

Systematic Survey to Investigate Smart Home Pre-Adoption Issues to Improve Elderly People's Quality of Life

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Abstract

Smart home solutions based on the internet of things (IoT) can improve quality of life management. However, there is a dearth of comprehensive literature that can help researchers and practitioners better comprehend why older adults accept or reject smart home services. These users represent a significant hurdle in the successful implementation of smart home services. Therefore, this study's primary objective was to provide a concise, systematic review of current issues in the pre-adoption of smart home services for the elderly. In addition, factors that impact the intention of the elderly on IoT-based smart home services (SHS-IoT) pre-adoption were also examined. A total of 705 initial papers on smart homes for the elderly were found across credible scientific databases. Out of these papers, 30 publications met this study's inclusion criteria for the final review. The findings revealed that older adults' attitudes towards smart homes are positive, particularly for safety/security monitoring and independent assisted living. Besides, the lack of well-defined information theories exists in the literature on the use of smart home services by the elderly. Additionally, several challenges currently faced hindering the pre-adoption of smart home services and how future research could better understand the perspective of older adults to choose a suitable benchmark are presented in this paper.

Keywords

Smart Home, Elderly, Quality of Life, Pre-adoption.

Introduction

Today, many industrialised and developing countries rely heavily on technology to aid them in daily living (Feng et al., 2018). As technology advances, new opportunities for enhancing

wellness become available, and technology becomes a need, particularly in the field of gerontechnology (Vandebosch et al., 2001). whereby, the old global population is growing, as is the prevalence of age-related ailments such as chronic diseases, Parkinson's disease, and dementia (Jing et al., 2016). As a result of these occurrences, the burden on healthcare and medical resources increases, as does reliance on caregivers, families, and society as a whole. A greater focus should be made on promoting independence through technologies, particularly those present in the home, to offset this imbalance (Shin et al., 2018).

Over the last several decades, much attention has been dedicated to so-called smart homes, particularly by the research community, which has examined the benefits of improved monitoring and automation through the use of sensors and actuators for ambient support (Alaa et al., 2017b). All these smart solutions have the goal of enhancing the user's quality of life (QoL). Regarding the health status and numerous vulnerability issues that older adults face, an examination of their QOL is a priority. Nevertheless, the majority of recent studies on smart homes emphasised system development and prototyping, with little attention paid to the end-user perspective. Although the latter is vital towards realising the potential benefits of smart homes, it neglected the intention to use these systems (Debajyoti Pal, Triyason, et al., 2018).

This study's objective was to produce a review paper on pre-adoption concerns for smart home services. Therefore, a comprehensive systematic survey was conducted covering literature published over the last six years. Several research questions (RQs) spanning various areas of the subject were first defined as the basis for the investigation. As a further step, this study looked for papers that could provide light on the unanswered questions. Future directions for research in this area were also discussed. A systematic approach was used to gather and analyse the relevant published papers to meet the aims mentioned above.

The remainder of this paper is structured as follows: Section II describes the methodology used in this study; Section III presents the results and discussion; Section IV provides the conclusion and the scope of future work.

Methodology

This study followed the established best practices for conducting systematic mapping and literature review of studies (Petersen et al., 2015). Figure 1 depicts the five stages of this study's systematic process.

The first stage was to decide on this study's objectives and research questions. The research problem was defined, and several questions were developed to mitigate the problem.

Meanwhile, the second stage involved conducting the search process. A search strategy was specified in this stage to identify relevant publications on the subject of this study. The third stage involved the selection and filtering of publications from the previous stage. The fourth stage was data extraction, during which pertinent publications were thoroughly analysed and the critical details necessary to answer this study's identified questions were extracted. The concluding stage involved reporting and documenting the findings. The following subsection detail the five stages mentioned previously.

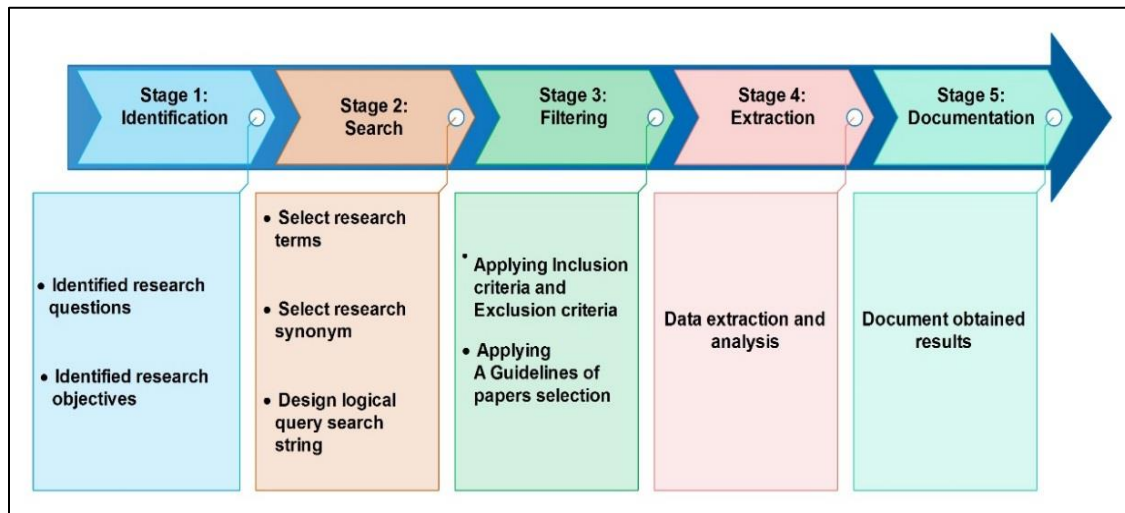


Figure 1 Stages of systematic review

A. Research Objectives and Questions Identification

1) Research Objectives

This systematic survey aimed to conduct a comprehensive investigation of all published research on current concerns relating to smart home services pre-adoption among the elderly. Additionally, factors affecting the elderly's intention to smart home services pre-adoption based on IoT were explored. The objectives were achieved by answering several related research questions to aid researchers and practitioners in better comprehending and contributing to the creation and investigation of these smart home systems.

2) Research Questions

This study described and addressed several research questions (RQs), each of which addressed a distinct aspect of the topic concerning this study's objectives.

- a. What are the current issues of pre-adoption smart home services among the elderly?

- b. What are the factors that impact the intention to use smart home services based on IoT among the elderly?

B. Search Strategy

1) Literature Sources

A wide range of databases was searched for this investigation from February to August 2019 for relevant information. Six standard online databases that index the publications relevant to the survey's scope were chosen as sources because the research questions spanned computer science (information system) and engineering. Table1 presents the list of database sources and their associated web links.

Table 1 Databases used for literature search

No.	Database	Websites
1	Ieeexplore.	https://ieeexplore.ieee.org
2	Scopus	https://www.scopus.com
3	Springer	https://www.springer.com
4	Elsevier Science Direct	https://www.sciencedirect.com
5	Taylor and France	https://www.tandfonline.com
6	Emerald	https://www.emerald.com

2) Search String

The following search string was run against the database's literature sources to locate appropriate publications for this analysis. To obtain the initial search results, a combination of the logical operators "AND" and "OR" was employed in conjunction with the keywords like "elderly", "smart home", "adoption", and "quality of life", as well as possible synonyms. The following is the search phrases used: ("smart home" AND "adoption" AND "quality of life" AND "technology" AND "internet of things") AND ("elderly" OR "old people" OR "senior" OR "older adult" OR "aged" OR "aging population") AND (model" OR "theoretical" OR "conceptual" OR "framework").

C. Selection of Papers

1) Inclusion or Exclusion Criteria

A set of inclusion and exclusion criteria was developed and implemented to determine to assess the relevance of a publication to this study. The following requirements were applied on the basis of names, abstracts, and full-text reading.

a. Inclusion Criteria

The inclusion criteria that were applied for the selected articles are as follow:

1. Computer science, engineering, and information systems should be the primary disciplines.
2. If the age is specified in the research, participants should be 55 years or older.
3. It is recommended that articles be published in 2014 or later due to technological advancements.
4. Inclusion of systematic reviews or any review, quantitative studies, qualitative studies, or mixed-method approaches permissible under certain conditions.
5. It is necessary to write the articles in the English language.
6. Articles should be available online.

b. Exclusion Criteria

Meanwhile, the inclusion criteria are as follow:

1. Studies that have been published in PhD or Masters theses.
2. Papers that were used as lecture notes in conferences.
3. Studies that were not linked to smart homes, but instead focused on home-based technology for a variety of different objectives.
4. Research on various types of technologies that are not connected to the deployment of smart homes.
5. Abstracts or papers that were not available due to technical difficulties.

2) Paper Selection Process

A search for relevant literature was conducted on electronic sources in multiple databases. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines were followed for the inclusion and exclusion of papers selection (Moher et al., 2010) by including the four phases of the PRISMA flow diagram: identification, screening, eligibility and included.

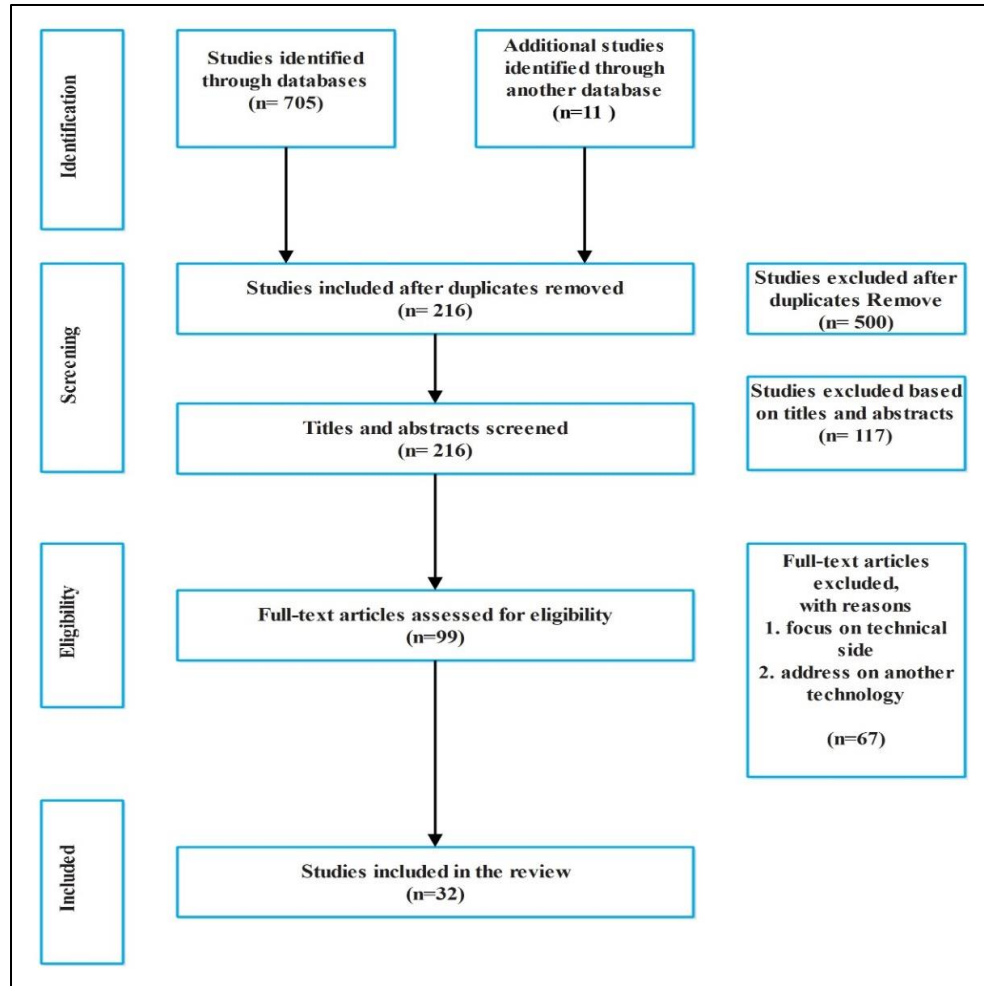


Figure 2 Flow diagram of the paper selection process

D. Extraction and Analysis of Data

Data were extracted and thoroughly analysed from the selected papers to address the identified research questions. Additionally, the extracted data were entered into an excel sheet that contained the following critical information about the papers selected: year, publication type, publisher name, library, paper title, objectives, study motivation, factors, theory, research method, sample, gaps, limitations, results, and findings. This stage began with data extraction and was followed by accuracy checks.

Results and Discussion

This study conducted an in-depth analysis of the selected publications to address the established research questions. Each RQ is addressed in the subsections that follow in light of the obtained results and is denoted by a brief title.

A. Factors Hindering the Intention to Use Smart Home Services (RQ1)

From the literature review, 32 findings were identified that addressed various aspects of intention to use smart home services. Upon review of these findings, seven distinctive influential factors on the smart home system pre-adoption among the elderly were identified: 1) Control; 2) Personal innovativeness in information technology (IT); 3) Cost; 4) Electricity consumption; 5) Safety/security; 6) Government support; 7) Training. The findings were elicited from these studies' theoretical framework (see Table 2).

Table 2 Summary of influencing factors

No.	Factor	References
1	Control	(Guiot et al., 2019; Huang & Yang, 2018; Lee, 2016; Yu et al., 2016)
2	Personal innovativeness in IT	(Al-Hadban, Hashim, & Mohd, 2016; Baudier, Ammi, Lecouteux, et al., 2018; Behrend et al., 2011; Jackson et al., 2013; Xiang et al., 2008; Yusof et al., 2008)
3	Cost	(D. Pal et al., 2018; Debajyoti Pal, Triyason, et al., 2018; Rind et al., 2017; Yusif et al., 2016)
4	Electricity consumption	(Abdekhooda et al., 2015; Jacobsson et al., 2016; Jacobsson & Davidsson, 2016; Moser et al., 2014)
5	Safety/security	(Alaa et al., 2017a; Baudier, Ammi, & Deboeuf-Rouchon, 2018; Özsungur, 2019; Siegel & Dorner, 2017; Wong & Leung, 2016)
6	Government support	(Al-Hadban, Hashim, & Yusof, 2016; Mandari & Chong, 2018; Wong & Leung, 2016)
7	Training	(Carlyle et al., 2015; Milovich & Burleson, 2018; Debajyoti Pal, Funilkul, et al., 2018; Yusif et al., 2016)

B. Present Smart Home Service Pre-Adoption Problems (RQ2)

The review found that most of the theories that work in smart home pre-adoption studies are the technology acceptance model (e.g. TAM, TAM2, and TAM3), unified theory of acceptance and use of technology (UTAUT and UTAUT2), theory of planned behaviour (TPB), and theory of reasoned action (TRA). These theories have primarily been applied to the elderly population (see Figure 3). However, these theories are insufficient to translate the elderly's perception towards the intention to use smart home services.

Although user perceptions of these smart home systems are generally favourable, no research has assessed smart home services among the elderly using well-defined information theories such as the Almere TAM (Heerink et al., 2010) or the senior technology acceptance model (STAM) (Chen & Chan, 2014). Simultaneously, the STAM suggests that physical, psychological, and social characteristics linked with ageing may influence the elderly's interaction with technology and devices. Meanwhile, Almere TAM

evaluates the elderly's acceptance of technology through the use of constructs that help to understand their social abilities and behaviours, as well as potential impediments while engaging with robotics devices (see Figure 3).

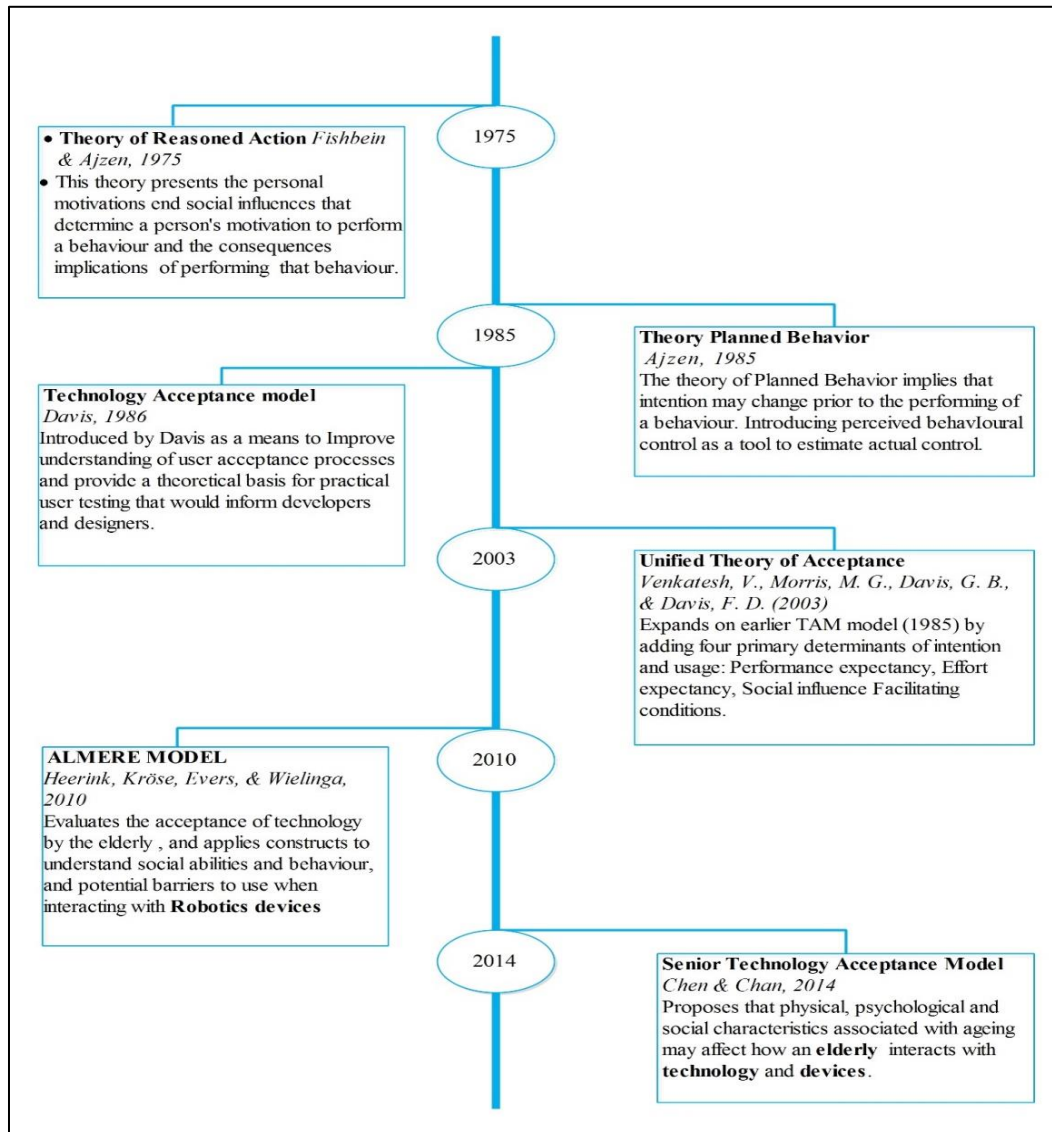


Figure 3 Chronology of relevant theories

Conclusion

This study documented the state-of-the-art contributions to the pre-adoption of smart home services in a methodical manner. For this purpose, 32 related articles from six well-known literature databases that were published in the last six years (2014 to 2019) were chosen. The published papers were a mix of conference and journal contributions, with the majority

appearing in journals. The chosen papers were thoroughly examined and analysed from a variety of perspectives using the established RQs as a guide.

When it comes to using smart homes to enhance QoL, older adults have a favourable opinion. However, the elderly's pre-adoption of smart homes technologies is relatively low. Most studies in this domain focused on the technical sides and neglected end-users perceptions. Moreover, no study has evaluated the elderly's intention to use smart home services using a real smart home system that provides a realistic vision to the end-user.

Apart from that, the focus of research should be shifted. Future research should focus on safe/security and recreational activities that can help improve older people's mental states. Additionally, the training aspects and the cost of implementing such technology should be considered. Moreover, the effects of government support on the use of smart homes by the elderly should be investigated. In conclusion, it is imperative to examine the factors (safe/security, recreational, training, cost, government support and personal innovativeness) that influence the elderly's intention to use smart home services.

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