Adoption of Socio-Cultural Aspects in PSS Design for Smart Home Products: An Integrative Review

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Abstract

Background Smart homes are becoming an increasingly integral part of our daily lives. Smart homes consist of domestic Internet of Things (IoT) products that are connected to a communication network and provide various functions and services to their consumers with the purpose of improvement of their quality of life. However previous research suggests there is very limited user-centric research published in this domain. One of the main factors for the success of smart homes is the acceptance and adoption of technology by new users. This report presents a literature review conducted with the aim of exploring smart homes, their characteristics, advantages, and challenges perceived by the consumer. This paper investigates various factors influencing the acceptance and adoption of new technologies by consumers and how the design of smart homes can be integrated with a product-service system (PSS), considering socio-cultural aspects.

Methods The study is an integrative review of papers from major journals in design, consumer research, management, and marketing on the topic of smart home IoT products from 2000 to 2020 relevant articles were shortlisted and analyzed considering the purpose, method, and main findings of the studies.

Results The four major categories that emerged through the analysis of the shortlisted articles are as follows: 1. The Terminology used in smart home and IoT products, 2. Consumer behavior and its relationship with the other factors such as benefits, barriers, and socio-cultural aspects in smart homes, 3. New technology acceptance, and 4. Product service system (PSS) design in smart homes.

Conclusions A multi-faceted evaluation of articles of the first two categories proposes a new theoretical framework investigating consumer behavior related to smart homes and IoT product adoption. The framework is described illustrating key terms and associations between them with future directions on smart home IoT products. It is expected that design practitioners and researchers would find the developed framework helpful while designing IoT products.

Keywords Smart Home, Smart Product, Consumer Adoption, New Technology Acceptance, Integrative Review

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1. Introduction

The term ‘smart’ has become a buzzword for innovative products and revolutionary business models. Smart home products and services have seen tremendous growth in the past decade. Globally, there have been a lot of new innovative products that have entered the market (Khedekar et al., 2017). One of the most important qualities and usage of smart products is the potential to understand the consumer’s environment and their behavior in a particular situation and respond accordingly (Chan et al., 2008; Balta-Ozkan et al., 2014). In the long term, there are many benefits to using smart home technologies for its users to live a comfortable and healthy lifestyle. Marikyan (2019) highlights that these products and services help increase the quality of life, especially for the elderly, and in sectors such as healthcare, security, and entertainment. Due to the benefits of smart homes and their impact on everyday life, it has seen great market penetration globally. A major driver for user adoption has been science fiction movies that have shown us the possibilities of integrating smart technologies in our household. We have seen in the last decade a lot of innovative household products in the market where smart technology has an important direction to work on. However, studies in this field have seen a marked lack of user-centric research (Marikyan et al., 2019; Kim et al., 2019a). The focus of majority research in the field of smart homes has focused on the technology involved. Hence, there is a need for the user’s perspective in designing smart home technologies, in the acceptance and adoption of new technologies by users (Chen et al., 2017; Bhati et al., 2017; Hong et al., 2016; Chiang & Wang et al., 2016; Kim et al., 2019a).

In smart homes, digital and physical services are integrated into household products which involve an exchange of information and communication networks (Balta-Ozkan et al., 2014). When tangible products and intangible services come together in an interactive way to provide a consumer's real needs, it is perceived as a product-service system (PSS). PSS integrates smart home technology, service, and communication networks around the different stakeholders. It is also important to explore different stakeholders involved and their roles (Sakao, T. et al, 2009). The development of product-service systems is continuously improving its perspective from including only consumers to including all the various stakeholders involved in the communication network (Sojung Kim et al., 2019). Generally, a smart home product’s smartness is studied through technical aspects which ultimately results in a gap with what consumers really want from smart home products and services like highly customized and empowering experiences. This shift in focus of research, from technology to users and stakeholders will allow researchers to better understand the user and design products to satisfy their needs and reach a wider user base for their products and services.

2. Method

This study is an integrative review, defined as one in which the published research studies are critically analyzed and synthesized into a significant contribution to new knowledge about the theme under study. The development of an integrative review includes six steps: the selection of research questions, defining the criteria for literature screening, defining categories or themes that emerged from the existing research articles, analysis, and synthesis, logical and conceptual reasoning, implications for future research (Snyder, 2019).

The questions that this research tries to answer are:

- What are the fundamental terminologies in smart home IoT products?
- Which are the factors affecting consumer adoption of smart home IoT products?

A systematic search was conducted using online databases: Google Scholar, Scopus, and Web of Sciences. The keywords used for this purpose were "Smart home product", "IoT product", "Consumer adoption", "Cultural aspect in smart home" and "PSS in smart home" with limitations to studies conducted in design, consumer research, management, marketing, psychology, cognitive science, philosophy, and technology.

The inclusion criteria were: (a) Works written in English language only in the timeframe of 2000 to 2020, (b) the presence of the search term in keywords or title, (c) full-text availability, (d) original and relevant articles in the IoT products and smart home adoption.

Furthermore, additional papers from reference lists of the articles reviewed were also identified. The initial search resulted in the identification of 825 articles. After the application of inclusion and exclusion criteria, 143 articles remained for our review. A systematic approach of indexing and categorising research articles were done. Notes were taken and extracted in a tabular format for future references and thematic coding process. Next, coding or thematic extraction process were carried out by the help of two-three external research scholars including my doctoral supervisor to derive various themes from the notes extracted earlier and categorise them. Coding process were done in two phases: open coding phase and axial coding phase. Open code and axial code were generated as key themes and factors which influenced the acceptance of smart home products and services innovation and implementation by the users. Through the assessment of selected articles and thematic analysis, four main categories emerged, which are represented in Figure 1. The critical analysis of identified literature was conducted phase-wise based on the first two categories. The majority of authors tended to generate theoretical/conceptual papers. Other types of publications included 9 review papers, 32 papers adopting a survey method, 15 case study papers, 2 papers adopting an experimental approach, 10 based on interviews, and only one based on ethnographic study (Fig. 2).

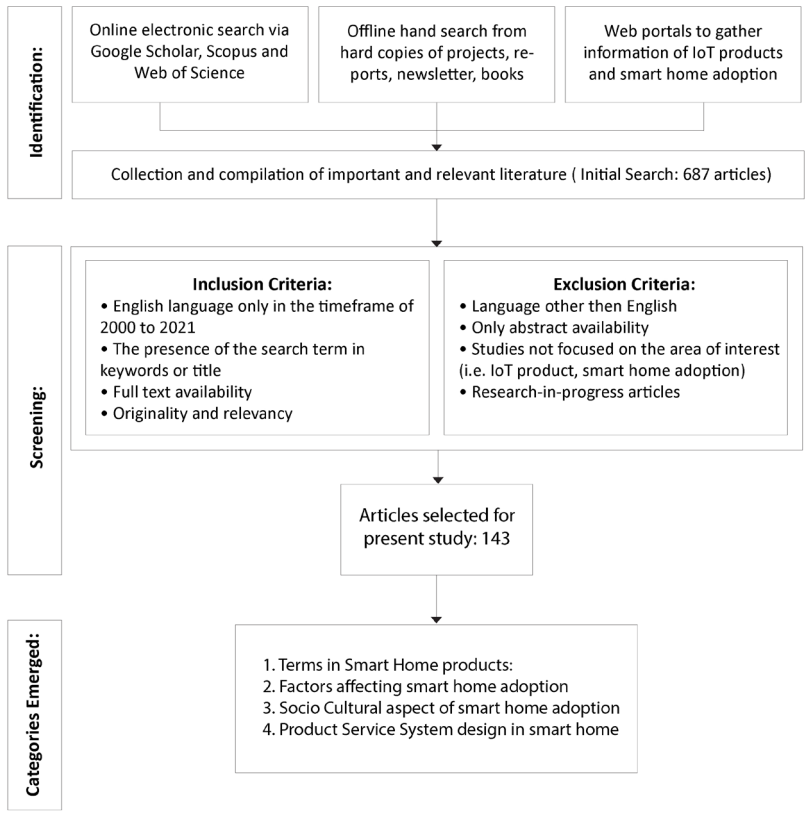

Figure 1 Process and method of research

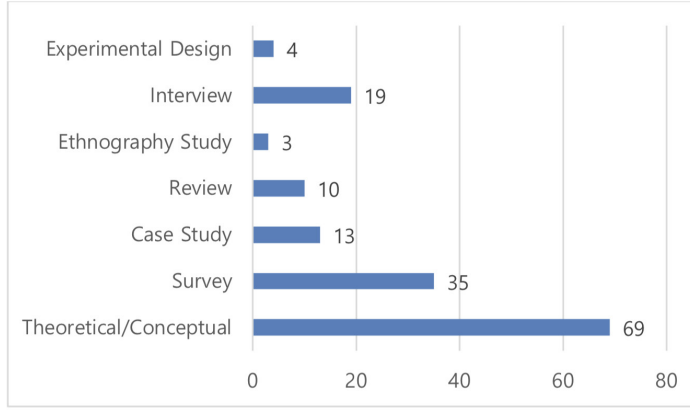

Figure 2 Research methods utilised by the reviewed articles

The concept map shown in Figure 3 is the visual representation of the categories and sub-categories of the current research topic, created to enhance the understanding and explain the structure of the paper.

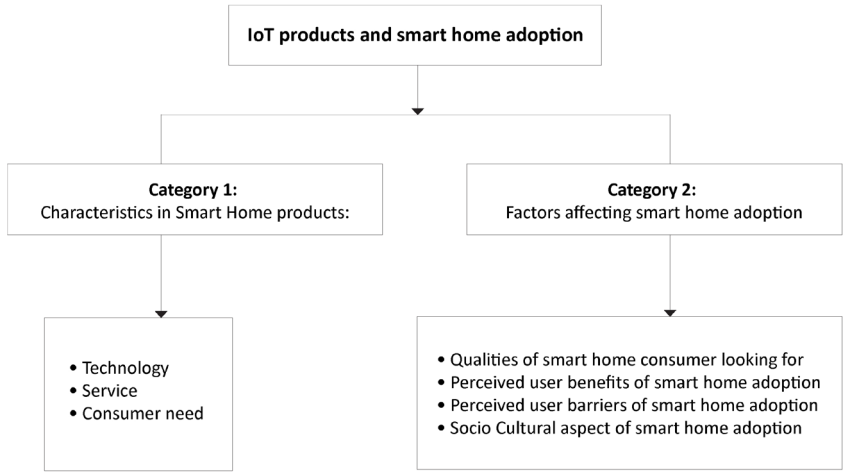

Figure 3 Concept Map of the critical analysis

3. Analysis of literature

3. 1. Smart Home and IoT Products:

Smart homes comprise primarily of domestic appliances and products, which form a communication network, using different technologies, devices, and sensors. This network can be remotely accessed, monitored and controlled, and provides us with different services that satisfy the various needs of the user (Marikyan et al., 2019; Kim et al., 2019a).

In the 1990s, smart homes were mainly used for home automation. The network was built using broadband internet. The 2000s saw the advent of smartphones and applications. This caused smart homes to move towards home networks, whose main function was to control and monitor devices. In the 2010s, smart homes have incorporated Internet of Things (IoT) and Artificial Intelligence (AI) technologies. The main application of smart homes has shifted to context awareness, which arises the need for user-centric research (Yang et al., 2018).

Over the years, researchers have defined smart homes, and their characteristics in three distinct perspectives as shown in Table 1, which are 'products', 'services', 'consumer's needs' (Marikyan et al., 2019).

- Technology: Products, Sensors, Devices
- Service: Control, Monitor, Energy management, Support and assistance, Anticipation and response
- Consumer need: Cost efficiency, Comfort, Emotional support, Security, Health, Quality of life, Sustainability

While perusing the literature, we came to know that many researchers have identified various characteristics, that define smart homes in their particular directions (Marikyan et al., 2019). Some of these researchers have attempted to study smart homes from a technological perspective. These studies mainly focus on the sensors and communication networks that

form the various smart products and devices, that are comprised in a smart home (Aldrich, 2003; Lutolf, 1992; De Silva et al., 2012; Reinisch et al., 2011; Scott, 2007; Balta-Ozkan et al., 2014; Diegel et al., 2005; Alam et al., 2012).

Many researchers have also studied smart homes from the perspective of the services they provide. Smart home products and technologies are used for a variety of activities and purposes, which are of value to the user. These services may include control and monitoring of remote systems, energy management systems, which use smart technologies to optimize energy consumption (Aldrich, 2003; Lutolf, 1992; De Silva et al., 2012; Reinisch et al., 2011; Scott, 2007; Balta-Ozkan et al., 2014; Diegel et al., 2005; Alam et al., 2012; Chan et al., 2008). Smart homes also provide support and assistance for healthcare and telecare (Alam et al., 2012; Chan et al., 2008). Recent literature also discusses context awareness, which allows smart home systems to anticipate and respond to a user's needs and requirements (Aldrich, 2003). •

Table 1 Chracteristics of Smart Home Products

S. No.	Characteristics	Themes	Sources	No.
1	Product	· Technology · Sensors · Devices	Aldrich, 2003; Lutolf, 1992; De Silva et al., 2012; Reinisch et al., 2011; Scott, 2007; Balta–Ozkan et al., 2014; Diegel et al., 2005;	8
2	Service	· Control · Monitor ·Energy management · Support and assistance · Anticipation and response	Aldrich, 2003; Lutolf, 1992; De Silve et al., 2012; Reinisch et al., 2011; Scott, 2007; Balta–Ozkan et al., 2014; Diegel et al., 2005; Alam et al., 2012; Chan et al., 2008; Alam et al. 2012; Chan et al., 2008; Aldrich, 2003	12
3	Consumer need	· Cost efficiency · Comfort · Emotional support · Security · Health · Quality of life · Sustainability	Balta–Ozkan et al., 2013a; Kerbler, 2013; Kim & Shcherbakova, 2011; Hu et al., 2003; Yang et al., 2017; Mani & Chouk, 2017; Ram & Sheth 1989; Alam et al., 2011; Kleinberger et al., 2007; Sun et al., 2010; Fuchsberger, 2008; Stringer et al., 2006; Keith Edwards & Grinter, 2001; Hu et al., 2011; Wu & Fu, 2012; Meng & Lee, 2006	

A lot of studies also discuss smart homes from the perspective of the consumer's needs and their requirements. Researchers have observed that users gain benefits in certain directions. The use of smart homes has contributed to cost benefits for the users, which has led to increased comfort in their lives (Lutolf, 1992; Reinisch et al., 2011; Scott, 2007; Chan et al., 2008). Users also seek healthcare and emotional support through telecare services (Aldrich, 2003; Reinisch et al., 2011; Alam et al., 2012; Chan et al., 2008). Smart home services also include security, which helps users remotely monitor and control security devices (Aldrich, 2003; Lutolf, 1992). Some literature also discusses the sustainability of smart homes, which is important for having minimal impact on the environment with sustained use (Reinisch et al., 2011; Scott, 2007). All the researchers have discussed the importance of the effect smart homes have on the quality of life of their users. An increase in the quality of life is one of the major characteristics towards acceptance and adoption of smart homes (Aldrich, 2003; Lutolf, 1992; De Silva et al., 2012; Reinisch et al., 2011; Scott, 2007; Balta-Ozkan et al., 2014; Diegel et al., 2005; Alam et al., 2012; Chan et al., 2008).

3. 2. Factors affecting consumer adoption of smart home products:

3. 2. 1. Fundamental IoT product design element:

The literature discusses qualities that define a product as smart like (Rijsdijk et al., 2009): 'independent', 'adaptive', 'multi-functional', 'ability to cooperate', 'humanlike interaction', 'personality'. All the qualities express various design elements of smart home products, and hence it becomes necessary to define each of them.

It is important for a smart home product to be independent and function as an individual unit to understand and complete / implement its intended task without any assistance from the user. In addition, smart home products also need to adapt to their surroundings and to various use cases. The surrounding of a smart home product includes various stimuli and other smart home products. A product needs to react to these stimuli and to the functions of the other products in its vicinity (Bradshaw, 1997). Products that satisfy more than one user objective are called multifunctional. These products provide multiple uses and use cases to the user. The ability of smart products to cooperate with other smart products and complete shared objectives is also termed as multi-functional (Poole et al., 1997). Humanlike interactions involve smart products responding to the users, in a manner similar to how the user interacts with other human beings. This humanlike user experience helps make smart products more emotionally atttached to the user (Bauer et al., 1995). It is also important for smart products to appear credible and safe, and create a personality of trustworthiness with the user (Bradshaw, 1997).

In previous studies various qualities, that a consumer looks for in a smart home product. These qualities are categorized as 'within the product', 'related to the usage of the product' and 'related to other products'. These qualities are crucial as they will affect consumer behavior, on the decision to adopt smart home products.

Quality of smart home product consumer looking for:

- Within product: Context awareness, Interpretation, Proactive, Self-description
- Usage: Personalisation, User friendly interaction
- With other products: Communication, Cooperation, Openness, Collaboration

When consumers tend to adopt any smart home product, they look for certain qualities within a product (Fig. 4). These include context awareness and interpretation which enable smart products to respond to various situations and responses (Mühlhäuser, M., 2007). Proactiveness, where a smart product anticipates the requirements of a user and aims to satisfy them before the need arises (Maass, W., 2007). Products should also be self-descriptive and self-explanatory, where a user should seamlessly understand its purpose and function (Ahram et al., 2011). Consumers also seek qualities related to the usage of smart home products. Qualities such as personalization where the service provided is customized to a user's specific needs and user-friendly interactions enable users to extract maximum use and potential from these products (Miche et al., 2009). Qualities related to the interaction of smart home products with other smart home products that consumers look for include ease of communication of data between two products and how they cooperate with each other to perform functions, which satisfy common goals (Gutiérrez et al., 2013). How open a system is

in terms of compatibility with other systems and the ability to seamlessly collaborate affect consumer behavior towards the adoption of smart homes products (Sojung Kim et al., 2019).

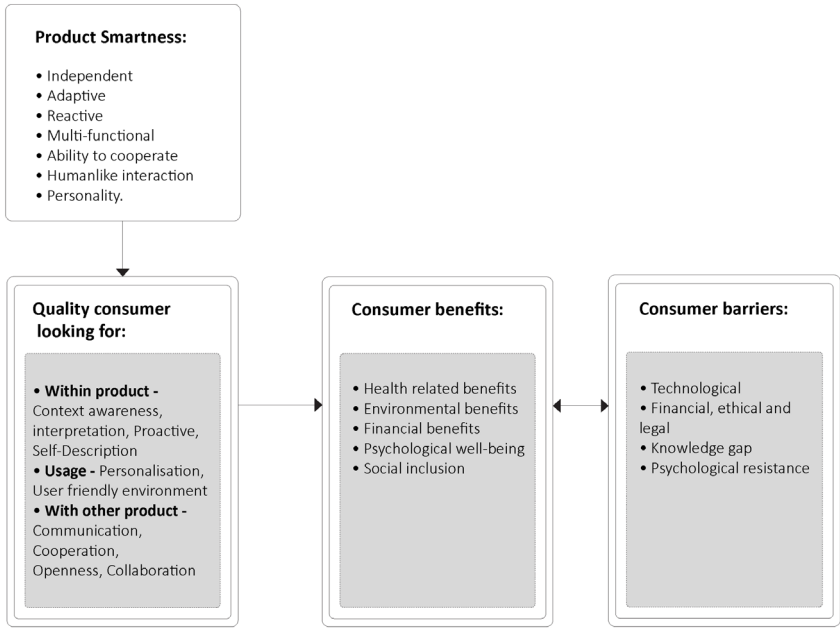

Figure 4 Fundamental smart home product design elements affecting consumer new technology acceptance

3. 2. 2. Consumer benefits of smart home adoption:

Various advantages of smart home products that we have observed from the literature include health-related advantages. This includes care for the elderly, telecare, health monitoring, and fitness. This has promoted a healthy lifestyle amongst consumers and earned the trust of consumers, especially in critical or life-threatening situations. There are also environmental benefits of smart home products. Smart products using AI technologies help optimize power consumption and limit carbon emissions. This promotes sustainable living and a sense of responsibility towards the environment. Smart homes also provide monetary gains to consumers, in the form of savings on bills due to optimization of resource consumption. Lastly, there is mental well-being. Smart products provide connectivity, online interactions, and leisure activities that help cope with feelings of isolation. These factors affect consumer behavior in a positive manner and promote smart home acceptance and adoption. The consumer benefits of smart home adoption are summarized in Table 2.

Table 2 Consumer Benefits of Smart Home Adoption

S. No.	Consumer benefits	Themes	Sources	No.
1	Health related benefits	· Promoting well-being of ageing and vulnerable people. · Care accessiblity and comfort · Monitoring user's safety · Consultancy for social connectivity and communication · Supporting detection of life-threatening events · Therapy for reduction of medical errors	Chan et al., 2008; Demiris et al., 2008; Demiris & Hensel, 2009; Reeder et al., 2013; Courtney et al., 2008; Rantz et al., 2005; Demiris et al., 2004; Finkelstein et al., 2004; Chan et al., 2009; Czaja, 2016; Mynatt et al., 2004; Celler et al., 2003; Finch et al., 2008; Walsh & Callan, 2011; Cavicchi & Vagnoni, 2017; Rahimpour et al., 2008; Matlabi et al., 2012; Kerbler, 2013;	18
2	Environmental benefits	· Environmental sustainability · Monitoring and reducing energy usage · Consultancy and feedback on energy and resource consumption · Suggestions on how to use electricity efficiently and comfortably.	Balta-Ozkan et al., 2014; Chen et al., 2017; Elkhorchani & Grayaa, 2016; Zhou et al., 2016; Beaudin & Zareipour, 2015; Kyriakopoulos & Arabatzis, 2016; Kiesling, 2016; Aye & Fujiwara, 2014; El-hawary, 2014; Balta-Ozkan et al., 2013a; Paetz et al., 2011; Paetz et al., 2012	12
3	Financial benefits	· Affordability of health care · Sustainable consumption · Cheaper consultancy and monitoring cost of virtual visits	Balta-Ozkan et al., 2013a; Darby & McKenna, 2012; Hargreaves et al., 2013; Paetz et al., 2012; Faruqui et al., 2010; Balta-Ozkan et al., 2014; Paetz et al., 2011; Park et al., 2018; Park et al., 2018; Steele et al., 2009; Ehrenhard et al., 2014; Kun, 2001	12
4	Psychological well-being and social inclusion	· Overcome the feeling of isolation · Support · Entertainment · Virtual interaction	Chan et al., 2008; Percival & Hanson, 2006; Demiris et al., 2004; Brandt et al., 2011; Damodaran & Olphert, 2010; Gaul & Ziefle, 2009; Kim et al., 2013; Balta-Ozkan et al., 2013a; Balta-Ozkan et al., 2013b; Khedekar et al., 2017	10

3. 2. 3. Consumer barriers of smart home adoption:

On the other hand, various researchers discuses challenges towards smart home acceptance and adoption, which influence consumer behavior negatively. These include technological barriers, which consists of security and privacy issues, where a user feels that their private data is not secured. This makes consumers feel that smart home systems are not reliable. Another dimension of challenges includes usability issues, where users find smart home products complex and challenging to use. The overhead costs of using smart home products are also a deterrent for consumers. The initial investment, installation, and running cost of maintenance and repair might make smart home products not be economically viable for consumers. According to the researchers, the most influencing challenge in using smart home products is a lack of proficiency and psychological resistance. This causes people to resist the adoption of new technologies, mainly due to a lack of knowledge and exposure to such technologies. The consumer barriers of smart home adoption are summarized in Table 3.

Table 3 Consumer Barrier to Smart Home Adoption

S. No.	Consumer barriers	Themes	Sources	No.
1	Technological barriers	· Security · Usability · Privacy intrusion · Reliability	Balta-Ozkan et al., 2013a; Park et al., 2018; Yang et al., 2017; Alsulami & Atkins, 2016; Czaja, 2016; Diegel, 2005; Kim & Shcherbakova, 2011	7
2	Financial, ethical and legal barriers	· Price · Cost of installation · Cost of repair and maintenance · Concern about misuse of private data	Balta-Ozkan et al., 2013a; Steele et al., 2009; Chan et al., 2012; Chan et al., 2008; Wells, 2003; Chan et al., 2009; Jacobsson et al., 2016; Friedewald et al., 2005; Kotz et al., 2009; Sundström et al., 2002; Coughlan et al., 2013; Hanson et al., 2007; Paetz et al., 2011; Yang et al., 2017; Wilson et al., 2017; Theoharidou et al., 2016; Paetz et al., 2012; Chung et al., 2016; Zwijsen et al., 2011; Courtney, 2008; Lorenzen-Huber et al., 2011; Chan & Perrig, 2003; Chiang & Wang, 2016; Anderson, 2007; Harkke et al., 2003; Balta-Ozkan et al., 2014	26
3	Knowledge gap and psychological resistance	· Human barrier · Resistance to using innovative technology · Lack of prior knowledge and/or experience	Balta-Ozkan et al., 2013a; Kerbler, 2013; Kim & Shcherbakova, 2011; Hu et al., 2003; Yang et al., 2017; Mani & Chouk, 2017; Ram & Sheth 1989; Alam et al., 2011; Kleinberger et al., 2007; Sun et al., 2010; Fuchsberger, 2008; Stringer et al., 2006; Keith Edwards & Grinter, 2001; Hu et al., 2011; Wu & Fu, 2012; Meng & Lee, 2006;	16

3. 2. 4. Socio-cultural aspect in smart home adoption:

In our systematic study of literature, although there is limited study on how individual cultures affect the adoption of new technologies, there is not a lot of prior research on the differences in culture between user demographics and how these differences affect user adoptions. As seen in the case of the USA and Japan, the primary factor affecting a user's smart home acceptance is trust, in the fact that these products and services will complete their intended goals and tasks. A user's satisfaction and trust increase when they connect with the product emotionally. Users begin to have moral concerns as they start using a product or service with an emotional attachment (Dylan et al., 2021). For example, in Japan, owners of robots start to get emotionally attached to them and are left with a void when these robots reach the end of their life cycle. There have been cases of users conducting funerals for their defunct robots (James, 2018). While studying literature, we discovered researchers shedding light on how local social practices, beliefs, behavioral routines, and socio-technical expressions affect new technology adoption (B Lee et al., 2017). Studies on the link between usage of smart home products and culture show that there is a risk of cultural values and behaviors being compromised. Hence, researchers argue that for the growth and development of smart home products it is essential to be empathetic towards a user's culture, their experiences, and expectations. It is also observed that a user's adoption of smart homes is affected by their respective country's socio-economic status (Dylan et al., 2021).

By studying how cultures of different countries affect user behavior, researchers have observed various perceptions of smart homes by users of different demographics (Demiris et al., 2008; LN Lee et al., 2020). Literature elaborates how consumers in the USA and Japan both mainly bought smart homes to assist the elderly population, whereas in the UAE smart

homes are mainly used to connect with friends and families. Meanwhile, in the UK and UAE, smart homes are perceived with social standing, which is not the case with the USA and Japan (Dylan et al., 2021; Gram-Hanssen et al., 2004; Foye et al., 2018; Sovacool et al., 2018; Aljomaa et al., 2016; Tsetsi et al., 2017). Using smart products to make homes more resilient is an important factor in Japan due to the frequent occurrence of natural disasters in the country, however, this is not a key factor in other countries such as the USA and UK (Ton et al., 2015; Dylan et al., 2021). UAE and USA have a comparatively young user base, who are very technologically enthusiastic. These users actively seek to use the latest and best technology available in the market (Van, 2020; Galperin, 2017; Dylan et al., 2021).

In the way difference in culture affects the applications and uses of smart home products, it also leads to cultural barriers to the adoption of smart homes (Fig. 4). In order for smart homes to function, they collect a lot of data regarding the usage patterns and behaviors of their users. There is a potential for such private data to be misused (Sovacool et al., 2021). For example, in the UAE, homes are perceived as sacred places. Their users are skeptical about sharing their private data as they feel it is an invasion of their private space. In comparison, users in Asia are more willing to share their private data in exchange for good service (Dylan et al., 2021). The level of effort and skill required to use a smart home product can be perceived as a barrier. Consumers who are not technically proficient may find it hard to use a smart product to its full potential. The majority of younger users will be able to use smart products with greater ease, as they are more exposed to technology compared to elderly users (Dylan et al., 2021). The incompatibility of smart products with its user's lifestyles is another cultural barrier. The functionality of a smart product may not be harmonious with the needs and gaps in a user's lifestyle. For example, smart home products that automate certain tasks, may not be desirable by elderly people, who wish to perform these tasks manually on their own (Dylan et al., 2021). Also, consumers may not want to relinquish control and become dependent on smart home products (Sovacool et al., 2021). Service providers seek to limit consumers to their proprietary ecosystems, which are not compatible with products and services offered by other providers. The willingness of service providers to work together will encourage greater development in home automation (Wilson et al., 2017). Religious practices and gender roles may also hinder the adoption of smart homes (West et al., 2019). For example, cultures in the middle east which require their women to hide their faces in public, may not be comfortable with the presence of cameras on smart devices inside their homes (Dylan et al., 2021). Language challenges are also a cultural barrier. Certain services do not support a wide variety of languages, which leads to certain user groups not being able to use their services and products. The naming of products and services may also cause a gap in users of different cultures connecting with the service or product. Certain functions and features can get lost in translation, which will result in users not appreciating the function of these technologies (Koenecke et al., 2020; Carrie et al., 2021; Lopez-Lloreda, 2020; Buolamwini et al., 2018, Dylan et al., 2021).

3. 2. 5 Scope of PSS in smart home adoption:

A product-service system (PSS) is a mix of tangible products, intangible services, and the various stakeholders involved. These components combine in a complex communication network to fulfill a consumer's needs. The way smart home products are currently developed,

from a technological perspective rather than a user-centric or stakeholder approach, makes it difficult to approach them from a PSS perspective. Currently, it is tough to develop a service, around the product-oriented solutions of problems a consumer faces in their living space. It is important to explore the potential of smart home products and services to enhance the advantages of designing smart homes with a PSS approach. The various qualities of smart homes and how they are integrated with a PSS have to be studied, in order to create a link between the two.

While exploring the qualities of smart home products and the advantages of a PSS, we discovered two directions of the "smartness" of smart home products. The first direction is smartness to create custom user experiences. The ability of smart home products and services to collect, process and respond to data from its surroundings is important for a customized user experience, personalized to each user's particular need and requirements. The second direction is the ability of smart home products to communicate and collaborate with one another. Smart home products require communicating their data with other smart home products in their surroundings, to satisfy common goals and provide an enhanced and integrated user experience. Exploring these two directions enabled researchers to integrate the development of smart homes with PSS (Kim et al., 2019).

Consumers expect highly customized and empowering experiences from smart home products. To this end, there is a need to integrate the development of smart home products with PSS. From the literature studied, designers and developers have realized there is a shift in focus required, from technology to consumers, and more importantly, the various stakeholders involved to increase the advantages of a PSS approach (Kim et al., 2019; Watanabe et al., 2020). Smart homes are an umbrella, consisting of various smaller and individual products and services that communicate and function in tandem. As we know, the home is a very private space for its occupant, and it is essential to be sensitive to a user's needs and not invade their privacy (Kim et al., 2019). For this, it is important to build a relationship with the user, in order for them to better connect with the product required and to receive feedback from the user. This will enable service providers to better optimize their offerings and develop flexible solutions. A PSS approach will enable designers to take into account all these factors and design better and personalized solutions that empower their users.

4. Result

Despite numerous advantages observed in various studies, there is very limited user centric study pertaining to smart products and services. A lot of researchers have highlighted this shortcoming in research published so far and the need for it. Prominent research articles published so far in the domain primarily discuss only the technological aspects of smart homes. The research gaps and future research directions were summarised by Marikyan et al. (2019) which we have outlined in Table 4, where researchers suggest the need for adopting a user-centric approach by understanding user perception of smart home technology and

change in demographics and geography for focusing on smart home technology benefits for users while keeping in mind the ageing population. A limited number of articles that we studied which incorporate a user-centric approach discuss only about certain user groups, such as the elderly while ignoring other demographics (Khedekar et al., 2017; Peek et al., 2014; Czaja, 2016; Ehrenhard et al., 2014; Morris et al., 2014; Cassarino & Setti, 2016). It is important to explore and understand the various stakeholders involved who influence a user's acceptance and adoption of smart homes. This shift in focus from technology to the user's perspective will lead to better development of smart home products and enable service providers to deliver better service to their users.

Understanding the pre and post-adoption user behavior will shed light on the consumer's cognitive process of adopting new technology. Studying this behavioral change will help with the better implementation of new products in the market. User-centric studies (Fig. 4) on the perceived advantages and challenges of smart homes, and how they relate to the adoption of smart homes by users have been contradictory across different geographical locations and demographics. These contradictions suggest that there should be further studies conducted that examine factors that influence user adoption in greater detail (Ehrenhard et al., 2014; Kerbler, 2013; Alsulami & Atkins, 2016). The emotional, psychological, symbolic, social, functional, and financial factors that affect a user's decision on the acceptance or rejection of new technology, and how differences in culture and geography affect these factors should be examined further. (Balta-Ozkan et al., 2014) Psychological resistance is another important factor and studying variables that influence a user's cognitive state of mind and a user's impression of the usefulness of the technology will enable us to overcome this resistance to adopting technology (Mani et al., 2017). The above gaps identified from the literature suggest that there is an increasing need to conduct studies on a user's perception towards smart home products and adopt new technologies (Amiribesheli et al., 2015; Peek et al., 2014; Czaja, 2016; Chen et al., 2017; Bhati et al., 2017; Chiang & Wang, 2016; Hong et al., 2016).

Table 4 Future Research Suggestions

S. No.	Consumer barriers	Themes	Sources	No.
1	User centric research of smart home products	· User perception of smart home technology ·Demographics and geographic change · Smart home technology benefits for users ·Focus on ageing population	Chan et al., 2008; Coughlan et al., 2013; Chan et al., 2009; Amiribesheli et al.,2015; Kim et al., 2013; Demiris & Hensel, 2008; Alam et al., 2012; Peek et al., 2014; Czaja, 2016; Balta-Ozkan et al., 2013a; Diegel et al., 2005; Bowes et al., 2012; Chen et al., 2017; Bhati et al., 2017; Balta-Ozkan et al., 2013b; Paetz et al., 2011; Demiris et al., 2008; Brandt et al., 2011; Stringer etal.,2006; Wu & Fu, 2012; Chan et al., 2012; Chiang & Wang, 2016; Matlabi et al., 2012; Paetz et al., 2012; Demiris et al., 2004; Gaul & Ziefle, 2009; Courtney et al., 2008; Yamazaki, 2006; Hong et al., 2016; Vilas et al., 2010;	30
2	Smart home acceptance and adoption	· Smart home technology acceptance factors	Chan et al., 2008; Dawid et al., 2017; Khedekar et al., 2017; Chan et al., 2009; Peetoom et al., 2015; Kim et al., 2013; Peek et al., 2014; Balta-Ozkan et al., 2013a; Diegel et al., 2005; Ehrenhard et al., 2014; Bowes et al., 2012; Balta-Ozkan et al., 2013b; Kleinberger et al., 2007; Demiris et al., 2008; Park et al., 2018; Yang et al., 2017; Alsulami & Atkins, 2016; Steele et al., 2009; Mayer et al., 2011; Paetz et al., 2012; Gaul & Ziefle, 2009; Courtney et al., 2008; Mani & Chouk, 2017; Chung et al., 2016	24

5. Discussion

The design and development of smart homes will greatly benefit by approaching it from a product-service system (PSS) perspective. However, designers and developers lack a systematic approach to smart products, which will help in integration with PSS. In this data-driven market, the focus is shifting from only consumers to including all stakeholders involved as the consumer is part of a larger interconnected network. In this network, individual smart products and services will collaborate and function in tandem to fulfill common goals and provide value to the user. Hence it is essential to study and understand interconnected socio-technical systems with the goal of shifting smart home development towards a PSS approach. There is limited prior research on the integration of smart homes with PSS.

Continuous research in this direction is required to approach the design of smart homes by taking into consideration the various systems and subsystems involved, accounting for the diverse cultures and varied demographics (Fig. 5).

In the proposed framework, initially, we focused on the factors which define any product as a “smart” product and qualities that consumers look for within the product, while using it in cooperation with other products and using smart products. Secondly, we focused on consumer benefits and barriers which influence the new technology acceptance. Also, we have identified consumer behaviour and its relation to socio-cultural aspects of smart home

products. At last, we have determined a need for user-centric research and a product service system design (PSS) perspective in smart homes, which includes a communication network between tangible products, intangible services and all the stakeholders involved in the system.

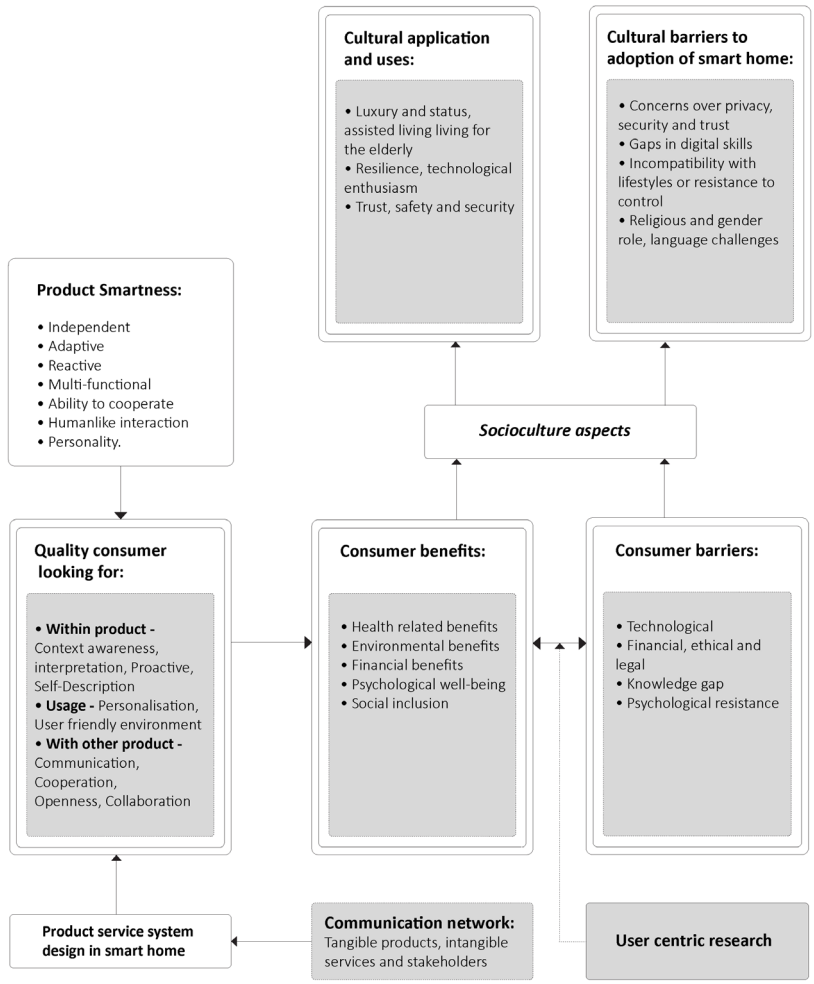

Figure 5 Conceptual framework for factors affecting consumer's new technology acceptance

In this paper, we conducted an integrative review of 143 articles relevant to the topic of smart home and IoT products. Through the critical analysis of these articles, four main themes or categories emerged:

1. The Terminology used in smart home and IoT products,
2. Consumer behaviour and its relation with the other factors such as benefits, barriers, and socio-cultural aspects in smart homes.
3. New technology acceptance, and
4. Product service system (PSS) design in smart homes.

The integration of valuable insights drawn from the review of the first two categories has resulted in developing a conceptual framework (Fig. 4) of fundamental smart home product

design elements affecting consumer new technology acceptance. A key contribution of this study is that the insights gained from the review of the available literature provide an overview of the range of socio-cultural factors and PSS design factors that are most likely to influence consumer adoption to smart homes and IoT products (Fig. 5).

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