established before jumping in.
A_Four	Adopter	I was a beta tester for the Amazon Echo a year before it reached the market.
A_Nineteen	Adopter	I would say I am pretty ahead of the curve on that. I find that I adopt them pretty fast.
A_Sixteen	Adopter	I think I do not mind using it right away, even If it doesn't work quite right.
A_Thirteen	Adopter	I am an early adopter, but my standards and expectations differ from others. I, as an engineer, grew up in technology. I used to beta test Microsoft windows. I do not beta test products anymore.
A_Eleven	Adopter	I am ahead of the family for sure. I mean, everybody in my family comes to me to fix things. So I am ahead of them on smart devices, absolutely.
A_Two	Adopter	I would probably put myself in the top 10 to 20 percent of adopters. I usually only wait on one or two of my friends to adopt something before I consider splurging on it
A_Eight	Adopter	I definitely wait too long. I want to see the products mature and I want to read the reviews before jumping into them.
A_Seven	Adopter	Early adopters pay a little bit higher price for sure. I am a price-conscious customer. Therefore, I am not an early adopter.

A_Three	Adopter	I wait for products to mature. Most of my friends are in generation fourth of a product, and I will still be in the second.
A_Twenty	Adopter	I am not an early adopter. I am somewhere in the middle. I like to see things proven out a little before I go out and buy them.
N_Seven	Non-adopter	I definitely would be considered an extremely slow adopter and most of it has to do with price.
N_TwentyTwo	Non-adopter	I am old-fashioned where I would rather just do it manually and deal with it instead of buying something to be convenient.
N_Twenty	Non-adopter	I am not really concerned with the use of technology. I see people using it, and that is okay. I have not yet had to jump to (technology) to enjoy life.
N_Fourteen	Non-adopter	Most of my friends and family refuse to have a smartphone or any technology.
N_Eighteen	Non-adopoter	I was one of the last of my friends to get a smartphone.
N_Nine	Non-adopter	I am way far behind others. I say I am a decade beyond. However, as far as life-living fulfillment goes, about two decades ahead

Table 23: Selected quotes – innovativeness (ahead, same, or behind social network)

Adoption Risks

Our literature review has identified several risks associated with the adoption of smart-home appliances. In particular, risks arising from the breach of privacy and security of personal information and from ceding autonomy and independence due to technology dependence were identified as underlying risk factors from smart-home appliance adoption. Our interview revealed that privacy and security risks were significant for rejectors, former adopters who stopped adopting smart-home appliances. Although this was a concern for most adopters, it did not stop them all from adopting smart-home appliances. Data also revealed that privacy and security risks comprised of illegal data breaches by bad actors, such as hackers, and legal collection and use of data by suppliers of smart-home appliances.

Surprisingly, our data found that people were concerned less with hacking risk than the risk from manufacturers' data mining and use of their data. Instead, we found that the consumers assumed that the probability of getting hacked was very low. On top of that, adopters managed a calculated risk by employing various risk mitigation techniques. For example, choosing the right manufacturer they think invests in securing their appliances will minimize the risks of being hacked.

Further, data suggest that consumers do not thoroughly read and comprehend the manufacturers' product license agreements before signing them. They either do not understand the legal language or assume that even if they were to read and object to specific terms and conditions, it would only prevent them from using the smart features on their appliances, rendering them useless. Either way, they perceived being forced into signing the legal agreement that possibly allows manufacturers to misuse consumers' data. Thus, privacy and security risk from smart-home appliances is of significant concern for both adopters and non-adopters.

Participant	Adopter/ Non-adopter	Selected Quotes: adoption risks – privacy & security
A_Seven	Adopter	What worries me is that everything we do is recorded and becomes a digital breadcrumb that never goes away. So I turned off my Alexa, because every time I talk to the bank about credit cards or other things, or personal stuff with friends or yelling at my kids, everything is recorded by Alexa. Thus, the security makes me slightly worried about all these devices. But, as I have said, these devices

		are also helping me feel secure. Of course, Amazon and Google have the latest security features embedded in the technology, but cyber hackers are always one step ahead of the good guys. Cyber hackers have to get it right only once to breach, but on the other side, the good guys have to be right on every occasion. That is what bothers me about this.
A_Ten	Adopter	If there is a data breach, people might be able to access my home information. So that is a concern, but it has never happened to me. As the pros outweigh the cons, I will continue to use them.
A_TwentyTwo	Adopter	The biggest concern for me is privacy. So having a secure device will be the number one requirement. I have not had any device issues, but it can still happen.
A_Nine	Adopter	I am less concerned about garage door opener, thermostat, or doorbell cameras because they are more well-known brands. So I am a little more confident that they will correctly use my data. And then there are light bulbs or smart plugs that I use, made by companies that I have never heard about, but I bought them because they were cheap. So in that context, I am sure they are collecting a lot of data regarding my behavior in my house and I am frankly not entirely sure how they use it. So what gives me a little bit more peace is that bulbs and plugs are limited to only recording OFF and ON behavior, unlike a camera, where they can record footage. So I am less concerned, from that point of view.
A_Nineteen	Adopter	If someone does get hold of my network, they have access to a lot of information from me. So that part is a bit scary. But I believe that if you treat security as a priority and know how to interact correctly with your home network, you can prevent a lot of that from happening.
N_Fifteen	Non-adopter (rejector)	My first example is that I bought this device that could connect to a wired garage door opener. I bought it for about $25, which was cheap but could do wireless, which was pretty cool. The next day I got an email from Amazon asking to download a

		particular APP and give them access before using the device. The app allows capturing of the image of the entire garage. As soon as I saw that, I did not even install it. I like the convenience, but I do not want somebody to be able to control it.
N_Fourteen	Non-adopter	Privacy concern is the number one reason (for not using any smart appliances). If I were a thousand-millionaire and could build a section of my house in a faraday cage, I would not have to worry about outside sources interacting with it. I would have it loaded up with all sorts of smart technologies.
N_Nine	Non-adopter (rejector)	I am concerned about trends that I see with technology that is looking to help me. For example, I get an ad in my Amazon feed about a conversation I had in the room because I have a thing listening to me constantly. Another case in point is that I fight with my Xbox constantly because Microsoft turns on the Cortana setting periodically. I do not want Cortana on in that room because that is where my family spends our time. So I have to turn it off manually.
N_TwentyThree	Non-adopter (rejector)	About a year and a half ago, when my garage door opener broke, I purchased a new one. I think every garage door opener I found had a wifi connection. Thus, I bought one for my house, but the wifi connections are not active. Security concern is the primary reason why I have not adopted connectivity.
N_Six	Non-adopter	I do not need somebody to know when I leave the house and when I am coming home. I do not need anybody to track my family, especially my kids. So that was the number one reason I decided not to buy one at the time. There are just too many people with too much time on their hands moving around where they should not be.
N_Twenty	Non-adopter	I imagine the negative consequence of opening your house using the phone. If someone accesses your phone, they can also easily open your house.
A_Two	Adopter	I have to have some sort of trust in the companies from whom I purchase these appliances.

A_Twelve	Adopter	I made a mistake once by not using the smart cameras in the house when we went on vacation. I had let the hose run in my swimming pool but forgot to turn it off before leaving for vacation. As a result, it cost $600 in water bill because it overfilled my pool for ten days straight. However, if I had looked at the cameras, I would have been able to save that.
A_Four	Adopter	If you choose to have a smartphone or even a PC connected to the Internet, you have already given up some security and data privacy. So it is rather meaningless to say that I am worried about my doorbell knowing who comes in and out of the house. Google already uses Google Maps to know who comes into our house based on which cell phones come in and out of the house.
A_Fourteen	Adopter	I have an Alexa, and the bottom of it lights up when I walk through the room. So I do have concerns as to what they are monitoring.
A_Ninteen	Adopter	There are certain situations where I believe that my information should be private. For example, say I am having a private conversation with my wife, my Google home picks up on it, and then uses an algorithm to start sending advertisements or something to that effect to us.
A_TwentyTwo	Adopter	I am concerned about anything with AI, what it can collect, and how it can monitor and use my data. So that is the one concern that discourages me.
A_Seven	Adopter	What bothers me is that there is no filtering on how they (companies) can use the data. I am not a lawyer. I never read one of those license agreements because what is my alternative? You buy a device, and if you do not agree (to license agreements), then you just have to return it, right? To use it, by default, have to agree to the terms and conditions. I think FCC or other government organizations need to step in.
N_Thirteen	Non-adopter	The bigger concern for me is the misuse of data. Companies already have security features put in

		place, which makes it difficult to hack. But the risk from misuse of legally collected data is more significant. Legally collected data can be sold or misused, which is more concerning than the hacker hacking in to your data.

Table 24: Selected quotes – privacy and security risk

The literature review suggested that consumers can face the risk of ceding autonomy and independence to smart home appliances. Consumers may want to do specific tasks in their homes that make them human and avoid becoming like robots. Our data showed that the automation of tasks by smart appliances is a concern for consumers. People who value their independence and autonomy tend to become non-adopters of smart-home appliances. Further, data showed that adopters valued convenience more, which reduced their perceived risks of losing independence and autonomy from smart-home appliances.

Participant	Adopter/ Non-adopter	Selected Quote: adoption risks – ceding autonomy & independence
A_Eighteen	Adopter	When I think about things in my home, so many things connect to the Internet, and we depend on it. It seems almost a little artificial but disgustingly makes my life simple and is helpful. However, at the same time, it is a real double-edged sword. I worry when something else is doing the work for me. What am I using that time for? Am I using it to do something better, or am I just sitting and scrolling more? So I think that is an issue I think a bit more of that from the standpoint. When everything becomes more convenient, is it helping me as much as I think it is in the long run? Right now, it really is helpful.
N_Twenty	Non-adopter	That is (becoming dependent on technology) one of the main reasons that I do not use technology much. I think I will become useless.

A_Three	Adopter	I strongly believe that is why I have not put smart lights within our house. For one, I think we have got to do those things ourselves. Also, I am a little traditional in my views. I think it loses that human touch. I like to turn it on and off myself when I am in my house. That is why I have not put those systems in place.
N_Four	Non-adopter	I would rather turn my lights on. Growing up, my dad used to turn the lights on (in my room), which irritated me. I did not like him telling me when it was time to get up. I rather tell myself to get up. I think it takes away your responsibilities and your decision-making.
A_Eleven	Adopter	There can be a level of smart devices and smart technology that adds convenience but does not take away your autonomy. Instead, it just makes your life easier and removes some of the burdens from you.
A_Nine	Adopter	I am not concerned about losing autonomy per se, but I am more concerned about automating things we do not necessarily need to. There is a fine line between losing autonomy and letting something else do things automatically. I can imagine a time when I walk into the room, and something starts reading the book to me. So the question is, is that good or bad? It is easy for me to just sit on the couch and listen to a book, but at the same time, I am losing that ability to open a book and read it on my own.
A_One	Adopter	I do not think I am overly concerned about ceding autonomy. I think it is more of a convenience factor.
A_Seven	Adopter	It actually improves me as a human being. As a human being, I forget things. As a human being, sometimes I am lazy and want convenience. That is human nature. How often have you left your garage door open? Probably many times in your life. Wouldn't it be easy just to press a button from your office, lock your garage door and enable your home security? And, when it gets warm at night, and you need to turn on the air conditioner, do you want to

		get up and go downstairs in the middle of the night, or would you instead just do it from the phone?
A_TwentyThree	Adopter	I would say that it is not an issue for me. When I have to worry about those sorts of things less, I feel like I have more freedom and more autonomy to do what I want to do rather than dealing with all these little fiddly house things.

Table 25: Selected quotes – ceding autonomy and independence risk

Potential health risks from using smart-home appliances were a concern to some participants. However, they were not a significant influence on their adoption behaviors. As mentioned previously, automation benefits consumers by providing them with the convenience of being able to interact remotely with the appliances. However, some have concerns that this may lead us to be lazy and cause us to be unhealthy – do we need to use the phone to turn off a light switch? Another is high-frequency radio waves (Ghz waves) for communication by the IoT devices in the smart-home appliances. As the number of smart appliances grows in the homes, some are concerned about the increased number of radio waves traversing their homes. Since there have been minimal studies on the long-term effects of Ghz frequency waves on the human brain, this raised concern in a few of our participants but was not significant in affecting adoption behavior.

Participant	Adopter/ Non-adopter	Selected Quote: adoption risks – health risk
A_Nine	Adopter	This could be a figment of my imagination, but I have a slight concern in the back of my head, with so many devices using the airwaves to transmit wireless signals, about how it might cause harm, especially to younger children. Of course, we have long heard about the potential harms of using cell phones.
A_Eighteen	Adopter	I think the overuse (radio waves) could potentially affect the biological makeup of the brain.

Table 26: Selected quotes – health risk

Individual Constraints

Our literature review has shown that facilitating conditions or factors in the environment contribute to the actual use of technology once an individual intends to adopt it. Further, our review suggested cost as a facilitating condition for smart-home appliance adoption. Our data shows that besides costs, technology constraints can be another significant factor affecting the use of smart-home appliances.

Consumers face several costs associated with the adoption of smart-home appliances. First, there is the overall cost of purchasing and installing the appliance. Then, over the appliance's life, consumers may need to pay for its maintenance and use. Our data shows that consumers perceive the costs associated with smart appliances to be higher than traditional ones. These higher costs will prohibit some consumers' positive behavioral intentions of adopting smart appliances from turning into actual purchases and adoption.

Participant	Adopter/ Non-adopter	Selected Quote: Facilitating conditions – financial constraints
N_Six	Non-adopter	I am aware of them (smart appliances), and I am not against their use. I think most of the people I associate with are in my realm. It is a great idea, and it is something they wish they could afford, of course. However, from a financial standpoint, it may not be feasible.
A_Fifteen	Adopter	Some are rather pricey, so there are some technologies I have not got into just because of the sheer cost of it. Subscription costs are also another issue. Many devices require cloud access. That requires subscriptions which can add up over time and offset any benefit.
A_Four	Adopter	I think the cost is probably the number one driver.

A_Nine	Adopter	Cost does come into factor, but I have to balance that with the potential convenience and benefit I can get.
A_Nineteen	Adopter	It (cost) does play a role. I gauge it like this: are the features they give worthy, or am I paying for something that does not really do anything special?
A_Ten	Adopter	I think the foremost thing (influence) is probably the cost.
A_TwentyOne	Adopter	I think every convenience is worth a certain dollar figure. I will pay a little more for convenience, but it has a threshold. For example, there is only a 1% chance that I would ever buy a smart refrigerator. It is cool but not worth that much money to me.
A_Two	Adopter	I probably would if I could live with a dumb appliance to save that kind of money. I have a very low threshold for differences between the dumb and the smart tech.
N_Eighteen	Non-adopter	I do not know how much they cost, but I would imagine it is smart technology, so it is probably financially on the higher end.
N_Nineteen	Non-adopter	Cost is the number one driver. For example, I feel that the benefit of having Roomba, has not, in my mind, reached a point of overcoming the cost. I cannot see myself paying 5,6, or 7 hundred dollars for a Roomba that I barely use. I will still have to sweep the floor half the time anyway. However, if it were to cost me $150, It may not be that big of a deal.
N_Six	Non-adopter	I would have to say my biggest issue is the cost.
N_Ten	Non-adopter	I think the expense of it is the reason that prevents me from buying it
N_Thirteen	Non-adopter	So I have to consider the cost versus the benefit of these devices. If I think I can live without them, I will not consider buying unless it is very critical.
N_TwentyTwo	Non-adopter	We do not see the advantage of buying something to add convenience to our home. So, in other words,

		the cost to buy something for convenience is probably just not worth it to us. I would say that is a top reason (why we do not have smart appliances).
N_Ten	Non-adopter	One thing that concerns me is what happens when it (smart home appliance) breaks. I will not only be replacing a dishwasher but also pay extra to replace the smarts.

Table 27: Selected quotes – financial constraints

Our data showed that even when consumers can afford and intend to adopt smart appliances, they may be limited by technology constraints in their homes. For example, consumers may not be technology savvy, making their smart appliance use experience very difficult. Also, consumers living in certain areas, rural areas, apartments, etc., may have connectivity issues that prevent them from adding smart-home appliances. Our data shows that connectivity issues can be from not having the availability of the needed high-speed internet access for remote accessing of smart appliances. Even when high-speed internet access is available in their homes, the homeowners may lack the necessary bandwidth to add additional smart-home appliances. These various technology constraints can prevent some consumers from adopting smart-home appliances.

Participant	Adopter/ Non-adopter	Selected Quote: Facilitating conditions – technology constraints
N_Thirteen	Non-adopter	I am not that tech-savvy, and I do not have much time to play with those devices. So if it breaks, I need to call those people (installers) again or have to figure it out somehow on my own. I will be in much bigger trouble than without those devices.
N_Eleven	Non-adopter	Another problem is that we are out in the country, and our only Internet is satellite. The plans are pretty expensive, and they do not come with a ton of data. So we have to be pretty careful with how much data we use. So that is a big factor for us because we have often run out of data before the month is out, so having

		anything else that connects will make that happen faster.
A_One	Adopter	As my portfolio (of smart appliances) is growing, I am trying to understand if I have enough bandwidth to control many of these on the network side. I know some of them are not capable of operating on 5G.
N_Six	Non-adopter	We are in an area where the network is not very strong. Smart devices all rely on the wifi. If the network or the wi-fi signal is not good, then they are useless.

Table 28: Selected quotes – technology constraints

Risk Mitigation

Another central theme developed from our data is the consumers' perception of the factors that can mitigate privacy and security risks from adopting smart-home appliances. Most adopters take various steps to minimize privacy and security risks when using the appliances. For example, some only adopt appliances of a particular brand they trust most. Our data has highlighted that manufacturers will benefit significantly by winning the trust from the consumers, especially as it applies to the collection and use of their data. Adopters understand that data collection is necessary to make the most of smart appliances. To get the most out of artificial intelligence, which has a tremendous value proposition for smart homes, collecting data using various sensors to understand consumers home environment and habits is necessary. However, if there is no trust in the manufacturers that they will be their own moral and ethical police, this will discourage people from adopting these appliances.

Participant	Adopter/ Non-adopter	Selected Quote: risk mitigation through brand selection

A_Fifteen	Adopter	I would not look at a device if it were not Google compatible. I would ignore a vast majority of products because they are incompatible with the system I use.
A_Thirteen	Adopter	I will be honest, I am specifically targeting Apple home kit compatible products only. There are other products, but I am concerned about security and privacy with those.
A_Two	Adopter	I have to have some sort of trust in the companies from whom I purchase these appliances. For example, there is a Chinese robotic vacuum cleaner that can do an infrared map of my house, but I do not know where that map of my house goes. So I checked their privacy statements on their US-based website. They claim it does not get transmitted overseas, but you can never be too sure.
A_Eighteen	Adopter	If certain brands were associated with that (ethical use of data), I would be purchasing just those brands, or I would look into them first.
A_Five	Adopter	I know some companies are better at watching and maybe are advocating for the right of the customers, but I do not know to what extent, but I know they exist.
A_Nineteen	Adopter	I want to ensure that these smart home appliances do not overstep their boundaries on certain things, especially in cases where they are taking my information and selling it to other people and making a profit.
A_Seventeen	Adopter	I would have to trust that manufacturer.

Table 29: Selected quotes – risk mitigation through brand selection

Another way consumers mitigate privacy and security risks is by limiting how specific sensors can access the network. Primarily, data suggested two ways through which consumers were able to achieve this: turning off access to the network entirely so that the smart appliance cannot collect data when not in use or choosing not to use appliances that collect visual and audio data.

Participant	Adopter/ Non-adopter	Selected Quote: riks mitigation through access control
A_Fifteen	Adopter	I do not have cameras inside my home. I have some exterior cameras, but I prefer not to have those cameras indoors. If someone, for whatever reason, were to access my yard, I would not care, but if they were accessing my living room, that would be a little different.
A_Twelve	Adopter	We have one in the house, but I unplugged it (Alexa). The voice-activated stuff is more concerning to me than anything else.
A_TwentyThree	Adopter	I would not want a doorbell on my house that can tell somebody whenever I come and go.
A_TwentyTwo	Adopter	I get discouraged with Ai running in the background in smart appliances or even a camera monitoring you. So for those types of things, I physically shut them off or mute them when they are not needed.

Table 30: Selected quotes – risk mitigation through sensors and network selection

Summary

By using NVvio, a qualitative data analysis computer software, our data revealed 83 themes or nodes. These were further grouped into eight primary themes that affected consumers' adoption of smart-home appliances. The eight primary themes are performance expectations, output expectations, personal effort expectations, external influences, internal influences, adoption risks, individual constraints, and risk mitigation. All the themes and most of the sub-themes are consistent with our findings from the literature review. Our data showed that the primary concerns for consumers that affected smart appliances were the cost and the perceived privacy and security risks to their data. Our data also showed that consumers see a severe lack of policies or regulations to prevent harm resulting from their data misuse and breach. Thus, some were taking steps to minimize these risks on their own. These included purchasing only specific brands they trust and limiting the network access to appliances with certain types of sensors inside the home, such as audio and video recording.

Chapter 5: Discussions

This chapter will discuss the results of our analysis. In particular, we will review our propositions to the results from our data analysis to see if there is any evidence for their support. We will also discuss any new findings that emerged from the data different from our propositions but are integral to consumers' smart-home appliance adoption decisions. Further, we will review our previously proposed smart-home technology adoption research model in light of any new findings to refine a model for future research. We will then discuss the limitations of this study, followed by research implications to the academia and the practitioners involved in furthering the adoption of smart-home appliances. Finally, we will conclude with recommendations for future research.

Propositions and Evidence

In this section, we will analyze the data to provide two different sets of evidence to support the relationship between the factors and adoption behavior in our propositions – the overall stated importance of the factors to the participants and the strength of the statistical relationship between the factors and the adoption behavior. The stated importance of the factors is highlighted through selected quotes from participants (see chapter 4) and the number of mentions of the importance of the factors by the participants (shown as % votes in Appendix C). The strength of the statistical relationship between each factor in the proposition and adoption behavior will be summarized through cross-tabulations output from SPSS. Cross tabulations complement our qualitative data analysis. Instead of only looking at the aggregate importance of the factors, cross tabulation output further explains how different levels in factors relate to the adopters, rejectors, and the non-adopters of smart home appliances.

Data output from SPSS used in the analysis are shown in Appendix D, Appendix E, Appendix F, and Appendix G. These statistical results are not meant to infer a definite test of significance of the relationship between the factors and adoption behavior due to the limited response size and the nature of our collected interview data. However, the statistical results are used to derive a relative measure to complement the qualitative analysis to say that the association between the factor and adoption seems not due to randomness.

Proposition 1: Perceived technical performance is related to an individual's behavioral intention to adopt smart-home appliances.

Users' perceived benefits shape their expected technical performance from adopting smart-home appliances. Our data suggests three main distinguishing technical features in smart appliances that differentiate them from traditional ones: the ability to have remote access, the ability to incorporate varying levels of automation, and the ability to interoperate readily with other appliances, including home appliances automation systems. Table 10, 11, and 12 provide the selected quotes that highlight the importance of expected technical performance of smart home appliances to the participants in the research.

Our data associated remote access as the most important of these three features in a smart appliance. Unlike traditional appliances that require users' physical presence for interaction, remote access allows consumers to access their appliances using their phones from a geographical distance. Remote access also enables the consumers to operate or monitor their appliances when they are not at home. Our data showed that 87 percent of adopters and 91 percent of non-adopters associated smart appliances with remote access.

Automation in smart appliances was associated with 70 percent of our sample's adopters and 30 percent of the non-adopters. Automation allows setting a schedule to turn on and off various appliances in the home automatically. For example, automation enables a thermostat to maintain a specific temperature based on time or occupancy. Likewise, it enables the lighting system to schedule the lights inside to turn on and off depending on daylight outside the house.

Our data showed that interoperability was associated with smart appliance by 30 percent of our adopters. Interoperability enables appliances to work seamlessly with other appliances and home automation systems. Additionally, this can have the added advantage of reducing the number of phone apps needed to control the appliances. As adopters add more smart appliances, managing and using multiple phone apps discourages them from adopting them. Further, appliances from manufacturers that do not interoperate with the ecosystem in the homes can be frustrating to consumers. Therefore, the interoperability of an appliance is an important consideration when choosing between similar appliances from different manufacturers.

Our statistical analysis shows that perceived technical performance is moderately and positively related to an individual’s adoption behavior (Pearson’s correlation coefficient is $\rho(44) = .410$, $p = .0046$). Further, when cross-tabulations were performed to examine the association between the level of perceived technical performance and adoption behavior, Chi-Square statistics show the relationship between these variables was significant, X^2 (1, N = 46) = 7.6, $p < .05$. A higher level of perceived technical performance expectancy is more likely associated with adopters than non-adopters, and the relationship is not likely to be random. Appendix G shows the Chi-Square statistics for various grouping of both perceived technical performance and adoption level that show similar results.

Thus, our data suggest that the perceived technical performance of smart appliances is important to both adopters and non-adopters. It is also an important factor in forming adoption behavior.

Proposition 2: Perceived economic performance is related to an individual's behavioral intention to adopt smart home appliances.

As mentioned, the technical performance of smart appliances is associated with various benefits for users. However, our data suggest that the most important benefits of smart appliances are timesaving and convenience for the consumers. All of our 26 adopters and over 90 percent of non-adopters in our sample mentioned convenience as a distinguishing benefit of smart appliances over traditional ones. Through various remote access, automation, and interoperability applications, consumers can save time and effort by interacting with appliances from a physical distance. For example, when consumers forget to close the garage door on the way to their kids' baseball games, they can readily close the garage door from their phones. Similarly, they can answer or choose not to answer a pesky salesperson at their door from their office or even when they are on their favorite vacation spot miles away.

Consumers also associated smart appliances with providing money and energy savings. Thirteen percent of adopters and 22 percent of non-adopters associated smart appliances with providing money and energy savings. The lower percentage of adopters than non-adopters associating smart appliances with money and energy savings is most likely due to adopters ranking the convenience benefit of smart appliances higher than saving money and energy. Some of our adopters suggested that they will choose convenience over saving money and energy.

Our results also suggested that physical security is another critical benefit of smart appliances, which is not included as part of our proposition. Physical security was mentioned by 39 percent of adopters and 22 percent of non-adopters as a benefit from smart appliances. This may also be apparent from the popularity of many available smart appliances that provide security to the home, including vision-equipped doorbells, garage door openers, door locks, and light bulbs and switches.

Thus, we propose modifying this proposition to include all of our consumers' perceived benefits associated with their smart appliances. Based on our findings, we suggest changing the determining factor in the proposition from *perceived economic performance* to *perceived outcome performanc*e in future research. *Perceived outcome performance* will include three sub-factors: energy and money-saving, timesaving and convenience, and physical security.

Our statistical analysis shows that perceived outcome performance is weakly and positively related to individual adoption behavior and is insignificant (Pearson's correlation coefficient is, $\rho(44) = .117$, $p = .4378$). Further, when cross-tabulations were performed to examine the association between the level of perceived outcome performance and adoption behavior, Chi-Square statistics did not show the relationship between these variables was significant, X^2 (1, N = 46) = .84, p =.271.

Our data suggest that the perceived outcome performance of smart appliances is important to both adopters and non-adopters. However, our cross-tabulations output does not support this factor's association with forming adoption behavior.

Proposition 3: Perceived effort is related to an individual's behavioral intention to adopt smart home appliances.

Many smart-home appliances require to be self-installed and managed by the users. The option to self-install decreases the cost for the consumers but becomes a burden when the effort required is more than they are technically capable of handling. In addition, consumers need to train themselves to use and manage these smart appliances that require much more interaction than traditional ones. Thus, the consumers' collective effort to adopt smart appliances is a sum of their perception of how difficult they are to install, use, and manage.

Our data showed that when our participants had an overall lower perceived effort to install, use, and maintain smart appliances, they were more likely to adopt them. For example, more non-adopters (48%) compared to only 4% of adopters mentioned perceived use effort higher to be higher for smart appliances. Half of our non-adopters were discouraged from adopting smart appliances due to their higher perceived effort, whereas only a handful of adopters felt the same. Similar percentages of adopters and non-adopters mentioned the installation (26% and 22% respectively) and maintenance (both at 17%) effort to be higher for smart appliances.

Additionally, our data suggested that the higher perceived use effort can lead some adopters of smart appliances to reject them. When the burden of managing or using smart appliances outweighs their benefit, adopters will lower the use of these products. In some cases, this can lead to the rejection of the technology. For example, our data showed that half of the rejectors in our sample stopped using smart appliances due to the higher level of perceived use effort.

Our statistical analysis shows that perceived effort is negatively related to an individual's adoption behavior (Pearson's correlation coefficient is $\rho(44) = -.234$, $p = .11$). Further, when cross-tabulations were performed to examine the association between the level of perceived effort and adoption behavior, Chi-Square statistics show the relationship between these variables was significant, X^2 (2, N = 46) = 5.297, p = .055. A higher level of perceived effort is more likely associated with adopters than non-adopters, and the relationship is not likely to be random. Appendix G shows the Chi-Square statistics for various grouping of both perceived effort and adoption levels that show similar results.

Thus, our data suggest that the perceived effort in adopting smart appliances is an important factor to both adopters and non-adopters and is also essential in forming their adoption behavior.

Proposition 4: Perceived government policy is related to an individual's behavioral intention to adopt smart home appliances.

Consumers understand why manufacturers need to collect and analyze our personal data to provide us features that have increased automation and control of our appliances.

However, our research showed that consumers fear that manufacturers may not be good stewards of the collected data which adversely affected consumers data privacy and security in two different ways. First, manufacturers may not provide adequate security protection in their appliances to prevent bad actors from hacking and stealing our personal data. Second, even when they provide adequate security to deter hackers, manufacturers themselves may be collecting data, legally with the consumers permissions, but may be misusing them for their own financial gain. For example, manufacturers may be using the collected data in more ways than for its intended purpose, such as to sell the data to a third party or to use the data to sell the consumers additional products.

Our research showed that most consumers expect government to set policies and regulations that will protect them from both the illegal data breaches by bad actors as well as the misuse of their legally collected data by the manufacturers. When manufacturers are not required to meet stringent policies and standards, their products may have weaker security which bad actors can easily hack and exploit personal data for their gain. Unlike organizations that have resources that are constantly monitoring threats from hackers, most individual consumers don't have the resources nor the technical know-how to be on top of the threats from the hackers. They rely on the manufactures to make the products secure against any external attacks. However, the level of security and protection in a smart appliance will not be obvious to consumers if they are not able to see the policies and regulations that manufacturers meet labeled on the appliances. Our data showed that 70 percent of the adopters and 48 percent of non-adopters mentioned the need for government to set policies that would limit how manufacturers collect and use personal data from the sensors in the smart appliances.

Further, our participants said they would choose manufacturers that were protective of their data over other manufacturers they did not trust. More than 50 percent of participants in our study associated the lack of government policy with increased privacy and security risks from their smart appliance use. Smart home appliance market is ever increasing. As consumers get flooded with appliance options to choose from amongst many global manufacturers, the issue of finding the right manufacturer that protects consumers privacy is ever more difficult. This was especially worrisome for our consumers that blindly sign manufacturer's license agreements. Manufacturers from other countries may not have the onus to provide the same level of privacy and security protection in their appliances as domestic manufacturers either. Further, manufacturers may provide varying levels of privacy and security to consumers in different countries depending upon the expectations of the consumers and the need to meet any local regulations. Thus, there is a need to set privacy and security policies and regulations surrounding smart home appliances at a local, regional, and global level such that consumers can choose the manufacturer that best satisfies their level of privacy and security expectations.

Our consumers cautioned that policy implementation could be a two-edged sword with both positive and negative consequences for them. Having the right policies will help consumers by decreasing their risk perceptions from smart appliance adoption. However, if the policies are improperly implemented, they will introduce loopholes that manufacturers will exploit to stay compliant and still legally collect and misuse data. Consumers also highlighted how the European Union already had policies to protect consumers' data, which the U.S policymakers can take as an example.

Our statistical analysis shows that perceived government policy is weakly and positively related to an individual's adoption behavior (Pearson's correlation coefficient is $\rho(44) = .221$, $p = .14$). Further, when cross-tabulations were performed to examine the association between the level of policy influence and adoption behavior, Chi-Square statistics show the relationship between these variables was significant, X^2 (2, N = 46) = 7.713, $p < .05$. A higher level of perceived government policy is more likely associated with adopters than non-adopters, and the relationship is not likely to be random. Appendix G shows the Chi-Square statistics.

Thus, our data suggest that perceived government policy is an important factor in forming adoption behavior.

Proposition 5: Perceived media bias is related to an individual's behavioral intention to adopt smart home appliances.

For most of our participants, accessing media related to smart appliances was the first line of inquiry to find more information on them. Social media, in particular, allowed the participants to easily access information from others that have already purchased these appliances. The information the participants use on social media are ratings on the appliances and the users' experiences detailing both pros and cons on them. Some participants were concerned with basing their purchase decisions solely on the ratings and experiences of people they did not know and trust. In addition, some were concerned that paid reviewers might give high ratings and write favorable reviews on lower-quality appliances. Thus, some participants focused on reviewing negative factors about appliances, including any interoperability or privacy and security issues, that will help them to avoid specific appliances from their purchase decisions.

Social media reviews are not only critical to consumers but also necessary to manufacturers. As consumers engage more in social media reviews, manufacturers can use the crowd's collective wisdom to disperse innovation to the masses without spending on advertisements. In addition, manufacturers can also take advantage of their products' reviews to improve their innovations and address consumer concerns. Thus, social media can serve as a conduit that generates rich data for consumers and manufacturers. Consumers can use the experience of others who have used smart appliances to analyze the pros and cons before purchasing them. Furthermore, social media allows manufacturers to disperse their innovations without spending considerably on advertisements. The manufacturers' product teams can also use the reviews to improve products and bring forth innovations that consumers expect.

Social media was mentioned as influential in their smart-home appliance adoption decisions by 74 percent of the adopters in the sample. Additionally, 26 percent of non-adopters mentioned that they would refer to social media to learn more about smart appliances.

Our statistical analysis shows that perceived media influence is moderately and positively related to an individual's adoption behavior (Pearson's correlation coefficient is $\rho(44) = .478$, $p < .001$). Further, when cross-tabulations were performed to examine the association between the level of media influence and adoption behavior, Chi-Square statistics show the relationship between these variables was significant, X^2 (1, $N = 46$) = 10.6, $p < .01$. A higher level of perceived media influence is more likely associated with adopters than non-adopters, and the relationship is not likely to be random. Appendix G shows the Chi-Square statistics from the cross-tabulations.

Thus, our data suggest that perceived media influence is an important factor in forming adoption behavior.

Proposition 6: Perceived social network bias is related to an individual's behavioral intention to adopt smart home appliances.

Besides relying on social media to get information on smart appliances, our participants also relied on the experiences of their social networks. From the collective experiences of their friends, family, and co-workers, our participants could get more trustworthy information on the pros and cons of smart appliances. To most of our participants, positive word-of-mouth referral of an appliance by their social network ranked higher than any positive feedback on social media from an unknown person. Additionally, seeing the appliance in action in a friend or a family member's home was even more influential. Our data shows that 65 percent of adopters and 43 percent of non-adopters mentioned social network influence as being important in forming their decisions to choose a particular smart-home appliance.

Our statistical analysis shows that perceived influence from social networks is weakly and positively related to individuals' adoption behavior (Pearson’s correlation coefficient is ρ(44) = .218, p =.14). Further, when cross-tabulations were performed to examine the association between the level of perceived social network influence and adoption behavior, Chi-Square statistics show the relationship between these variables was moderately significant, X^2 (2, N = 46) = 5.395, p =.08. A higher level of perceived social network influence is more likely associated with adopters than non-adopters, and the relationship is not likely to be random. Appendix G shows the Chi-Square statistics from cross-tabulation analysis.

Thus, our data suggest that perceived media influence is an important factor in forming adoption behavior.

Proposition 7: The level of environmental responsibility is related to an individual's behavioral intention to adopt smart home appliances.

Our interview data showed that people positively want to impact society through environmental or other societal contributions. For example, consumers want to reduce energy consumption to reduce their negative impact on the electrical power grid. They want to share the video recordings from their doorbell cameras to assist law enforcement in helping solve crimes in the neighborhood. However, data also showed that some were hesitant to inconvenience themselves or pay more money to make such contributions to society. Only a small number of adopters (26 percent) were keen to pay more or be inconvenienced to impact society. Since consumers want to impact society overall and not only on the environment, we propose to change our proposition to the following: *The level of social responsibility is related to an individual's behavioral intention to adopt smart home appliances.*

Our statistical analysis shows that the perceived level of social responsibility is moderately and positively related to individuals' adoption behavior (Pearson’s correlation coefficient is $\rho(44) = .387$, $p = .0078$). Further, when cross-tabulations were performed to examine the association between the level of social responsibility and adoption behavior, Chi-Square statistics show the relationship between these variables was significant, X^2 (2, N = 46) = 6.9, $p < .05$. A higher level of social responsibility is more likely associated with adopters than non-adopters, and the relationship is not likely to be random. Appendix G shows the Chi-Square statistics output from cross-tabulations analysis.

Thus, our data suggest that although perceived social responsibility is not an important factor to our participants, it is important in forming their adoption behavior.

Proposition 8: The level of innovativeness is related to an individual's behavioral intention to adopt smart home appliances.

Our research data showed that consumers that adopt a higher number of smart-home appliances tended to be more innovative or technologically savvy. In addition, these consumers perceived themselves as being ahead of their network of friends, family, and co-workers in terms of understanding and adopting smart appliances. For example, all of the adopters with the highest number of smart appliances (11 or more) in their homes perceived themselves as being ahead of their social network when it comes to adopting smart appliances. Also, 65 percent of all adopters considered themselves to be ahead of their social network. On the other end, non-adopters (100 percent) considered themselves behind or the same as their social network in being technologically savvy.

Our statistical analysis shows that perceived innovativeness is positively related to an individual’s adoption behavior (Pearson’s correlation coefficient is $\rho(44) = .703$, $p < .001$). Further, when cross-tabulations were performed to examine the association between the level of perceived innovativeness and adoption behavior, Chi-Square statistics show the relationship between these variables was significant, X^2 (2, N = 46) = 22.2585, p < .001. A higher level of perceived innovativeness is more likely associated with adopters than non-adopters, and the relationship is not likely to be random. Appendix G shows the Chi-Square statistics output from cross-tabulations analysis.

Thus, our data suggest that the perceived innovativeness of consumers is an important factor in forming adoption behavior.

Proposition 9: Perceived level of privacy and security concern is related to an individual's behavioral intention to adopt smart home appliances.

Privacy and security risks from smart appliances are a major concern for most of our participants. Eighty-seven percent of adopters and 96 percent of non-adopters mentioned privacy and security risk of their data in adopting smart appliances. They identified two kinds of privacy and security risks concerning their data – hacking by bad actors and data mining and misuse by manufacturers. Data mining and misuse of personal data by manufacturers was a more significant concern to the participant than the risk from hackers. To minimize privacy and security concerns, some of the adopters were limiting themselves to only adopting appliances from certain manufacturers whom they trusted would provide the highest level of protection, both from hackers and from internal misuse of data. Further, some participants turned off some appliances' connection to the network to minimize data collection by manufacturers.

Our statistical analysis shows that the perceived level of privacy and security concern is negatively related to an individual's adoption behavior and is insignificant

(Pearson's correlation coefficient is $\rho(44) = -.154$, $p = .31$). Further, when cross-tabulations were performed to examine the association between the level of privacy and security concerns and adoption behavior, Chi-Square statistics show the relationship between these variables was not significant, X^2 (2, $N = 46$) = 1.447, $p = .548$. A higher level of privacy and security concern is not likely associated with adopters than non-adopters. Appendix G shows the Chi-Square statistics output from cross-tabulations analysis.

Thus, our data suggest that although privacy and security concern is an important factor to both adopters and non-adopters, it is not important in forming adoption behavior.

Proposition 10: Perceived level of autonomy is related to an individual's behavioral intention to adopt smart home appliances.

As highlighted earlier, one of the primary benefits of smart home appliances is using automation to provide convenience to consumers. However, to some of our participants, the added convenience sometimes came at the cost of their independence and autonomy. For most younger participants, the added convenience of automating a task saved them time and energy. However, for most older and traditional participants, some of this was unnecessary convenience, making them lazy and dependent on technology. Although, at the current level of automation available in smart appliances, most adopters were not very concerned with the risk to their autonomy. However, with the increasing use of artificial intelligence and automation in smart appliances, they were concerned that this might not be the case in the future. Over 60 percent of our adopters and 39 percent of the non-adopters mentioned the dependence on technology as a possible concern.

Our statistical analysis shows that perceived technical performance is positively but weakly related to an individual’s adoption behavior (Pearson’s correlation coefficient is ρ(44) = .217, *p* =.1467). Further, when cross-tabulations were performed to examine the association between the level of autonomy concern and adoption behavior, Chi-Square statistics show the relationship between these variables was not significant, X^2 (2, *N* = 46) = 2.375, *p* =.3. A higher level of perceived autonomy concern is not more likely associated with adopters than non-adopters, and the relationship is likely to be random. Appendix G shows the Chi-Square statistics output from cross-tabulations analysis.

Thus, our data suggest that although perceived level of autonomy concern is important to both adopters and non-adopters of smart appliances, it is not an important factor in forming adoption behavior.

Proposition 11: Financial constraints acts as a facilitating condition that directly affects an individual's adoption of smart home appliances.

The cost of the appliance was a significant factor in the adoption decisions of both adopters and non-adopters of smart home appliances. Data suggested that each customer has their level of the cost they are willing to pay to add convenience, automation, scheduling, and remote monitoring to their appliances. However, both adopters and non-adopters (74 percent each) mentioned that smart appliances were associated with higher costs.

Technology constraint was also identified to affect consumers' smart appliance adoption directly. For example, smart appliances constantly transfer a significant volume of data between the home and the cloud service providers. As a result, some consumers are worried that their network bandwidth may not be able to support adding additional appliances at some point without upgrading their network to 5G, which may or may not be available in their homes. Thus, we propose to change proposition 11 to include technology as a constraint: *financial and technical constraints act as a facilitating condition that directly affects an individual's adoption of smart home appliances.*

Our statistical analysis shows that financial and technology constraints are negatively related to an individual's adoption behavior (Pearson's correlation coefficient is ρ(44) = -.041, *p* =.7587), and the relationship is not significant. Further, when cross-tabulations were performed to examine the association between the level of financial and technology constraints and adoption behavior, Chi-Square statistics show the relationship between these variables was still not significant, X^2 (4, N = 46) = .497, p = .974. A higher level of perceived constraints is not more likely associated with adopters than non-adopters, and the relationship is likely to be random. Appendix G shows the Chi-Square statistics output from the cross-tabulations analysis.

Thus, our data suggest that although financial and technical constraints are important factors for adopters and non-adopters, they are not important in forming adoption behavior.

Revised Research Model

As described earlier, to incorporate additional findings that were uncovered in our data that were not in the original research model and the propositions, we revise our research model below in Figure 13. Our new model will increase the explaining power of UTAUT as it applies to smart home adoption and should be used in further research.

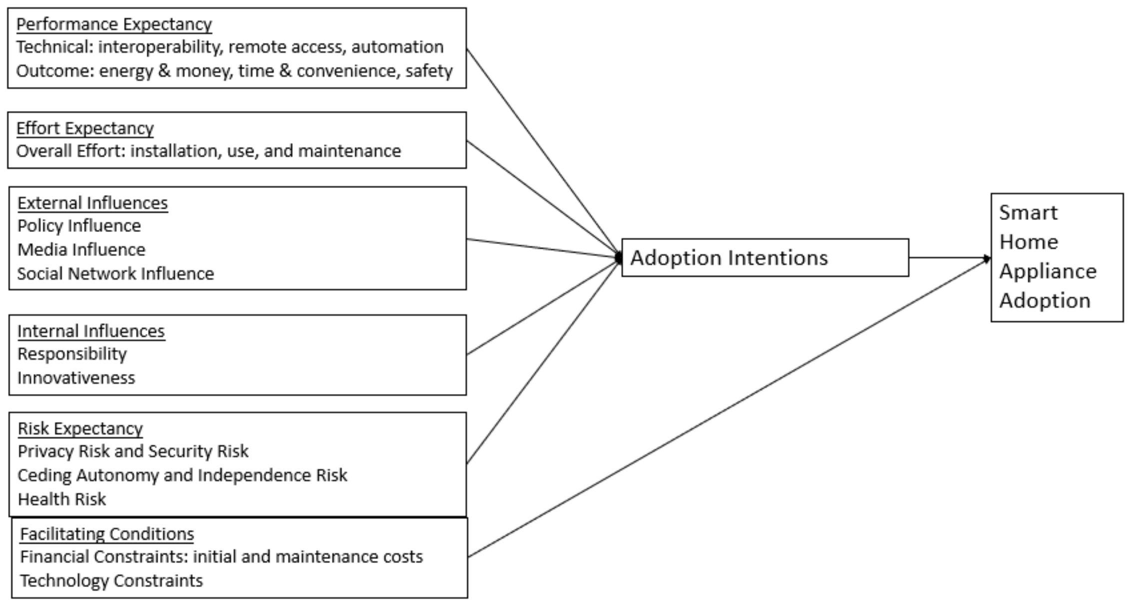

Figure 13: Revised model of smart-home appliance adoption

Limitations of the Study

- Limited sample and demographics: One of the significant limitations of this study is that the participants were all chosen by the researcher. Our sample consisted of only 23 adopters and 23 non-adopters of smart home appliances, all chosen from within the researcher's professional network. This limited sample size provides a small window to the actual world of adopters and non-adopters of smart appliances. Additionally, the limited number of samples means the demographic representation was limited. The participants were US-centric and were mainly from the St. Louis region. Only 11 of our 46 participants, or less than 25 percent, were female. Although we did not find any gender-specific factors that affected smart home appliances adoption, our research would benefit from including more female participation. Similarly, our participation sample did not include any retirees and people with health care needs who may have different reasons to adopt smart appliances in their homes. Thus, the size of the samples limits the generalizability of our findings.

- Potential bias of the research participants: Our findings are based on self-reported data of our participants. There is a possibility that the participants are biased about their beliefs and experiences with smart appliances. Although we use data from both the adopters and non-adopters to triangulate the findings, we cannot avoid the biases of the participant based on a limited set of questions that were asked. For example, adopters who have already purchased smart appliances may have developed a positive attitude toward the risks from smart appliances. Similarly, the non-adopters may have developed negative bias since they do not own any. Also, the participants may have had recall issues or timing issues that the researcher cannot uncover due to the nature of this research process.
- Correlation and causation issues: Another limitation of this study is the correlation and causation issue in this qualitative case study. Although our findings suggest a certain relationship direction between factors based on the literature review, this may not be the case. For example, the correlated factors may have shown this relationship due to an unknown third factor, also called the confounding factor, not revealed in the literature review. Similarly, the

relationship direction may be the opposite of the suggested direction in the research which can be the case with qualitative propositions. Therefore, to reduce correlation and causation issues from the findings of this study, an appropriate quantitative research design will need to be done and tested in the future.

Research Implications

This research has implications for both academia involved in the smart home appliance adoption research and the practitioners involved in developing, manufacturing, and marketing them.

- Theoretical Contribution: This research expands the application of the universal theory of acceptance and use of technology (UTAUT) to address the adoption of smart home appliances. Smart home appliance market is expected to grow substantially in the next decade. Therefore, understanding the factors that influence consumers' adoption behavior is essential to the researchers involved in proliferating the adoption of smart appliances. Through in-depth interviews with 23 adopters and 23 non-adopters, we have decomposed core determinants of UTAUT into factors and sub-factors that influence smart home appliance adoption. Additionally, we have added determinants of risk expectancy and internal influences to UTAUT. In doing so, we have enhanced the explaining power of UTAUT as it applies to the adoption of smart appliances and other similar technologies.

- Practical Contributions: This research makes the following suggestions to practitioners involved in developing, manufacturing, and marketing smart appliances:

- Focus on interoperability: This research suggests that a significant dissatisfaction with smart appliances is that they do not always connect well with other appliances, including home automation systems. Consumers, especially those that purchase multiple smart appliances, want to maintain an eco-system of appliances that will minimize the number of phone apps. Therefore, when an appliance manufacturer makes an appliance that cannot operate within the home automation ecosystem or with similar appliances, the consumer would be more likely to avoid them.
- Focus on lowering consumers' effort with appliances: Our research showed that one of the significant reasons adopters reject smart appliances and become non-adopters is that they find the effort needed to install and use unacceptable. Consumers are expected to self-learn to install, use, and maintain most smart appliances to save cost. If the appliance is not appropriately designed with customers' effort in mind, consumers will not adopt them readily. This research suggests that manufacturers should make this experience easy and fun so that even technologically less savvy consumers can easily manage this.
- Ethical use of data: Our data shows that consumers are wary of manufacturers handling consumers' data. Consumers understand that manufacturers need to collect data to enable automation and other benefits from smart appliances. However, consumers fear that manufacturers will misuse their collected data. This research suggests that consumers that address this concern will significantly benefit by building a brand that

promotes ethical use of data. One example that our participants suggested is to have a board of ethics in the organization that oversees the responsible use of consumers' data.

- Remedies for resistance: Currently, only 12 to 16 percent of the U.S. households use smart products (McKinsey & Co, 2021). Our research shows that some people who do not adopt smart appliances resist for various reasons. Our research suggests that manufacturers can benefit by addressing the following:
    - Acceptable level of automation – Although automation is key to providing convenience for consumers, traditional consumers may not want everything to be automated. Providing the ability to set varying levels of automation will help manufacturers address the traditional consumers' concerns and make their products attractive to them.
    - Acceptable level of connectivity – Similar to automation, some consumers do not want all their appliances to be connected to the cloud and to everything else. For example, some consumers want appliances with certain sensors, such as audio or video sensors, to limit the home's connectivity to a local level. Manufacturers will benefit by addressing this concern of consumers by finding means to allow for local connectivity on some appliances.

Recommendation for Future Research

As highlighted earlier, this research has implications both for academia and practitioners. However, this research has limitations which prevent the findings from being generalized. Thus, we suggest the following for future researchers:

- Expand research participation size and demographics: Our sample was limited to 23 adopters and 23 non-adopters, with less than 25 percent female participation, all from the researcher's professional network. Further, our participants were limited to the St. Louis area geographically. We encourage future research to randomize the sample and expand it to address the limitations we discussed with our sample.
- Consumers' expectation of the ethical use of data by manufacturers: This is an essential factor that affects smart home appliance adoption and will need to be researched further to explore what consumers mean by ethical use of data. As mentioned earlier, data collection is already integral to making the appliances smarter. In the future, this will be even more important with the increasing use of artificial intelligence and the increasing level of automation in our homes. Therefore, it is crucial to understand and include consumers' perceptions of data collection and use in products to be readily adopted.
- Manufacturers' views on the ethical use of data: In addition to consumers' views, it is also essential to understand the good practices of manufacturers that are widely regarded as better at managing users' data. We suggest future research on this topic that has the potential to help other manufacturers become good stewards of consumers' data.

- Government policymakers' views on the ethical use of data: Our participants highlighted European Union policies regarding data collection and use by manufacturers. We suggest future research to find what the U.S. policymakers are doing to address consumers' concerns regarding data mining and use risks. As suggested by our participants, we also suggest future researchers find the efficacy of European policies on consumers' perceived risks of privacy and security from smart appliances and how that can be applied to the U.S.
- Quantitate research: As mentioned earlier, one of the significant limitations of qualitative research is the correlation and causation issue related to the relationship between factors. Therefore, we suggest future research to explore smart home appliance adoption by quantitatively testing our refined model of UTAUT.

Conclusion

Smart home appliances are expected to change our residences and how we interact with them in the future. Already, smart appliances are incorporating various technologies, including software, hardware, connectivity, artificial intelligence, and machine learning. Unlike traditional appliances requiring consumers to physically turn an appliance on or off, smart appliances can be accessed and controlled from your office, the grocery store, or a favorite vacation spot. For example, you can see if a pesky salesman is ringing the doorbell without looking out the window or seeing the contents inside your refrigerator from the grocery store.

Based on in-depth interviews with 46 participants, this research explores the determining factors that affect the adoption of smart home appliances. We analyzed the perceptions, experiences, and perceptions of the adopters (26 participants) and non-adopters (26 participants). The resulting 896 pages of interview transcripts found 83 themes that affected smart appliance adoption. Finally, these were grouped together into eight major themes or factors: performance expectations, output expectations, personal effort expectations, external influences, internal influences, adoption risks, individual constraints, and risk mitigation. These findings and the data provided support our eleven propositions. Further, we also made improvements to the propositions, which resulted in a revised model of UTAUT that will explain consumers' smart home appliance adoption behavior.

The research findings are helpful to the practitioners involved in developing, manufacturing, and marketing smart home appliances. Besides the engineering focus on incorporating the latest technology to drive features that may benefit consumers, manufacturers need to be aware of other factors that affect the eventual adoption of the smart appliances. In particular, a lower level of interoperability with other smart appliances within the ecosystem of appliances already in a home can detrimentally affect an appliance’s consumer adoption. Further, even when the appliance is compatible and can interoperate with other appliances in the home ecosystem, it may not be adopted if the effort needed to integrate, use, and maintain them are extensive and beyond the skills of the less technologically savvy consumers. Thus, manufacturers need to pay attention to features that can easily be used and adopted by consumers rather than features that may have more benefit but are complicated for consumers to use.

As smart home appliances have become more automated, the level of data collection has reached an unprecedented level. As a result, consumers are seriously concerned that hackers and manufacturers may misuse their data. Manufacturers perceived as better stewards of consumer data will win consumers' trust that they will protect and not misuse their information. Thus, as a manufacturer, to build trust with the consumers and to stand out amongst competitors, manufacturers need to address how they will collect and protect personal data from external and internal misuse. Our research findings suggest that manufacturers can benefit from a two-pronged approach to addressing privacy and security besides being compliant with available standards and policies. First, manufacturers can reduce the concerns of their less innovative consumers by allowing them to dial down and choose the correct level of automation and connectivity in their appliances. Incorporating varying automation and connectivity options in the appliances will allow their more innovative consumers to use full automation and connectivity features without forcing them on other consumers that resist them. Second, manufacturers can win consumer trust by implementing a corporate strategy to address the governance of ethical collection and use of consumers' data. One such application might include data governance as part of corporate ESG (environmental, social, and Governance) strategy.

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Appendix A: NVivo output showing hierarchy charts

Figure 14: NVivo hierarchy chart of the adopters

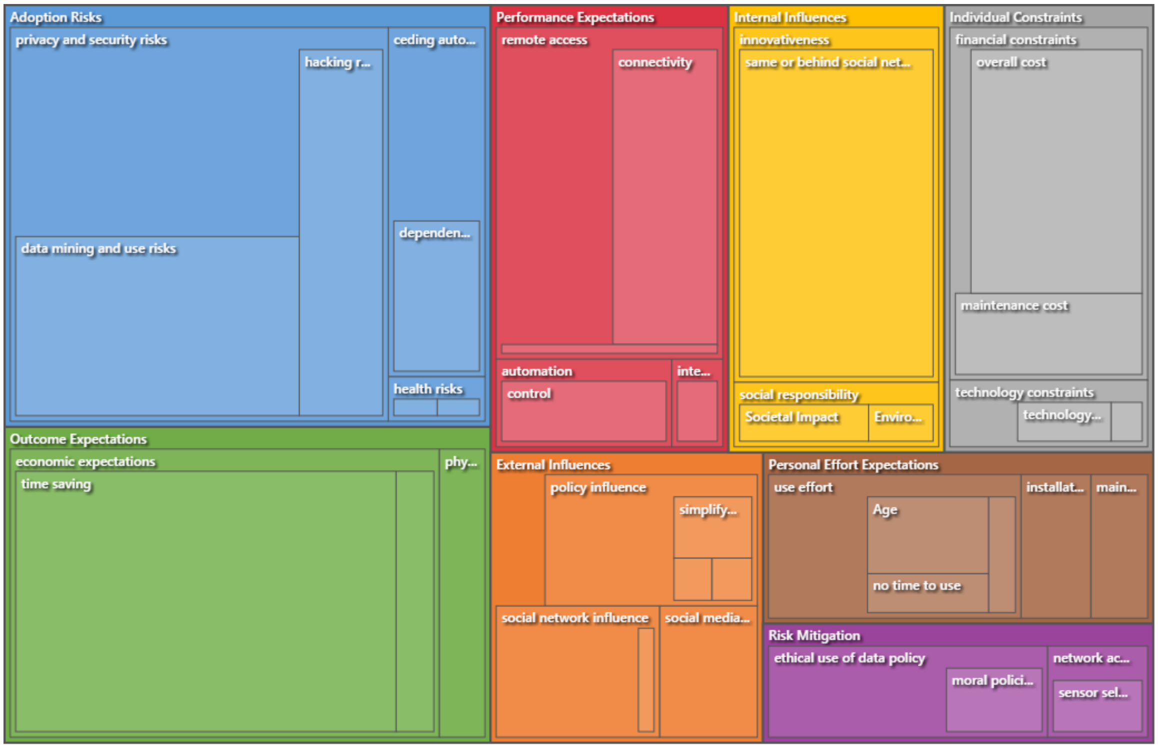

Figure 15: NVivo hierarchy chart of the non-adopters

Appendix B: NVivo output showing codebook

Name	Files	References
Adoption Risks	45	170
ceding autonomy and independence risk	23	38
dependence on technology	18	25
autonomy risk	12	14
health risks	5	10
Laziness	3	4
long term radiation	3	6
privacy and security risks	43	122
data mining and use risks	28	51
blind trust - do not read license	15	15
tracking risk	1	1
hacking risks	21	26
External Influences	41	95
policy influence	27	37
moral policing	4	4
opting out options	3	3
simplifying licenses	9	9
social media influence	23	26
social network influence	25	27
seeing in action	1	1
word of mouth	3	3
Individual Constraints	38	67

Name	Files	References
financial constraints	34	56
maintenance cost	12	14
overall cost	31	39
technology constraints	9	11
technology bandwidth	1	1
technology knowhow	7	8
technologically savvy	4	5
Internal Influences	46	76
Innovativeness	46	66
ahead of social network	15	21
early adopter	10	10
same or behind social network	31	45
against technology	2	2
late adopter - cost conscious	10	14
same as social network	9	9
Traditions	2	2
social responsibility	7	10
Environmental Impact	3	3
Energy saving	5	5
Environmental responsibility	4	5
Adding to landfill	2	3

Name	Files	References
Societal Impact	6	7
neighborhood crime watch	7	7
Outcome Expectations	44	136
economic expectations	44	119
money saving	8	10
energy saving	5	6
time saving	44	109
Comfort	19	24
Automation	18	22
scheduling	13	15
Control	5	5
Convenience	41	73
ease of use	11	13
enhanced usability	2	2
remote access and control	18	20
physical safety	14	17
Performance Expectations	43	121
Automation	23	31
Control	22	27
remote access and control	19	21
sensor integration	1	1

Name	Files	References
Interactivity	4	4
fun interaction	2	2
Interoperability	8	19
apps interoperability	3	4
device interoperability	5	10
technology longetivity	4	6
remote access	40	70
Connectivity	28	30
Monitoring	7	9
Personal Effort Expectations	22	39
installation effort	11	11
technology capability	1	1
maintenance effort	8	8
use effort	12	19
Age	3	6
no time to use	1	3
working from home	1	2
Risk Mitigation	28	61
brand selection	7	10
Compatibility	6	9
Interoperability	4	5
ethical use of data policy	15	28
moral policing	7	10
network access selection	16	23

Name	Files	References
sensor selection	15	21
vision sensor selection	3	4
voice detection sensor selection	10	12

Appendix C: Votes tally of themes

Votes tally represents the level of participants’ reference to each theme. A vote means a participant mentioned the theme at least one time.

Codes used in the tables below – the first table below is for adopters and the second for non-adopters

1: less than 50K
2: 50K to 100k
3: 100k to 150k
4: 150k to 200k
5: 200K higher

Age Group Codes
1: 25 to 34
2: 35 to 44
3: 45 to 54
4: 55 to 64
5: 65 plus

Home-ownership Codes
0: own
R: rent

Appliances Codes
A: 1 to 5
B: 6 to 10
C: 11 or more
0: zero

Education Level Codes

HS: High school
Asc: Associate
BA: Bacheolar
MA: Masters
PhD: Doctorate

		Adopters (total of 23 participants)																								
Emerged Themes	Sub-themes	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23	Total Votes	% votes
Performance Expectations	automation	x			x		x	x	x	x		x			x	x	x	x	x	x	x	x	x		16	70%
	interoperability	x	x		x									x		x	x		x						7	30%
	remote access		x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	20	87%
Output Expectations	energy & money		x											x										x	3	13%
	time and convenience	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	23	100%
	physical safety		x	x			x	x	x				x	x				x	x						9	39%
Personal Effort Expectations	installation effort												x		x					x	x	x		x	6	26%
	maintenance effort										x	x								x	x				4	17%
	use effort																				x				1	4%
External Influences	policy influence		x		x	x	x	x		x	x	x	x	x	x					x	x	x	x	x	16	70%
	social media influence		x	x	x				x	x	x	x		x	x	x	x		x	x	x	x	x	x	17	74%
	social network influence		x	x		x			x	x	x	x	x		x	x			x	x	x		x	x	15	65%
Internal Influences	ahead of social network	x	x		x	x	x			x	x	x		x		x	x	x	x	x		x			15	65%
	same or behind social network			x				x	x				x		x						x		x	x	8	35%
	social responsibillity				x			x				x				x						x	x		6	26%
Adoption Risks	independence	x		x	x		x	x		x	x	x		x	x				x		x		x	x	14	61%
	health risks			x						x							x		x						4	17%
	privacy and security	x	x	x	x		x	x	x	x	x	x	x	x	x		x	x		x	x	x	x	x	20	87%
Individual Constraints	financial constraints		x	x	x	x	x			x	x		x		x	x		x	x	x	x	x	x	x	17	74%
	technology constraints		x					x		x		x													4	17%
Risk Mitigation	brand selection	x	x		x									x		x	x		x						7	30%
	ethical use of data policing	x				x		x					x	x				x	x	x					8	35%
	network access selection			x			x						x	x	x	x	x		x			x	x	x	11	48%
Demographics	Home ownership	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O		
	# in household	4	3	4	2	4	4	3	2	3	4	2	2	6	2	4	2	4	5+	3	4	4	3	2		
	Age group	1	2	2	4	2	2	2	2	4	4	4	4	4	4	1	1	3	3	1	3	1	3	1		
	Gender	M	M	M	M	F	F	M	F	M	M	M	M	M	M	M	F	M	F	M	M	M	M	F		
	Household income	3	NA	NA	4	5	4	NA	NA	5	5	4	NA	5	2	NA	5	4	5	3	4	4	NA	2		
	Education level	MA	MA	MA	MA	MA	MA	PhD	MA	MA	MA	MA	BA	MA	BA	BA	BA	MA	BA	BA	MA	BA	MA	BA		
	#smart appliances	B	B	B	C	B	A	B	A	C	B	A	B	C	A	C	A	B	B	C	A	B	B	A		

Emerged Themes	Sub-themes	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12	N13	N14	N15	N16	N17	N18	N19	N20	N21	N22	N23	Total Votes	% votes
		Non- adopters (total of 23 participants)																								
Performance Expectations	automation			x						x	x							x		x	x			x	7	30%
	interoperability																			x					1	4%
	remote access	x		x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	21	91%
Output Expectations	energy and money					x	x							x			x			x					5	22%
	time and convenience	x	x	x	x	x	x	x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	21	91%
	physical safety				x		x				x			x			x								5	22%
Personal Effort Expectations	installation effort			x				x														x	x	x	5	22%
	maintenance effort						x			x	x			x											4	17%
	use effort	x	x	x			x	x		x				x				x		x		x	x		11	48%
External Influences	policy influence	x		x				x				x	x	x	x	x				x	x			x	11	48%
	social media influence								x								x	x		x		x	x		6	26%
	social network influence	x		x	x					x						x	x				x	x	x	x	10	43%
Internal Influences	ahead of social network																								0	0%
	same or behind social network	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	23	100%
	social responsibillity																								0	0%
Adoption Risks	independence				x		x	x		x		x	x	x					x		x				9	39%
	health risks																					x			1	4%
	privacy and security	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	22	96%
Individual Constraints	financial constraints		x	x	x	x	x	x	x	x	x	x		x			x		x	x		x	x	x	17	74%
	technology constraints	x			x							x		x							x				5	22%
Risk Mitigation	brand selection																								0	0%
	ethical use of data policy									x	x		x	x	x	x				x	x				8	35%
	network access selection			x								x		x		x	x								5	22%
Demographics	Home ownership	O	O	O	O	O	O	O	O	O	O	O	R	O	R	O	R	O	R	R	R	R	O	O		
	# in household	4	5+	3	2	1	1	4	4	2	2	3	1	1	4	4	2	2	1	5	3	1	4	2		
	Age group	4	NA	1	2	1	3	4	4	4	3	4	3	3	2	3	1	NA	1	3	3	4	3	4		
	Gender	F	M	M	F	M	M	M	M	M	F	M	M	M	M	M	F	M	F	M	M	M	M	M		
	Household income	3	NA	3	NA	2	2	4	3	2	1	3	4	NA	NA	5	2	NA	2	5	2	2	3	3		
	Education level	BA	MA	MA	BA	BA	Asc	BA	HS	MA	Asc	MA	MA	MA	HS	MA	MA	MA	MA	MA	MA	HS	BA	BA		
	#smart appliances	A	0	A	0	0	0	0	0	A	0	0	0	A	A	A	0	0	0	A	A	A	0	0		

Appendix D: Descriptive Statistics

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
adoptor	46	0	1	.50	.506
automation	46	0	1	.50	.506
interoperability	46	0	1	.17	.383
remote_access	46	0	1	.89	.315
energyandmoney	46	0	1	.17	.383
timeandconven	46	0	1	.96	.206
physical_safety	46	0	1	.30	.465
installation_effort	46	0	1	.24	.431
maint_effort	46	0	1	.17	.383
use_effort	46	0	1	.26	.444
policy_influence	46	0	1	.59	.498
social_Media_infl	46	0	1	.50	.506
social_net_infl	46	0	1	.54	.504
ahead_soc_net	46	0	1	.33	.474
social_responsib	46	0	1	.13	.341
ceding_autonomy	46	0	1	.50	.506
health_risks	46	0	1	.11	.315
privacy_security	46	0	1	.91	.285
financial_constraint	46	0	1	.74	.444
tech_constraints	46	0	1	.20	.401
brand_selection	46	0	1	.15	.363
ethical_use	46	0	1	.35	.482
network_access	46	0	1	.35	.482
numinhousehold	46	1	6	2.98	1.273
perfexp	46	0	3	1.57	.750
outputexp	46	0	3	1.43	.750
effortexp	46	0	3	.67	.845
externalinflence	46	0	3	1.63	.974
internalinfluence	46	0	2	.46	.657
adoptionrisk	46	0	3	1.52	.658
constraints	46	0	2	.93	.533
riskmitigation	46	0	3	.85	.816

Valid N (listwise)	46				

Appendix E: Sorted Correlations

	Adopter	
Correlated Variable	Pearson correlation	p-value
internalinfluence	.703**	0.0000
ahead_soc_net	.696**	0.0000
use_effort	-.495**	0.0005
social_Media_infl	.478**	0.0008
externalinflence	.474**	0.0009
brand_selection	.424**	0.0033
perfexp	.410**	0.0046
automation	.391**	0.0072
social_responsib	.387**	0.0078
riskmitigation	.350*	0.0170
interoperability	.344*	0.0192
network_access	0.274	0.0655
numinhousehold	0.259	0.0823
policy_influence	0.221	0.1404
social_net_infl	0.218	0.1451
ceding_autonomy	0.217	0.1467
timeandconven	0.213	0.1548
health_risks	0.210	0.1622
adoptionrisk	0.200	0.1817
physical_safety	0.189	0.2085
outputexp	0.117	0.4378
installation_effort	0.051	0.7366
maint_effort	0.000	1.0000
financial_constraint	0.000	1.0000
ethical_use	0.000	1.0000
constraints	-0.041	0.7857
tech_constraints	-0.055	0.7176
remote_access	-0.070	0.6446
energyandmoney	-0.115	0.4478
privacy_security	-0.154	0.3059
effortexp	-0.234	0.1172

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix F: Correlations for selected target and explanatory variables

Correlations

		adoptor	automation	interoperability	remote_access	energyandmoney	timeandconven	physical_safety	installation_effort	maint_effort	use_effort
adoptor	Pearson Correlation	1	.391**	.344*	-0.070	-0.115	0.213	0.189	0.051	0.000	-.495**
	Sig. (2-tailed)		0.007	0.019	0.645	0.448	0.155	0.208	0.737	1.000	0.000
	N	46	46	46	46	46	46	46	46	46	46
automation	Pearson Correlation	.391**	1	0.229	-0.070	-.344*	0.000	-0.094	0.051	0.115	-0.099
	Sig. (2-tailed)	0.007		0.125	0.645	0.019	1.000	0.532	0.737	0.448	0.513
	N	46	46	46	46	46	46	46	46	46	46
interoperability	Pearson Correlation	.344*	0.229	1	-0.024	0.243	0.098	0.070	-0.257	-0.211	-0.142
	Sig. (2-tailed)	0.019	0.125		0.874	0.103	0.518	0.642	0.084	0.160	0.347
	N	46	46	46	46	46	46	46	46	46	46
remote_access	Pearson Correlation	-0.070	-0.070	-0.024	1	-0.024	-0.074	-0.224	0.196	-0.024	-0.111
	Sig. (2-tailed)	0.645	0.645	0.874		0.874	0.623	0.134	0.192	0.874	0.464
	N	46	46	46	46	46	46	46	46	46	46
energyandmoney	Pearson Correlation	-0.115	-.344*	0.243	-0.024	1	0.098	.320*	-0.123	0.092	0.119
	Sig. (2-tailed)	0.448	0.019	0.103	0.874		0.518	0.030	0.416	0.543	0.430
	N	46	46	46	46	46	46	46	46	46	46
timeandconven	Pearson Correlation	0.213	0.000	0.098	-0.074	0.098	1	0.141	0.120	-0.183	-0.116
	Sig. (2-tailed)	0.155	1.000	0.518	0.623	0.518		0.350	0.429	0.222	0.442
	N	46	46	46	46	46	46	46	46	46	46
physical_safety	Pearson Correlation	0.189	-0.094	0.070	-0.224	.320*	0.141	1	-0.260	0.070	-0.178
	Sig. (2-tailed)	0.208	0.532	0.642	0.134	0.030	0.350		0.081	0.642	0.237
	N	46	46	46	46	46	46	46	46	46	46
installation_effort	Pearson Correlation	0.051	0.051	-0.257	0.196	-0.123	0.120	-0.260	1	0.012	0.247
	Sig. (2-tailed)	0.737	0.737	0.084	0.192	0.416	0.429	0.081		0.939	0.098
	N	46	46	46	46	46	46	46	46	46	46
maint_effort	Pearson Correlation	0.000	0.115	-0.211	-0.024	0.092	-0.183	0.070	0.012	1	0.250
	Sig. (2-tailed)	1.000	0.448	0.160	0.874	0.543	0.222	0.642	0.939		0.094
	N	46	46	46	46	46	46	46	46	46	46
use_effort	Pearson Correlation	-.495**	-0.099	-0.142	-0.111	0.119	-0.116	-0.178	0.247	0.250	1
	Sig. (2-tailed)	0.000	0.513	0.347	0.464	0.430	0.442	0.237	0.098	0.094	
	N	46	46	46	46	46	46	46	46	46	46
policy_influence	Pearson Correlation	0.221	0.044	-0.081	-0.009	0.035	0.038	-0.213	0.263	0.035	-0.105
	Sig. (2-tailed)	0.140	0.771	0.592	0.951	0.815	0.804	0.156	0.077	0.815	0.488
	N	46	46	46	46	46	46	46	46	46	46
social_Media_infl	Pearson Correlation	.478**	0.217	.344*	.349*	0.115	0.213	-0.094	0.153	0.000	-0.099
	Sig. (2-tailed)	0.001	0.147	0.019	0.017	0.448	0.155	0.532	0.310	1.000	0.513
	N	46	46	46	46	46	46	46	46	46	46
social_net_infl	Pearson Correlation	0.218	0.044	-0.155	.381**	-0.155	0.019	-0.058	.309*	0.075	-0.052
	Sig. (2-tailed)	0.145	0.773	0.303	0.009	0.303	0.902	0.703	0.037	0.620	0.732
	N	46	46	46	46	46	46	46	46	46	46
ahead_soc_net	Pearson Correlation	.696**	.325*	.537**	-0.055	-0.074	0.148	0.044	-0.173	0.048	-.413**
	Sig. (2-tailed)	0.000	0.028	0.000	0.716	0.623	0.325	0.772	0.252	0.752	0.004
	N	46	46	46	46	46	46	46	46	46	46
social_responsib	Pearson Correlation	.387**	.387**	0.163	-0.072	-0.178	0.083	-0.116	-0.066	-0.007	-0.230
	Sig. (2-tailed)	0.008	0.008	0.279	0.634	0.237	0.585	0.443	0.664	0.961	0.124
	N	46	46	46	46	46	46	46	46	46	46
ceding_autonomy	Pearson Correlation	0.217	0.043	0.000	-0.210	0.000	-0.213	0.094	-0.153	0.229	-0.099
	Sig. (2-tailed)	0.147	0.774	1.000	0.162	1.000	0.155	0.532	0.310	0.125	0.513
	N	46	46	46	46	46	46	46	46	46	46
health_risks	Pearson Correlation	0.210	0.070	0.208	0.122	-0.160	0.074	0.073	-0.032	-0.160	-0.048
	Sig. (2-tailed)	0.162	0.645	0.165	0.419	0.287	0.623	0.632	0.833	0.287	0.749
	N	46	46	46	46	46	46	46	46	46	46
privacy_security	Pearson Correlation	-0.154	0.000	-0.265	-0.108	0.142	-0.066	0.036	0.173	0.142	0.183
	Sig. (2-tailed)	0.306	1.000	0.075	0.476	0.348	0.664	0.810	0.250	0.348	0.223
	N	46	46	46	46	46	46	46	46	46	46
financial_constraint	Pearson Correlation	0.000	-0.099	-0.119	0.111	0.142	0.116	0.070	.333*	0.142	0.127
	Sig. (2-tailed)	1.000	0.513	0.430	0.464	0.347	0.442	0.643	0.024	0.347	0.399
	N	46	46	46	46	46	46	46	46	46	46
tech_constraints	Pearson Correlation	-0.055	-0.055	-0.082	-0.180	0.063	0.105	0.150	-0.276	0.063	-0.043
	Sig. (2-tailed)	0.718	0.718	0.589	0.232	0.678	0.487	0.319	0.063	0.678	0.775
	N	46	46	46	46	46	46	46	46	46	46
brand_selection	Pearson Correlation	.424**	0.182	.923**	-0.046	0.125	0.090	0.114	-0.238	-0.194	-0.252
	Sig. (2-tailed)	0.003	0.227	0.000	0.759	0.408	0.551	0.449	0.112	0.195	0.092
	N	46	46	46	46	46	46	46	46	46	46
ethical_use	Pearson Correlation	0.000	0.091	0.147	-0.185	0.026	-.292*	0.211	-0.195	0.147	-0.122
	Sig. (2-tailed)	1.000	0.546	0.331	0.219	0.863	0.049	0.159	0.193	0.331	0.419
	N	46	46	46	46	46	46	46	46	46	46
network_access	Pearson Correlation	0.274	0.000	0.147	-0.038	0.147	0.156	0.211	0.126	-0.215	-0.226
	Sig. (2-tailed)	0.066	1.000	0.331	0.801	0.331	0.301	0.159	0.406	0.152	0.131
	N	46	46	46	46	46	46	46	46	46	46
numinhousehold	Pearson Correlation	0.259	0.052	.327*	-0.117	-0.129	0.250	-0.026	-0.071	-0.220	0.010
	Sig. (2-tailed)	0.082	0.733	0.027	0.439	0.394	0.094	0.863	0.638	0.142	0.946
	N	46	46	46	46	46	46	46	46	46	46
perfexp	Pearson Correlation	.410**	.762**	.656**	.360*	-0.118	0.019	-0.122	-0.015	-0.040	-0.186
	Sig. (2-tailed)	0.005	0.000	0.000	0.014	0.436	0.902	0.420	0.922	0.790	0.217
	N	46	46	46	46	46	46	46	46	46	46
outputexp	Pearson Correlation	0.117	-0.234	0.195	-0.172	.736**	.412**	.823**	-0.191	0.040	-0.081
	Sig. (2-tailed)	0.438	0.117	0.194	0.253	0.000	0.004	0.000	0.203	0.790	0.591
	N	46	46	46	46	46	46	46	46	46	46
effortexp	Pearson Correlation	-0.234	0.026	-.301*	0.031	0.042	-0.083	-0.194	.646**	.591**	.765**
	Sig. (2-tailed)	0.117	0.864	0.042	0.838	0.783	0.582	0.196	0.000	0.000	0.000
	N	46	46	46	46	46	46	46	46	46	46
externalinfluence	Pearson Correlation	.474**	0.158	0.057	.373*	-0.003	0.139	-0.188	.374*	0.057	-0.132
	Sig. (2-tailed)	0.001	0.295	0.707	0.011	0.986	0.355	0.212	0.011	0.707	0.383
	N	46	46	46	46	46	46	46	46	46	46
internalinfluence	Pearson Correlation	.703**	.435**	.472**	-0.077	-0.146	0.150	-0.028	-0.159	0.031	-.417**
	Sig. (2-tailed)	0.000	0.003	0.001	0.610	0.333	0.320	0.851	0.292	0.839	0.004
	N	46	46	46	46	46	46	46	46	46	46
adoptionrisk	Pearson Correlation	0.200	0.067	-0.015	-0.149	-0.015	-0.157	0.123	-0.058	0.161	-0.020
	Sig. (2-tailed)	0.182	0.659	0.919	0.322	0.919	0.298	0.415	0.702	0.285	0.896
	N	46	46	46	46	46	46	46	46	46	46
constraints	Pearson Correlation	-0.041	-0.124	-0.161	-0.043	0.165	0.176	0.171	0.069	0.165	0.073
	Sig. (2-tailed)	0.786	0.413	0.286	0.776	0.272	0.243	0.255	0.647	0.272	0.628
	N	46	46	46	46	46	46	46	46	46	46
riskmitigation	Pearson Correlation	.350*	0.135	.584**	-0.152	0.158	-0.040	.300*	-0.147	-0.127	-.318*
	Sig. (2-tailed)	0.017	0.372	0.000	0.312	0.295	0.791	0.042	0.330	0.401	0.032
	N	46	46	46	46	46	46	46	46	46	46

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations

		policy_influence	social_Media_infl	social_net_infl	ahead_soc_net	social_responsib	ceding_autonomy	health_risks	privacy_security	financial_constraint	tech_constraints	brand_selection
adoptor	Pearson Correlation	0.221	.478**	0.218	.696**	.387**	0.217	0.210	-0.154	0.000	-0.055	.424**
	Sig. (2-tailed)	0.140	0.001	0.145	0.000	0.008	0.147	0.162	0.306	1.000	0.718	0.003
	N	46	46	46	46	46	46	46	46	46	46	46
automation	Pearson Correlation	0.044	0.217	0.044	.325*	.387**	0.043	0.070	0.000	-0.099	-0.055	0.182
	Sig. (2-tailed)	0.771	0.147	0.773	0.028	0.008	0.774	0.645	1.000	0.513	0.718	0.227
	N	46	46	46	46	46	46	46	46	46	46	46
interoperability	Pearson Correlation	-0.081	.344*	-0.155	.537**	0.163	0.000	0.208	-0.265	-0.119	-0.082	.923**
	Sig. (2-tailed)	0.592	0.019	0.303	0.000	0.279	1.000	0.165	0.075	0.430	0.589	0.000
	N	46	46	46	46	46	46	46	46	46	46	46
remote_access	Pearson Correlation	-0.009	.349*	.381**	-0.055	-0.072	-0.210	0.122	-0.108	0.111	-0.180	-0.046
	Sig. (2-tailed)	0.951	0.017	0.009	0.716	0.634	0.162	0.419	0.476	0.464	0.232	0.759
	N	46	46	46	46	46	46	46	46	46	46	46
energyandmoney	Pearson Correlation	0.035	0.115	-0.155	-0.074	-0.178	0.000	-0.160	0.142	0.142	0.063	0.125
	Sig. (2-tailed)	0.815	0.448	0.303	0.623	0.237	1.000	0.287	0.348	0.347	0.678	0.408
	N	46	46	46	46	46	46	46	46	46	46	46
timeandconven	Pearson Correlation	0.038	0.213	0.019	0.148	0.083	-0.213	0.074	-0.066	0.116	0.105	0.090
	Sig. (2-tailed)	0.804	0.155	0.902	0.325	0.585	0.155	0.623	0.664	0.442	0.487	0.551
	N	46	46	46	46	46	46	46	46	46	46	46
physical_safety	Pearson Correlation	-0.213	-0.094	-0.058	0.044	-0.116	0.094	0.073	0.036	0.070	0.150	0.114
	Sig. (2-tailed)	0.156	0.532	0.703	0.772	0.443	0.532	0.632	0.810	0.643	0.319	0.449
	N	46	46	46	46	46	46	46	46	46	46	46
installation_effort	Pearson Correlation	0.263	0.153	.309*	-0.173	-0.066	-0.153	-0.032	0.173	.333*	-0.276	-0.238
	Sig. (2-tailed)	0.077	0.310	0.037	0.252	0.664	0.310	0.833	0.250	0.024	0.063	0.112
	N	46	46	46	46	46	46	46	46	46	46	46
maint_effort	Pearson Correlation	0.035	0.000	0.075	0.048	-0.007	0.229	-0.160	0.142	0.142	0.063	-0.194
	Sig. (2-tailed)	0.815	1.000	0.620	0.752	0.961	0.125	0.287	0.348	0.347	0.678	0.195
	N	46	46	46	46	46	46	46	46	46	46	46
use_effort	Pearson Correlation	-0.105	-0.099	-0.052	-.413**	-0.230	-0.099	-0.048	0.183	0.127	-0.043	-0.252
	Sig. (2-tailed)	0.488	0.513	0.732	0.004	0.124	0.513	0.749	0.223	0.399	0.775	0.092
	N	46	46	46	46	46	46	46	46	46	46	46
policy_influence	Pearson Correlation	1	-0.044	0.118	0.113	0.194	0.221	-0.274	0.211	-0.096	.302*	-0.136
	Sig. (2-tailed)		0.771	0.437	0.456	0.197	0.140	0.065	0.159	0.525	0.041	0.366
	N	46	46	46	46	46	46	46	46	46	46	46
social_Media_infl	Pearson Correlation	-0.044	1	.306*	.325*	0.258	-0.043	.349*	0.000	0.099	-0.164	.303*
	Sig. (2-tailed)	0.771		0.039	0.028	0.083	0.774	0.017	1.000	0.513	0.275	0.041
	N	46	46	46	46	46	46	46	46	46	46	46
social_net_infl	Pearson Correlation	0.118	.306*	1	-0.014	-0.034	-0.044	0.180	-0.128	0.151	0.122	-0.098
	Sig. (2-tailed)	0.437	0.039		0.926	0.824	0.773	0.232	0.397	0.316	0.419	0.518
	N	46	46	46	46	46	46	46	46	46	46	46
ahead_soc_net	Pearson Correlation	0.113	.325*	-0.014	1	0.281	0.046	0.204	-0.279	-0.009	0.008	.609**
	Sig. (2-tailed)	0.456	0.028	0.926		0.058	0.760	0.174	0.060	0.952	0.960	0.000
	N	46	46	46	46	46	46	46	46	46	46	46
social_responsib	Pearson Correlation	0.194	0.258	-0.034	0.281	1	0.129	-0.135	-0.110	-0.064	0.134	0.195
	Sig. (2-tailed)	0.197	0.083	0.824	0.058		0.393	0.370	0.469	0.673	0.373	0.193
	N	46	46	46	46	46	46	46	46	46	46	46
ceding_autonomy	Pearson Correlation	0.221	-0.043	-0.044	0.046	0.129	1	0.070	0.000	0.000	0.274	0.061
	Sig. (2-tailed)	0.140	0.774	0.773	0.760	0.393		0.645	1.000	1.000	0.065	0.689
	N	46	46	46	46	46	46	46	46	46	46	46
health_risks	Pearson Correlation	-0.274	.349*	0.180	0.204	-0.135	0.070	1	-0.140	0.048	0.004	0.241
	Sig. (2-tailed)	0.065	0.017	0.232	0.174	0.370	0.645		0.353	0.749	0.980	0.107
	N	46	46	46	46	46	46	46	46	46	46	46
privacy_security	Pearson Correlation	0.211	0.000	-0.128	-0.279	-0.110	0.000	-0.140	1	-0.183	0.152	-.299*
	Sig. (2-tailed)	0.159	1.000	0.397	0.060	0.469	1.000	0.353		0.223	0.313	0.044
	N	46	46	46	46	46	46	46	46	46	46	46
financial_constraint	Pearson Correlation	-0.096	0.099	0.151	-0.009	-0.064	0.000	0.048	-0.183	1	-0.206	-0.162
	Sig. (2-tailed)	0.525	0.513	0.316	0.952	0.673	1.000	0.749	0.223		0.169	0.283
	N	46	46	46	46	46	46	46	46	46	46	46
tech_constraints	Pearson Correlation	.302*	-0.164	0.122	0.008	0.134	0.274	0.004	0.152	-0.206	1	-0.056
	Sig. (2-tailed)	0.041	0.275	0.419	0.960	0.373	0.065	0.980	0.313	0.169		0.710
	N	46	46	46	46	46	46	46	46	46	46	46
brand_selection	Pearson Correlation	-0.136	.303*	-0.098	.609**	0.195	0.061	0.241	-.299*	-0.162	-0.056	1
	Sig. (2-tailed)	0.366	0.041	0.518	0.000	0.193	0.689	0.107	0.044	0.283	0.710	
	N	46	46	46	46	46	46	46	46	46	46	46
ethical_use	Pearson Correlation	0.149	-.365*	-0.155	0.076	-0.147	0.000	-0.108	-0.099	-.294*	-0.015	0.072
	Sig. (2-tailed)	0.323	0.013	0.302	0.615	0.329	1.000	0.473	0.514	0.048	0.921	0.635
	N	46	46	46	46	46	46	46	46	46	46	46
network_access	Pearson Correlation	0.149	0.183	0.120	0.076	0.124	0.091	0.185	-0.099	0.122	-0.130	0.199
	Sig. (2-tailed)	0.323	0.225	0.429	0.615	0.413	0.546	0.219	0.514	0.419	0.389	0.185
	N	46	46	46	46	46	46	46	46	46	46	46
numinhousehold	Pearson Correlation	0.161	0.155	-0.016	.343*	0.007	-0.086	0.006	-0.128	-0.050	-0.122	0.248
	Sig. (2-tailed)	0.286	0.303	0.917	0.019	0.965	0.569	0.968	0.397	0.744	0.419	0.097
	N	46	46	46	46	46	46	46	46	46	46	46
perfexp	Pearson Correlation	-0.016	.469**	0.110	.470**	.314*	-0.059	0.205	-0.181	-0.081	-0.154	.575**
	Sig. (2-tailed)	0.918	0.001	0.467	0.001	0.034	0.699	0.172	0.229	0.591	0.306	0.000
	N	46	46	46	46	46	46	46	46	46	46	46
outputexp	Pearson Correlation	-0.104	0.059	-0.110	0.030	-0.140	0.000	-0.016	0.077	0.148	0.154	0.160
	Sig. (2-tailed)	0.494	0.699	0.467	0.844	0.353	1.000	0.914	0.612	0.326	0.306	0.289
	N	46	46	46	46	46	46	46	46	46	46	46
effortexp	Pearson Correlation	0.095	0.026	0.165	-0.284	-0.158	-0.026	-0.114	0.249	.301*	-0.135	-.342*
	Sig. (2-tailed)	0.528	0.864	0.274	0.056	0.295	0.864	0.449	0.095	0.042	0.369	0.020
	N	46	46	46	46	46	46	46	46	46	46	46
externalinfluence	Pearson Correlation	.549**	.654**	.735**	0.219	0.216	0.068	0.134	0.042	0.080	0.132	0.037
	Sig. (2-tailed)	0.000	0.000	0.000	0.144	0.150	0.655	0.375	0.783	0.595	0.381	0.808
	N	46	46	46	46	46	46	46	46	46	46	46
internalinfluence	Pearson Correlation	0.182	.368*	-0.028	.867**	.721**	0.100	0.077	-0.258	-0.040	0.075	.541**
	Sig. (2-tailed)	0.227	0.012	0.855	0.000	0.000	0.507	0.610	0.083	0.793	0.619	0.000
	N	46	46	46	46	46	46	46	46	46	46	46
adoptionrisk	Pearson Correlation	0.130	0.134	-0.003	0.012	-0.013	.802**	.471**	.366*	-0.056	0.278	0.032
	Sig. (2-tailed)	0.390	0.376	0.985	0.935	0.932	0.000	0.001	0.012	0.710	0.061	0.831
	N	46	46	46	46	46	46	46	46	46	46	46
constraints	Pearson Correlation	0.147	-0.041	0.218	-0.002	0.048	0.206	0.043	-0.038	.677**	.580**	-0.177
	Sig. (2-tailed)	0.328	0.786	0.146	0.990	0.752	0.170	0.776	0.801	0.000	0.000	0.239
	N	46	46	46	46	46	46	46	46	46	46	46
riskmitigation	Pearson Correlation	0.115	0.027	-0.065	.361*	0.073	0.081	0.152	-0.249	-0.173	-0.111	.605**
	Sig. (2-tailed)	0.445	0.859	0.669	0.014	0.629	0.593	0.312	0.094	0.249	0.464	0.000
	N	46	46	46	46	46	46	46	46	46	46	46

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations

		ethical_use	network_access	numinhousehold	perfexp	outputexp	effortexp	externalinfluence	internalinfluence	adoptionrisk	constraints	riskmitigation
adoptor	Pearson Correlation	0.000	0.274	0.259	.410**	0.117	-0.234	.474**	.703**	0.200	-0.041	.350*
	Sig. (2-tailed)	1.000	0.066	0.082	0.005	0.438	0.117	0.001	0.000	0.182	0.786	0.017
	N	46	46	46	46	46	46	46	46	46	46	46
automation	Pearson Correlation	0.091	0.000	0.052	.762**	-0.234	0.026	0.158	.435**	0.067	-0.124	0.135
	Sig. (2-tailed)	0.546	1.000	0.733	0.000	0.117	0.864	0.295	0.003	0.659	0.413	0.372
	N	46	46	46	46	46	46	46	46	46	46	46
interoperability	Pearson Correlation	0.147	0.147	.327*	.656**	0.195	-.301*	0.057	.472**	-0.015	-0.161	.584**
	Sig. (2-tailed)	0.331	0.331	0.027	0.000	0.194	0.042	0.707	0.001	0.919	0.286	0.000
	N	46	46	46	46	46	46	46	46	46	46	46
remote_access	Pearson Correlation	-0.185	-0.038	-0.117	.360*	-0.172	0.031	.373*	-0.077	-0.149	-0.043	-0.152
	Sig. (2-tailed)	0.219	0.801	0.439	0.014	0.253	0.838	0.011	0.610	0.322	0.776	0.312
	N	46	46	46	46	46	46	46	46	46	46	46
energyand money	Pearson Correlation	0.026	0.147	-0.129	-0.118	.736**	0.042	-0.003	-0.146	-0.015	0.165	0.158
	Sig. (2-tailed)	0.863	0.331	0.394	0.436	0.000	0.783	0.986	0.333	0.919	0.272	0.295
	N	46	46	46	46	46	46	46	46	46	46	46
timeandconven	Pearson Correlation	-.292*	0.156	0.250	0.019	.412**	-0.083	0.139	0.150	-0.157	0.176	-0.040
	Sig. (2-tailed)	0.049	0.301	0.094	0.902	0.004	0.582	0.355	0.320	0.298	0.243	0.791
	N	46	46	46	46	46	46	46	46	46	46	46
physical_safety	Pearson Correlation	0.211	0.211	-0.026	-0.122	.823**	-0.194	-0.188	-0.028	0.123	0.171	.300*
	Sig. (2-tailed)	0.159	0.159	0.863	0.420	0.000	0.196	0.212	0.851	0.415	0.255	0.042
	N	46	46	46	46	46	46	46	46	46	46	46
installation_effort	Pearson Correlation	-0.195	0.126	-0.071	-0.015	-0.191	.646**	.374*	-0.159	-0.058	0.069	-0.147
	Sig. (2-tailed)	0.193	0.406	0.638	0.922	0.203	0.000	0.011	0.292	0.702	0.647	0.330
	N	46	46	46	46	46	46	46	46	46	46	46
maint_effort	Pearson Correlation	0.147	-0.215	-0.220	-0.040	0.040	.591**	0.057	0.031	0.161	0.165	-0.127
	Sig. (2-tailed)	0.331	0.152	0.142	0.790	0.790	0.000	0.707	0.839	0.285	0.272	0.401
	N	46	46	46	46	46	46	46	46	46	46	46
use_effort	Pearson Correlation	-0.122	-0.226	0.010	-0.186	-0.081	.765**	-0.132	-.417**	-0.020	0.073	-.318*
	Sig. (2-tailed)	0.419	0.131	0.946	0.217	0.591	0.000	0.383	0.004	0.896	0.628	0.032
	N	46	46	46	46	46	46	46	46	46	46	46
policy_influence	Pearson Correlation	0.149	0.149	0.161	-0.016	-0.104	0.095	.549**	0.182	0.130	0.147	0.115
	Sig. (2-tailed)	0.323	0.323	0.286	0.918	0.494	0.528	0.000	0.227	0.390	0.328	0.445
	N	46	46	46	46	46	46	46	46	46	46	46
social_Media_infl	Pearson Correlation	-.365*	0.183	0.155	.469**	0.059	0.026	.654**	.368*	0.134	-0.041	0.027
	Sig. (2-tailed)	0.013	0.225	0.303	0.001	0.699	0.864	0.000	0.012	0.376	0.786	0.859
	N	46	46	46	46	46	46	46	46	46	46	46
social_net_infl	Pearson Correlation	-0.155	0.120	-0.016	0.110	-0.110	0.165	.735**	-0.028	-0.003	0.218	-0.065
	Sig. (2-tailed)	0.302	0.429	0.917	0.467	0.467	0.274	0.000	0.855	0.985	0.146	0.669
	N	46	46	46	46	46	46	46	46	46	46	46
ahead_soc_net	Pearson Correlation	0.076	0.076	.343*	.470**	0.030	-0.284	0.219	.867**	0.012	-0.002	.361*
	Sig. (2-tailed)	0.615	0.615	0.019	0.001	0.844	0.056	0.144	0.000	0.935	0.990	0.014
	N	46	46	46	46	46	46	46	46	46	46	46
social_responsib	Pearson Correlation	-0.147	0.124	0.007	.314*	-0.140	-0.158	0.216	.721**	-0.013	0.048	0.073
	Sig. (2-tailed)	0.329	0.413	0.965	0.034	0.353	0.295	0.150	0.000	0.932	0.752	0.629
	N	46	46	46	46	46	46	46	46	46	46	46
ceding_autonomy	Pearson Correlation	0.000	0.091	-0.086	-0.059	0.000	-0.026	0.068	0.100	.802**	0.206	0.081
	Sig. (2-tailed)	1.000	0.546	0.569	0.699	1.000	0.864	0.655	0.507	0.000	0.170	0.593
	N	46	46	46	46	46	46	46	46	46	46	46
health_risks	Pearson Correlation	-0.108	0.185	0.006	0.205	-0.016	-0.114	0.134	0.077	.471**	0.043	0.152
	Sig. (2-tailed)	0.473	0.219	0.968	0.172	0.914	0.449	0.375	0.610	0.001	0.776	0.312
	N	46	46	46	46	46	46	46	46	46	46	46
privacy_security	Pearson Correlation	-0.099	-0.099	-0.128	-0.181	0.077	0.249	0.042	-0.258	.366*	-0.038	-0.249
	Sig. (2-tailed)	0.514	0.514	0.397	0.229	0.612	0.095	0.783	0.083	0.012	0.801	0.094
	N	46	46	46	46	46	46	46	46	46	46	46
financial_constraint	Pearson Correlation	-.294*	0.122	-0.050	-0.081	0.148	.301*	0.080	-0.040	-0.056	.677**	-0.173
	Sig. (2-tailed)	0.048	0.419	0.744	0.591	0.326	0.042	0.595	0.793	0.710	0.000	0.249
	N	46	46	46	46	46	46	46	46	46	46	46
tech_constraints	Pearson Correlation	-0.015	-0.130	-0.122	-0.154	0.154	-0.135	0.132	0.075	0.278	.580**	-0.111
	Sig. (2-tailed)	0.921	0.389	0.419	0.306	0.306	0.369	0.381	0.619	0.061	0.000	0.464
	N	46	46	46	46	46	46	46	46	46	46	46
brand_selection	Pearson Correlation	0.072	0.199	0.248	.575**	0.160	-.342*	0.037	.541**	0.032	-0.177	.605**
	Sig. (2-tailed)	0.635	0.185	0.097	0.000	0.289	0.020	0.808	0.000	0.831	0.239	0.000
	N	46	46	46	46	46	46	46	46	46	46	46
ethical_use	Pearson Correlation	1	-0.054	0.194	0.059	0.064	-0.097	-0.194	-0.021	-0.095	-0.256	.590**
	Sig. (2-tailed)		0.721	0.197	0.698	0.672	0.520	0.197	0.888	0.532	0.086	0.000
	N	46	46	46	46	46	46	46	46	46	46	46
network_access	Pearson Correlation	-0.054	1	0.121	0.059	0.249	-0.152	0.233	0.119	0.116	0.004	.647**
	Sig. (2-tailed)	0.721		0.422	0.698	0.095	0.313	0.120	0.430	0.443	0.980	0.000
	N	46	46	46	46	46	46	46	46	46	46	46
numinhousehold	Pearson Correlation	0.194	0.121	1	0.153	-0.013	-0.131	0.155	0.251	-0.119	-0.133	.296*
	Sig. (2-tailed)	0.197	0.422		0.311	0.931	0.387	0.305	0.092	0.432	0.378	0.046
	N	46	46	46	46	46	46	46	46	46	46	46
perfexp	Pearson Correlation	0.059	0.059	0.153	1	-0.131	-0.124	.292*	.502**	-0.025	-0.184	.325*
	Sig. (2-tailed)	0.698	0.698	0.311		0.387	0.413	0.049	0.000	0.867	0.222	0.027
	N	46	46	46	46	46	46	46	46	46	46	46
outputexp	Pearson Correlation	0.064	0.249	-0.013	-0.131	1	-0.122	-0.079	-0.051	0.025	0.239	0.256
	Sig. (2-tailed)	0.672	0.095	0.931	0.387		0.419	0.600	0.736	0.867	0.109	0.086
	N	46	46	46	46	46	46	46	46	46	46	46
effortexp	Pearson Correlation	-0.097	-0.152	-0.131	-0.124	-0.122	1	0.147	-0.286	0.033	0.149	-.299*
	Sig. (2-tailed)	0.520	0.313	0.387	0.413	0.419		0.329	0.054	0.827	0.323	0.043
	N	46	46	46	46	46	46	46	46	46	46	46
externalinfluence	Pearson Correlation	-0.194	0.233	0.155	.292*	-0.079	0.147	1	0.270	0.134	0.166	0.040
	Sig. (2-tailed)	0.197	0.120	0.305	0.049	0.600	0.329		0.070	0.374	0.269	0.794
	N	46	46	46	46	46	46	46	46	46	46	46
internalinfluence	Pearson Correlation	-0.021	0.119	0.251	.502**	-0.051	-0.286	0.270	1	0.002	0.023	.298*
	Sig. (2-tailed)	0.888	0.430	0.092	0.000	0.736	0.054	0.070		0.988	0.877	0.044
	N	46	46	46	46	46	46	46	46	46	46	46
adoptionrisk	Pearson Correlation	-0.095	0.116	-0.119	-0.025	0.025	0.033	0.134	0.002	1	0.162	0.027
	Sig. (2-tailed)	0.532	0.443	0.432	0.867	0.867	0.827	0.374	0.988		0.281	0.859
	N	46	46	46	46	46	46	46	46	46	46	46
constraints	Pearson Correlation	-0.256	0.004	-0.133	-0.184	0.239	0.149	0.166	0.023	0.162	1	-0.228
	Sig. (2-tailed)	0.086	0.980	0.378	0.222	0.109	0.323	0.269	0.877	0.281		0.128
	N	46	46	46	46	46	46	46	46	46	46	46
riskmitigation	Pearson Correlation	.590**	.647**	.296*	.325*	0.256	-.299*	0.040	.298*	0.027	-0.228	1
	Sig. (2-tailed)	0.000	0.000	0.046	0.027	0.086	0.043	0.794	0.044	0.859	0.128	
	N	46	46	46	46	46	46	46	46	46	46	46

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Appendix G: Cross Tabulations and Chi-Square Statistics

SPSS output below show the results of cross-tabulations between factors and adopters and the related Chi-square statistics.

Performance expectancy and adoption (Proposition #1)

perfexp * adoptioncat Crosstabulation

		adoptioncat						Total	
		boughtandquit		buysanduses		nonbuyer			
		N	%	N	%	N	%	N	%
perfexp	0	1	11.1%	0	0.0%	1	7.1%	2	4.3%
	1	4	44.4%	7	30.4%	10	71.4%	21	45.7%
	2	3	33.3%	12	52.2%	3	21.4%	18	39.1%
	3	1	11.1%	4	17.4%	0	0.0%	5	10.9%
Total		9	100.0%	23	100.0%	14	100.0%	46	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	10.026[a]	6	.124	.117
Likelihood Ratio	12.065	6	.061	.080
Fisher-Freeman-Halton Exact Test	10.004			.068
N of Valid Cases	46			

a. 8 cells (66.7%) have expected count less than 5. The minimum expected count is .39.

Case 1: No grouping

perfexp * adoptioncat Crosstabulation

		adoptioncat						Total	
		boughtandquit		buysanduses		nonbuyer			
		N	%	N	%	N	%	N	%
perfexp	Low Expectation	5	55.6%	7	30.4%	11	78.6%	23	50.0%
	High Expectation	4	44.4%	16	69.6%	3	21.4%	23	50.0%
Total		9	100.0%	23	100.0%	14	100.0%	46	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	8.204[a]	2	.017	.012
Likelihood Ratio	8.589	2	.014	.015
Fisher-Freeman-Halton Exact Test	8.146			.012
N of Valid Cases	46			

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 4.50.

Case 2: Grouping Performance Expectancy (perfexp) into Low and High Expectations

perfexp * adoptioncat Crosstabulation

		adoptioncat				Total	
		non-adopter		adopter			
		N	%	N	%	N	%
perfexp	Low Expectation	16	69.6%	7	30.4%	23	50.0%
	High Expectation	7	30.4%	16	69.6%	23	50.0%
Total		23	100.0%	23	100.0%	46	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	7.043[a]	1	.008	.017	.009	
Continuity Correction[b]	5.565	1	.018			
Likelihood Ratio	7.235	1	.007	.017	.009	
Fisher's Exact Test				.017	.009	
Linear-by-Linear Association	6.890[c]	1	.009	.017	.009	.007
N of Valid Cases	46					

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 11.50.

b. Computed only for a 2x2 table

c. The standardized statistic is 2.625.

Case 3: Grouping participants into adopters and non-adopters

<u>Output expectancy and adoption (Proposition #2)</u>

outputexp * adoptioncat Crosstabulation

		adoptioncat						Total	
		buysanduses		boughtandquit		nonbuyer			
		N	%	N	%	N	%	N	%
outputexp	0	0	0.0%	1	11.1%	1	7.1%	2	4.3%
	1	13	56.5%	6	66.7%	8	57.1%	27	58.7%
	2	8	34.8%	1	11.1%	3	21.4%	12	26.1%
	3	2	8.7%	1	11.1%	2	14.3%	5	10.9%
Total		23	100.0%	9	100.0%	14	100.0%	46	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	4.128[a]	6	.659	.709		
Likelihood Ratio	4.947	6	.551	.715		
Fisher-Freeman-Halton Exact Test	4.698			.591		
Linear-by-Linear Association	.220[b]	1	.639	.660	.365	.080
N of Valid Cases	46					

a. 8 cells (66.7%) have expected count less than 5. The minimum expected count is .39.

b. The standardized statistic is -.469.

Case 1: No grouping

outputexp * adoptioncat Crosstabulation

		adoptioncat						Total	
		buysanduses		boughtandquit		nonbuyer			
		N	%	N	%	N	%	N	%
outputexp	Low Expectation	13	56.5%	7	77.8%	9	64.3%	29	63.0%
	High Expectation	10	43.5%	2	22.2%	5	35.7%	17	37.0%
Total		23	100.0%	9	100.0%	14	100.0%	46	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	1.268[a]	2	.531	.563		
Likelihood Ratio	1.326	2	.515	.563		
Fisher-Freeman-Halton Exact Test	1.205			.563		
Linear-by-Linear Association	.334[b]	1	.563	.609	.345	.117
N of Valid Cases	46					

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 3.33.

b. The standardized statistic is -.578.

Case 2: Grouping Outcome Expectancy (outputexp) into Low and High Output Expectations

outputexp * adoptioncat Crosstabulation

		adoptioncat				Total	
		non-adopter		adopter			
		N	%	N	%	N	%
outputexp	Low Expectation	16	69.6%	13	56.5%	29	63.0%
	High Expectation	7	30.4%	10	43.5%	17	37.0%
Total		23	100.0%	23	100.0%	46	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	.840[a]	1	.359	.542	.271	
Continuity Correction[b]	.373	1	.541			
Likelihood Ratio	.843	1	.359	.542	.271	
Fisher's Exact Test				.542	.271	
Linear-by-Linear Association	.822[c]	1	.365	.542	.271	.160
N of Valid Cases	46					

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.50.

b. Computed only for a 2x2 table

c. The standardized statistic is .906.

Case 3: Grouping participants into adopters and non-adopters

<u>Effort expectancy and adoption (Proposition #3)</u>

effortexp * adoptioncat Crosstabulation

		adoptioncat						Total	
		buysanduses		boughtandquit		nonbuyer			
		N	%	N	%	N	%	N	%
effortexp	.00	15	65.2%	3	33.3%	7	50.0%	25	54.3%
	1.00	6	26.1%	2	22.2%	4	28.6%	12	26.1%
	2.00	1	4.3%	4	44.4%	3	21.4%	8	17.4%
	3.00	1	4.3%	0	0.0%	0	0.0%	1	2.2%
Total		23	100.0%	9	100.0%	14	100.0%	46	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	8.533[a]	6	.202	.187		
Likelihood Ratio	8.828	6	.183	.222		
Fisher-Freeman-Halton Exact Test	8.394			.156		
Linear-by-Linear Association	1.020[b]	1	.312	.324	.183	.047
N of Valid Cases	46					

a. 9 cells (75.0%) have expected count less than 5. The minimum expected count is .20.

b. The standardized statistic is 1.010.

Case1: No grouping

effortexp * adoptioncat Crosstabulation

		adoptioncat						Total	
		buysanduses		boughtandquit		nonbuyer			
		N	%	N	%	N	%	N	%
effortexp	0	21	91.3%	5	55.6%	11	78.6%	37	80.4%
	1	2	8.7%	4	44.4%	3	21.4%	9	19.6%
Total		23	100.0%	9	100.0%	14	100.0%	46	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	5.297[a]	2	.071	.055		
Likelihood Ratio	4.973	2	.083	.107		
Fisher-Freeman-Halton Exact Test	4.986			.071		
Linear-by-Linear Association	1.345[b]	1	.246	.297	.172	.085
N of Valid Cases	46					

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is 1.76.

b. The standardized statistic is 1.160.

Case 2: Grouping Effort Expectancy (efforttexp) into Low and High Output Expectations

effortexp * adoptioncat Crosstabulation

		adoptioncat				Total	
		non-adopter		adopter			
		N	%	N	%	N	%
effortexp	0	16	69.6%	21	91.3%	37	80.4%
	1	7	30.4%	2	8.7%	9	19.6%
Total		23	100.0%	23	100.0%	46	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	3.453[a]	1	.063	.135	.067	
Continuity Correction[b]	2.210	1	.137			
Likelihood Ratio	3.620	1	.057	.135	.067	
Fisher's Exact Test				.135	.067	
Linear-by-Linear Association	3.378[c]	1	.066	.135	.067	.056
N of Valid Cases	46					

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 4.50.

b. Computed only for a 2x2 table

c. The standardized statistic is -1.838.

Case 3: Grouping participants into adopters and non-adopters

Policy expectancy and adoption (Proposition #4)

policy_influence * adoptioncat Crosstabulation

		adoptioncat							
		buysanduses		boughtandquit		nonbuyer		Total	
		N	%	N	%	N	%	N	%
policy_influence	0	7	30.4%	2	22.2%	10	71.4%	19	41.3%
	1	16	69.6%	7	77.8%	4	28.6%	27	58.7%
Total		23	100.0%	9	100.0%	14	100.0%	46	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	7.713[a]	2	.021	.020		
Likelihood Ratio	7.818	2	.020	.020		
Fisher-Freeman-Halton Exact Test	7.322			.026		
Linear-by-Linear Association	5.167[b]	1	.023	.027	.017	.010
N of Valid Cases	46					

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 3.72.

b. The standardized statistic is -2.273.

Social media influence and adoption (Proposition #5)

social_Media_infl * adoptioncat Crosstabulation

		adoptioncat							
		buysanduses		boughtandquit		nonbuyer		Total	
		N	%	N	%	N	%	N	%
social_Media_infl	0	6	26.1%	7	77.8%	10	71.4%	23	50.0%
	1	17	73.9%	2	22.2%	4	28.6%	23	50.0%
Total		23	100.0%	9	100.0%	14	100.0%	46	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	10.610[a]	2	.005	.006		
Likelihood Ratio	11.081	2	.004	.008		
Fisher-Freeman-Halton Exact Test	10.403			.006		
Linear-by-Linear Association	8.023[b]	1	.005	.007	.003	.002
N of Valid Cases	46					

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 4.50.

b. The standardized statistic is -2.832.

Social network influence and adoption (Proposition #6)

social_net_infl * adoptioncat Crosstabulation

		adoptioncat						Total	
		buysanduses		boughtandquit		nonbuyer			
		N	%	N	%	N	%	N	%
social_net_infl	0	8	34.8%	3	33.3%	10	71.4%	21	45.7%
	1	15	65.2%	6	66.7%	4	28.6%	25	54.3%
Total		23	100.0%	9	100.0%	14	100.0%	46	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	5.395[a]	2	.067	.080		
Likelihood Ratio	5.492	2	.064	.086		
Fisher-Freeman-Halton Exact Test	5.222			.080		
Linear-by-Linear Association	4.175[b]	1	.041	.045	.030	.017
N of Valid Cases	46					

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 4.11.

b. The standardized statistic is -2.043.

<u>Social responsibility influence and adoption (Proposition #7)</u>

social_responsib * adoptioncat Crosstabulation

		adoptioncat						Total	
		buysanduses		boughtandquit		nonbuyer			
		N	%	N	%	N	%	N	%
social_responsib	0	17	73.9%	9	100.0%	14	100.0%	40	87.0%
	1	6	26.1%	0	0.0%	0	0.0%	6	13.0%
Total		23	100.0%	9	100.0%	14	100.0%	46	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	6.900[a]	2	.032	.035		
Likelihood Ratio	9.221	2	.010	.025		
Fisher-Freeman-Halton Exact Test	5.595			.035		
Linear-by-Linear Association	5.701[b]	1	.017	.022	.011	.011
N of Valid Cases	46					

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is 1.17.

b. The standardized statistic is -2.388.

<u>Innovativeness inflence and adoption (Proposition #8)</u>

ahead_soc_net * adoptioncat Crosstabulation

		adoptioncat						Total	
		buysanduses		boughtandquit		nonbuyer			
		N	%	N	%	N	%	N	%
ahead_soc_net	0	8	34.8%	9	100.0%	14	100.0%	31	67.4%
	1	15	65.2%	0	0.0%	0	0.0%	15	32.6%
Total		23	100.0%	9	100.0%	14	100.0%	46	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	22.258[a]	2	<.001	<.001		
Likelihood Ratio	28.366	2	<.001	<.001		
Fisher-Freeman-Halton Exact Test	22.928			<.001		
Linear-by-Linear Association	18.389[b]	1	<.001	<.001	<.001	.000
N of Valid Cases	46					

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 2.93.

b. The standardized statistic is -4.288.

Privacy and security risks and adoption (Proposition #9)

privacy_security * adoptioncat Crosstabulation

		adoptioncat						Total	
		buysanduses		boughtandquit		nonbuyer			
		N	%	N	%	N	%	N	%
privacy_security	0	3	13.0%	0	0.0%	1	7.1%	4	8.7%
	1	20	87.0%	9	100.0%	13	92.9%	42	91.3%
Total		23	100.0%	9	100.0%	14	100.0%	46	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	1.447[a]	2	.485	.548		
Likelihood Ratio	2.164	2	.339	.548		
Fisher-Freeman-Halton Exact Test	1.016			.805		
Linear-by-Linear Association	.518[b]	1	.472	.580	.360	.208
N of Valid Cases	46					

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is .78.

b. The standardized statistic is .720.

Ceding autonomy and adoption (Proposition #10)

ceding_autonomy * adoptioncat Crosstabulation

		adoptioncat						Total	
		buysanduses		boughtandquit		nonbuyer			
		N	%	N	%	N	%	N	%
ceding_autonomy	0	9	39.1%	6	66.7%	8	57.1%	23	50.0%
	1	14	60.9%	3	33.3%	6	42.9%	23	50.0%
Total		23	100.0%	9	100.0%	14	100.0%	46	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	2.373[a]	2	.305	.290		
Likelihood Ratio	2.402	2	.301	.290		
Fisher-Freeman-Halton Exact Test	2.329			.340		
Linear-by-Linear Association	1.360[b]	1	.243	.318	.159	.068
N of Valid Cases	46					

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 4.50.

b. The standardized statistic is -1.166.

<u>Financial and technology constraints and adoption (Proposition #11)</u>

constraints * adoptioncat Crosstabulation

		adoptioncat							
		buysanduses		boughtandquit		nonbuyer		Total	
		N	%	N	%	N	%	N	%
constraints	0	4	17.4%	2	22.2%	2	14.3%	8	17.4%
	1	17	73.9%	6	66.7%	10	71.4%	33	71.7%
	2	2	8.7%	1	11.1%	2	14.3%	5	10.9%
Total		23	100.0%	9	100.0%	14	100.0%	46	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability
Pearson Chi-Square	.497[a]	4	.974	1.000		
Likelihood Ratio	.486	4	.975	1.000		
Fisher-Freeman-Halton Exact Test	1.055			.963		
Linear-by-Linear Association	.199[b]	1	.655	.756	.388	.113
N of Valid Cases	46					

a. 6 cells (66.7%) have expected count less than 5. The minimum expected count is .98.

b. The standardized statistic is .446.

Appendix H: Recruitment and follow-up emails

Below is the recruitment message that will be sent in email format to potential participants.

Hi ________,

My name is Prakash Shahi. I am a doctoral student at the University of Missouri - St. Louis. I am working on dissertation research to explore the factors determining consumers' adoption of smart-home appliances. For this research, any connected appliance that can be controlled remotely through a smartphone or a central controller, such as Amazon Echo or a home energy management system, qualifies as a smart-home appliance. Following are examples of appliances available as smart appliances in the market: clothes washers and dryers, coffee makers, dishwashers, door locks, light bulbs, oven and microwaves, refrigerators, robotic vacuums, security cameras, televisions, and thermostats.

I am interested in both adopters and non-adopters of smart-home appliances. Would you be interested in participating in this study? Your participation includes a one hour recorded interview using Zoom.

If you are interested, I will schedule an interview with you in the next few weeks. Before that, I will send you a follow-up email with the consent form that explains the research and your participation. Please send me an email with your interest and include the answers to the following questions:

1. *Do you have smart-home appliances in your household? If yes, how many? [1-5, 6-10, 11 or more]*
2. *Do you routinely use your smart-home appliances?*

3. *Were you involved in the decision to purchase these smart-home appliances?*

A $20 gift card will be provided to qualified participants after the interviews are completed. I look forward to hearing from you. Please feel free to email me or contact me at 314 440 7619 with any questions or concerns.

Best regards,

Prakash Shahi

After receiving a positive confirmation from the potential participant, the following email with the consent form and survey questions will be sent.

Hi ____________,

Thank you for agreeing to participate in my study. Please see the attached consent form I mentioned in my earlier email. Please note that the consent form gives information about the research study and your role in the study.

I have also listed below several one-hour time slots in the next two weeks. Would you please check your calendar and pick the three most convenient time slots? I will schedule a Zoom meeting during one of your available times.

Best regards,

Prakash Shahi

Appendix I: Semi-structured Interview Questions and Demographic Questionnaire

1. *What would you consider to be the main features that distinguish smart-home appliances from traditional appliances?*
2. *What would you consider to be the main benefits from smart-home appliances?*
3. *What features would you look for in your smart-home appliances?*
4. *What benefits would you expect from your smart-home appliances?*
5. *What would you expect the effort to be in installing smart-home appliances?*
6. *What would you expect the effort to be in using smart-home appliances?*
7. *What would you expect the effort to be in upgrading smart-home appliances?*
8. *How does government regulation affect your perception of smart-home appliances?*
9. *How does government regulation affect your decision to use smart-home appliances?*
10. *How do social media, including customer reviews, affect your perception of smart-home appliances?*
11. *How do social media, including customer reviews, affect your decision to use smart-home appliances?*
12. *How does your social network's (friends, families, co-workers, and acquaintances) experiences with smart-home appliances affect your perception of smart-home appliances?*
13. *How does your social network's (friends, families, co-workers, and acquaintances) experiences with smart-home appliances affect your decision to use smart-home appliances?*

14. *What are the environmental impacts of using smart-home appliances?*
15. *What are the social impacts of using smart-home appliances?*
16. *Are you ahead or behind your friends, families, co-workers, and acquaintances in the adoption of smart-home appliances?*
17. *Do you consider yourself an early adopter of smart-home appliances?*
18. *What are the main risks to you and your family from using smart-home appliances?*
19. *What features and characteristics of smart-home appliance discourage you from using them?*
20. *What concerns of privacy and security do you have about using smart-home appliances?*
21. *Are you concerned about possibly ceding autonomy and independence when/if you use smart-home appliances?*
22. *How does cost affect your decision to purchase smart-home appliances?*
23. *What do you think is the cost of keeping your smart-home appliance up to date?*

Demographic Questions

1. *Do you own or rent your home? The choices are yes, no, or prefer not to say.*
2. *How many people live in your home? The choices are 1, 2, 3, 4, more than 4, or prefer not to say.*
3. *What is your age? The choices are 18-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75 over, or prefer not to say.*
4. *What gender do you identify with? The choices are male, female, non-binary, or prefer not to say.*

5. *What is your household income? Choices in USD are less than 50000, 50001 to 100000, 100001 to 150000, 150001 to 200000, 200001 and higher, or prefer not to say.*
6. *What is your occupation?*
7. *What is your education level?*

Appendix J: Informed Consent

Informed Consent Form for Participation in Research Activities

Factors influencing the adoption of smart-home appliances: Users' perspectives

College of Business Administration

UMSL

8001 Natural Bridge Road
St. Louis, Missouri 63121-4499
Telephone: 314-516-5888
E-mail: pbsv92@mail.umsl.edu

Participant:_________________________________ HSC Approval Number ___________

Principal Investigator: Prakash Shahi P.I.'s Phone Number: (314) 440-7619

Summary of the Study

This project is for research purposes only and participation is voluntary. The purpose of this research is to explore the factors influencing consumers' adoption decisions by examining their perceptions, experiences, and expectations of smart-home appliances. We will achieve this by interviewing both adopters and non-adopters of smart-home appliances. A smart-home appliance is any connected appliance that can be controlled remotely through a smartphone or a central controller, such as Amazon Echo or a home energy management system. Following are examples of smart appliances currently available in the market: clothes washers and dryers, coffee makers, dishwashers, door locks, light bulbs, oven and microwaves, refrigerators, robotic vacuums, security cameras, televisions, and thermostats.

As part of this study, I will interview up to 60 participants. The interviews will be conducted and video-recorded via Zoom. They will also be transcribed. This study will use pseudonyms to summarize and discuss the responses to protect your identity. We do not anticipate any risks or discomfort to the participants; however, there is a slight risk of loss of confidentiality.

This research is expected to be beneficial to both the academia and practitioners involved in the adoption of smart-home appliances.

There are no direct benefits to participants.

1. You are invited to participate in a research study conducted by Prakash Shahi, a doctoral student at the University of Missouri-St. Louis and Dr. Joseph Rottman, a Professor of Information Systems at the University of Missouri-St. Louis. The purpose of this research is to explore the factors determining consumers' adoption decisions by examining their perceptions, experiences, and expectations of smart-home appliances.

2. Your participation will involve an interview with the Principal Investigator, Prakash Shahi. The interview will last approximately 60 minutes and will be conducted remotely via Zoom. The interview will be audio and video recorded and the audio will be transcribed. You will receive a $20 gift card when the interview is completed.

Informed Consent Form for Participation in Research Activities

Factors influencing the adoption of smart-home appliances: Users' perspectives

3. During the interview there is a minimal risk of boredom and fatigue from being interviewed. You can stop the interview at any time if you should experience boredom or fatigue. There is also a slight risk of loss of confidentiality, and we are taking the following steps to minimize this risk:
    - Names of the participants will be replaced with pseudonyms.
    - The audio and video files will be stored in a password-protected cloud storage location.
    - The recordings will be destroyed as soon as they are no longer needed, which is expected to be as soon as the dissertation has been completed.

4. There are no direct benefits for you participating in this study.

5. Your participation is voluntary, and you may choose not to participate in this research study or withdraw your consent at any time.

6. We will do everything we can to protect your privacy. As part of this effort, your identity will not be revealed in any publication that may result from this study. In rare instances, a researcher's study must undergo an audit or program evaluation by an oversight agency (such as the Office for Human Research Protection) that would lead to disclosure of your data as well as any other information collected by the researcher.

7. If you have any questions or concerns regarding this study, or if any problems arise, you may call the Principal Investigator, Prakash Shahi, at (314) 440-7619 or the Faculty Advisor, Dr. Joseph Rottman, at (314) 368-7370. You may also ask questions or state concerns regarding your rights as a research participant to the Office of Research, at (314) 516-5899.

I have read this consent form and have been given the opportunity to ask questions. I have been given a copy of this consent form for my records. I hereby consent to my participation in the research described above.

Appendix K: IRB Approval Letter

UMSL | Research
University of Missouri–St. Louis

February 09, 2022

Principal Investigator: Prakash Shahi (UMSL-Student)
Department: Business DBA

Your IRB Application to project entitled Factors influencing the adoption of smart-home appliances: Users' perspectives was reviewed and approved by the UMSL Institutional Review Board according to the terms and conditions described below:

IRB Project Number	2080182
IRB Review Number	354739
Funding Source	University of Missouri-St. Louis
Initial Application Approval Date	February 09, 2022
IRB Expiration Date	February 09, 2023
Level of Review	Exempt
Project Status	Active - Exempt
Exempt Categories (Revised Common Rule)	45 CFR 46.104d(2)(iii) with limited IRB review
Risk Level	Minimal Risk
Internal Funding	Departmental Funding
Approved Documents	Consent Form This document describes how the interview will be conducted and how long they will last. Interviews will be exploratory using semi-structured questions as outlined in the document. This email script will be sent to make first contact with possible participants. This email script will be sent as a follow up to the participants that agree and qualify for the research.

The principal investigator (PI) is responsible for all aspects and conduct of this study. The PI must comply with the following conditions of the approval:

1. Enrollment and study related procedures must remain in compliance with the University of Missouri regulations related to interaction with human participants following guidance at http://www.umsl.edu/recd/compliance/umsl-guidance-covid19-policy-7.2021.pdf.
2. No subjects may be involved in any study procedure prior to the IRB approval date or after the expiration date.

3. All changes must be IRB approved prior to implementation utilizing the Exempt Amendment Form.
4. The Annual Exempt Form must be submitted to the IRB for review and approval at least 30 days prior to the project expiration date to keep the study active or to close it.
5. Maintain all research records for a period of seven years from the project completion date.

If you are offering subject payments and would like more information about research participant payments, please click here to view the UM Policy: https://www.umsystem.edu/ums/policies/finance/payments_to_research_study_participants

If you have any questions or concerns, please contact the UMSL IRB Office at 314-516-5972 or email to irb@umsl.edu.

Thank you,
UMSL Institutional Review Board

Appendix L: Non-recorded Interview Script

First, I want to thank you again for being willing to participate in my research and for taking the time to meet with me today.

As I have mentioned to you before, this interview is an essential part of my research to explore how the unique characteristics of smart-home appliances affect your adoption decision. This research aims to find the factors and their effects in determining the adoption of smart-home appliances. This research is part of my dissertation toward a Doctorate in Business Administration at the University of Missouri – St. Louis.

Our interview today will last approximately one hour. During the interview, I will be asking you exploratory questions to understand your knowledge, perceptions, and expectations of smart-home appliances and your experiences with them.

As the informed consent form showed, I will be using Zoom to record this interview which will be transcribed. All collected data will be used for my research purposes only. The only other person that will have access to the data will be Dr. Joseph Rottman, the Chair of my Doctoral Dissertation Committee.

Please feel free to opt out of answering any of the questions or the interview at any time. Also, you can ask me to turn off the recorder as well. Do you understand the nature of your participation, and do you agree to participate?

[If no, kindly thank the participant and end the interview]

Thank you!

Before we begin our recorded interview, do you have any questions for me?

[Address any questions from interviewee]

Please feel free to ask any questions that may arise during the interview. I will now turn on the recording service in Zoom.

[Turn on the recorder in Zoom]