

## Acceptance of Smart Home Technology: A Bibliometric Analysis

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### Abstract

Following the internet, acceptance research has had a significant impact on smart home technology and has drawn the interest of scientists from a variety of fields. This study intends to investigate the research on acceptance that has been done in the field of smart home technology due to the rising interest of research scholars in the IT industry. In order to find the research trends and themes in this domain, a bibliometric analysis of the metadata was conducted. The study uses the R Package bibliometric to investigate a graphical representation of bibliometric data of acceptance in smart home domain. Thus, it conducted the following analyses: trends in annual publications, most productive authors, most productive nations, most cited papers, frequent journals, most productive affiliations, frequent keywords, and network analysis. According to the findings, research on smart home acceptance began in 1999, grew significantly in 2013, and has since continued to develop. Additionally, it is clear that research on the acceptance in the smart home is rapidly expanding, while it is still in its early stages and is anticipated to increase significantly. Since the data will continue to change and the scope of this study was limited to the Web Of Science database, it may be necessary to repeat it in the future.

**Keywords:** Aging in Place, Smart Home, Acceptance, IoT

### Introduction

The Smart home is one of the latest IT (information technology). The smart home in the Oxford Dictionary calls it as: "noun[;] a home equipped with lighting, heating, and electronic devices that can be controlled remotely by smartphone or computer: you can contact your smart home on the Internet to make sure the dinner is cooked, the central heating is on, the curtains are drawn, and a gas fire is roaring in the grate when you get home" (Michael. S, 2015). These items are employed in the medical profession for remote health monitoring, early diagnosis, and senior care because they have vast human detection capabilities (Nweke et al., n.d.). Because there are differences between different users, there are also differences in the acceptance of technology. Therefore, there is a huge demand for technology

acceptance research. Improve the feasibility and generalization of technology through acceptance studies (Yang et al., 2018). We can also regard smart home technology as a sub-sector of the Internet of Things (IoT). Smart homes are also connecting multiple smart devices to form a smart home. A revolution in the industry will result from smart home that affect the entire value chain.

Over the past few years, a lot of study has been conducted on initiatives connected to the Smart home in acceptance model. Research on smart homes has expanded quickly, particularly studies focusing on the use of cutting-edge devices in acceptance (Tural et al., 2021) (Fritz & Dermody, 2019). For example, Pal et al. in 2018 extend the original technology acceptance model (TAM) in order to develop and validate the elderly smart home technology acceptance model (ESHTAM), which may be used to explain the elderly's intention to utilise smart homes (Ma et al., 2021). This is accomplished by conducting an online questionnaire survey, the findings of which are analysed using data gathered from 254 subjects using the Partial Least Squares Structural Equation Modelling (PLS-SEM) method. However, there haven't been many reviews of the usage of smart homes for acceptance. The handful that we have located began researching the literature on smart home applications for ageing in place using bibliometric methodologies. Similarly, to this, Ma et al. in 2021 examined how manufacturing organizations and smart homes connected to acceptance (Yeon et al., 2018).

In contrast to earlier studies, our exploratory effort intends to evaluate the degree of alignment between the research and practice domains of smart homes in the ageing in place sector simultaneously. In order to determine whether there is a time asymmetry between research, we plot the research trend subjects over time. The goal of our research is to offer scholars and practitioners more useful solutions. As a result, the primary theoretical contribution of this study is the discovery of a novel method for tracking the development of problems in both the academic and industrial realms. This makes it possible to foresee how new research areas will affect the industrial sector and to compare the data found in both publications.

Following is an explanation of the study. The literature review on the function of the acceptance for smart home is presented in Section 2. The research tools and techniques we utilised to gather and analyse the data are described in Section 3 of the paper. The key findings are illustrated in Section 4 and discussed with research implications in Section 5.

## **Literature Review**

### **A. Acceptance of Smart home technology**

The first rubber "intelligent building" appeared in 1984 when United Technologies Building System applied the idea of building equipment informatization and integration to the urban construction of Hartford, Connecticut, USA. This marked the beginning of the era in which smart homes would be built all over the world (Carnemolla, 2018). Others place more emphasis on the kind of object (services and applications) and its application domains (smart cities, traffic congestion, waste management, structural health, security, emergency services, logistics, retail, industrial control, and health care), while some prefer the type of connectivity (Radio Frequency Identification, Wireless Sensor Network) that connects various objects.

In many industries, the smart home is now a reality, but it is still a relatively new concept in acceptance area. Most likely, this is a result of highly regulated to acceptance question. In 2018, the "HAST" model was proposed to be applied to smart home design, and a demand model was established based on multiple perspectives of the elderly, and smart home

services that meet the needs were designed accordingly (Carnemolla, 2018b). It is an important symbol in the course of this research.

Therefore, an "acceptance" can be characterised in the context of smart home. The research on acceptance improves the guiding role of smart home industry development and subsequent technological development. The acceptance of smart homes is, to some extent, a manifestation of technical flaws. Therefore, it can improve the help and explanation of industry and research and development from more angles. (Marikyan et al., 2019).

Acceptance arose from the smart home sector and is currently a topic of interest for academics, corporations, and industries as they explore acceptance in numerous sectors. The TAM (Technology Acceptance Model) model is a well-known one for technological acceptance (Ma et al., 2021). The TAM model was first proposed by Davies in 1986 and continued to be improved over the next thirty years. It is one of the most widely applicable and well-known models at present. Researchers are increasingly examining acceptance in the field of smart homes. The literature demonstrates how various factors—physical, mental, and connected (Jo et al., 2021)—will play a role in acceptance questions. things of a special nature, such as chronic illnesses, Alzheimer's disease, etc (Ghorayeb et al., 2021).

It is clear that acceptance research in the smart home space is popular, and the literature implies that acceptance acquisition will change the smart home landscape by enhancing IoT capabilities and workflows as a whole (Aria & Cuccurullo, 2017). Additionally, some bibliometric study in the field of smart homes has been done (Moral-Muñoz et al., 2020), although not in the conjunction of acceptance question.

Therefore, the primary goal of this article is to conduct a bibliometric analysis of acceptance in the field of smart homes in order to understand the research trends in this area.

## B. Scientometric analysis for exploring research

Smart homes will become more important to the ageing in place sector. The IoT device market is predicted by Gartner to double in value every two years (Belfiore et al., 2022). The smart home has grown significantly as a crucial element of the Internet of Things. The ageing in place industry is expected to see a rise in smart home entrepreneurship, with a broad and expanding range of applications.

Marikyan et al. in 2019 published a systematic literature review of smart homes in 2019, which mentions home retirement blocks. But the overall article is still based on the content published in the direction of smart home, and on the lower connectivity of home retirement (Martín-Martín et al., 2020).

Tan et al. in 2021 A systematic review of the literature on home pensions has been carried out, and this application further demonstrates how hot the issue of pensions is today. Therefore, the home pension industry based on smart homes is definitely one of the topics of future development (Aria & Cuccurullo, 2017).

Chung et al. in 2016 combines smart home and home retirement and makes a systematic review. And in 2023 (Dominguez-Romero et al., 2019), D'Angelo et al. in 2023 proposes the use of smart homes to provide home care for elderly people with chronic diseases. Over time, the relationship between the two became more and more intimate. Research in this direction is more mature (Arthanat et al., 2018).

Currently, neither from the perspective of entrepreneurial innovation nor from that of regulators, professionals, and patients, is there a clear framework for what research has so far created. By examining data from scholarly papers, this paper seeks to close this gap.

Scientific data, including articles, clinical trials, grants, and all other forms of scientific output, are subject to quantitative analysis in the field of scientometrics. Salatino et al. in 2020 proposed a method for analysing, tracking, and forecasting the flow of knowledge between academia and industry that combines semantic technology with machine learning. In contrast to this contribution, we examined the patterns of publications and identified the research front (Arthanat et al., 2020).

As a scientometric software tool, we made use of the Bibliometrix R package (Arthanat et al., 2022). According to a recent study on bibliometric software tools, Bibliometrix "stands out since it incorporates a great variety of different analyses" and for the usability of the Biblioshiny online interface (Elers et al., 2018). For example, it enables the creation of a bibliometric network for the visualisation of the conceptual, intellectual, and social knowledge structures as well as the performance analysis of three separate units (journals, authors, and documents) using impact metrics. Additionally, Bibliometrix conducts geographical, spectroscopy/RPYS, and longitudinal conceptual (burst detection and topic evolution) analyses (Hunter et al., 2020).

This article is a small research based on the Internet of Things and health care. This paper mainly refers to Belfiore et al. in 2022 and conducts a literature review and discussion in a small direction based on the general background of this study (Hunter et al., 2019).

## Research Methodology

We reviewed the fields of research (publication) to put the smart home in the art state of acceptance. From 1999 to 2023, we searched the Web of Science database thoroughly to find all the papers on smart homes and acceptance to Collection the data.

The database of the Scientific Network was searched. Scientific publications, Altmetric data, patents, scholarships, clinical trials and policy documents are included in the platform's most complete connected data set. (Bergeron et al., 2018). To find the English documentation, we used "smart home" and "acceptance" in the title, summary and keyword fields from all.

We used some exclusion criteria. Use the Bibliometrix program to download data in BibTex format, filter it, and then check it. (Bouchard et al., 2020). It is currently considered to be the most comprehensive, integrated and user-friendly Type A. Belfiore et al bibliometric tool, it is an open-source tool for scientific measurement and quantitative research of book measurements (Choi et al., 2021).

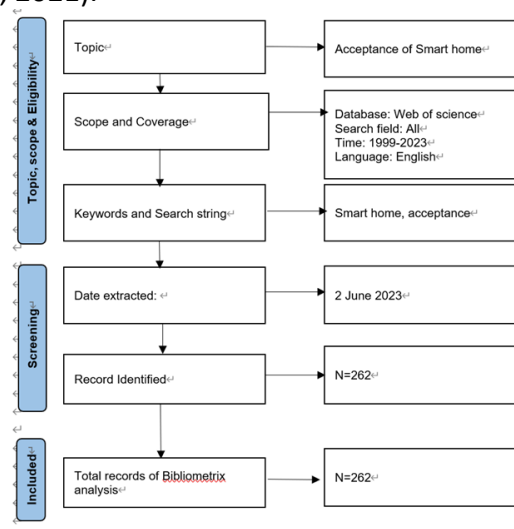


Figure 1. Analyse the Flowchart

Open the R run environment and enter "bibliometrix::biblioshiny". Run the code, pop up a network window, click "import row file(s)" on the data loading page, select the database type "Web of Science", load the previously filtered literature data, and click the Start button.

Bibliometrix offers a wide range of scientific metrics methods for analyzing bibliometric data. Some of the scientific metrics methods available in Bibliometrix include:

- Bibliometric analysis: Bibliometrix can analyze the quantity, type, year, authorship, publication, citation, and citation network of literature
- Collaboration analysis: Bibliometrix can analyze collaboration patterns, such as author and country collaboration, collaboration networks, and collaboration topics
- Word frequency analysis: Bibliometrix can perform text mining and word frequency analysis to identify the most frequent words and topics used in literature
- Topic modelling: Bibliometrix can use topicmodellingg techniques to classify and summarizthe e literature, revealing potential topics within the literature.
- Citation analysis: Bibliometrix can analyze how literature is cited, including the number, time, source, type, and field of citations.
- Social network analysis: Bibliometrix can perform social network analysis to identify key people and organizations in authorship, publication, and citation networks and reveal their relationships and influence.
- Visualization analysis: Bibliometrix can visualize the results of the above analyses, allowing users to more intuitively understand trends and patterns in bibliometric data.

The article analyzes Bibliometrix's measurement approaches to analyze and judge the feasibility and future trends in the discipline through intuitive scientific analysis.

## Results and Discussions

### A. Descriptive Analysis

The main information about the collection of selected articles retrieved from the "Biblioshiny tool of R-Package" is shown in Table 1.

Table 1  
*Main Information Regarding Selected Articles*

Description	Results
Timespan	1999-2023
Sources (Journals, Books, etc)	191
Journal articles	262
Annual Growth Rate %	12.8
Document Average Age	4.83
Average citations per doc	19.69
References	10767
Authors	840

The study covers the timespan from 1999 to 2023 and includes 191 sources, including 262 journal articles. The research has shown a steady annual growth rate of 12.8%. With an average of 19.69 citations per document, the study has demonstrated a significant impact. The dataset contains a total of 10,767 references, indicating extensive scholarly support in the field.

In terms of authors, 840 individuals have contributed to the study, reflecting collaboration and diversity within the field. The average age of the documents is 4.83 years, indicating a focus on recent findings and trends.

In summary, these data provide comprehensive insights into the research on the acceptance of smart home technology. Future research can explore emerging trends, enhance collaboration networks, and address research gaps. These findings have important implications and guidance for academia, practitioners, and policymakers.

Due to the majority of articles being published between 2017 and 2023, with only 65 articles published before that period, it should be noted that Table 2 does not include data from before 2017. The focus of publication is primarily centred around the years after 2017. Therefore, the table does not account for any data prior to 2017.

Table 2

*Annual Publication Trends for Acceptance of Smart Home*

Year	No. of Articles	Total Citations (TC)	Mean TC per year	Citable Year
2017	24	41.17	5.88	7
2018	20	33.45	5.58	6
2019	26	19.85	3.97	5
2020	29	20.48	5.12	4
2021	40	7.3	2.43	3
2022	40	3.2	1.60	2
2023	18	0.39	0.39	1

According to the provided data by Table 3. The analysis of the authors' contributions reveals several notable individuals in the field of acceptance of smart home technology. Ziefle emerges as the most prolific author with 9 articles, followed by Pal and Papagiannidis with 7 and 6 articles respectively. Marikyan, Arthanat, Bernotat, Funilkul, Mashal, and Shuhaiber each have 4 articles to their credit. These authors have made significant contributions to the understanding of the acceptance of smart home technology, demonstrating their expertise and engagement with the subject matter. Their collective body of work highlights the multifaceted nature of this research field and provides valuable insights for further exploration and study.

Table 3

*Most Productive Authors for Acceptance of Smart Home*

Authors	Articles	Articles Fractionalized
Ziefle, M.	9	3.28
Pal, D.	7	2.25
Papagiannidis, S.	6	2.17
Marikyan, D.	5	1.67
Arthanat, S.	4	1.17
Bernotat, J.	4	1.30
Funilkul, S.	4	1.25
Mashal, I.	4	1.67
Shuhaiber, A.	4	1.67

By Table 4, Through the analysis of the provided data, the following conclusions can be drawn: Alaa's paper has been cited 252 times, indicating its wide recognition and impact in the field. Peek and Portet have received 220 and 217 citations respectively, highlighting their significance in the academic community. El-Hawary and Yang's papers have also been cited 197 and 142 times respectively, demonstrating their contributions in the related research area. These findings underscore the influence and scholarly value of these authors' work in the acceptance of smart home technology. Their research provides valuable references and guidance for further exploration and development in the field.

Table 4

*Most Cited Papers for Acceptance of Smart Home*

Paper	Total Citations	Authors
[67]	252	Alaa, M.
[68]	220	Peek, S. T. M.
[69]	217	Portet, F.
[70]	197	El-Hawary, M. E.
[71]	142	Yang, H.

In Table 5, Taking into account the previous data, the analysis of regional distribution reveals that Germany has the highest number of total publications with 123, representing 46.94% of the publications. The USA follows closely with 109 publications, accounting for 41.60% of the total. China ranks third with 90 publications, making up 34.35% of the overall publications. The UK and South Korea also have significant contributions, with 68 and 58 publications respectively, representing 25.95% and 22.13% of the total. Other countries such as Australia, Italy, Netherlands, France, and Thailand also demonstrate notable involvement in the research, contributing varying percentages to the overall publication count. This regional distribution provides valuable insights into the geographical distribution of research efforts in the field of study.

Table 5

*Most Productive Countries for Acceptance of Smart Home*

Region	Total Publication	% Of Publication
Germany	123	46.94
USA	109	41.60
China	90	34.35
UK	68	25.95
South Korea	58	22.13
Australia	43	16.41
Italy	35	13.35
Netherlands	35	13.35
France	24	9.16
Thailand	20	7.63

Figure 2 shows that the Analysing the combined data, it can be observed that the research contributions from various affiliations or universities are quite diverse. Hanyang University emerges as the leading contributor with 22 articles, followed closely by King Mongkut's University of Technology Thonburi and Newcastle University with 17 and 12

articles respectively. Notably, the Human-Computer Interaction Centre, University of New Hampshire, and University of Tokyo each have 11 articles associated with them. Huazhong University of Science and Technology, Massey University, Eindhoven University of Technology, and Fontys University of Applied Sciences also demonstrate significant research output with 10, 9, 8, and 8 articles respectively.

Overall, these affiliations represent a wide range of international institutions, highlighting their active involvement and contributions to the field of study. The collective research efforts from these institutions contribute to the advancement and understanding of the topic at hand, further enriching the knowledge base in the academic community.

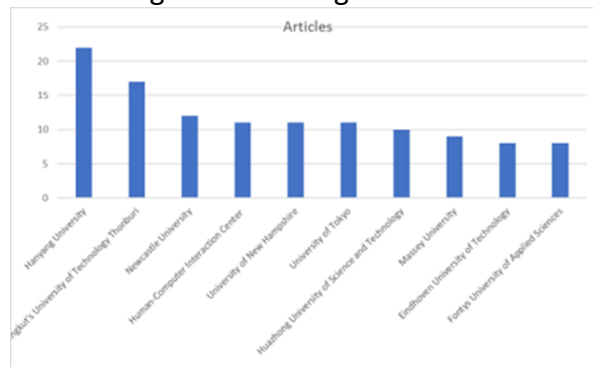


Figure 2. Most Relevant Affiliations

From Table 6, analysing the sources of the articles, it is evident that a diverse range of journals and publications have contributed to the research on the topic. "Sensors" and "Sustainability" emerge as the top sources with 7 and 6 articles respectively, indicating their significance in the field. The journals "Energy Research & Social Science," "IEEE Access," and "Energies" have also made notable contributions with 5 articles each.

Furthermore, "Informatics for Health & Social Care," "International Journal of Human-Computer Interaction," and "Universal Access in the Information Society" demonstrate a similar level of involvement with 4 articles each. The journals "Buildings" and "Energy Policy" have also contributed to the body of literature with 3 articles each.

Overall, these diverse sources highlight the interdisciplinary nature of the topic, covering areas such as sensors, sustainability, energy research, human-computer interaction, and more. The presence of multiple reputable journals in the list indicates the wide interest and engagement of the academic community in exploring various aspects of the subject matter.

Table 6  
Most Frequent Journals for Acceptance of Smart Home

Sources	Articles
SENSORS	7
SUSTAINABILITY	6
Energy Research & Social Science	5
IEEE Access	5
ENERGIES	4
Informatics for Health & Social Care	4
International Journal of Human-Computer Interaction	4
Universal Access in the Information Society	4
BUILDINGS	3
Energy Policy	3



Analysing the exported data, several key terms and their frequencies shed light on the research topic of acceptance and adoption of smart home technology in relation to aging-in-place and assistive technology.

The term "acceptance" appears most frequently, with a frequency of 61, indicating a significant focus on understanding the factors influencing the acceptance of smart home technology among users. Similarly, the term "adoption" is also prominent, appearing 53 times, suggesting a strong interest in studying the actual adoption and utilization of these technologies in real-world settings.

The presence of terms like "aging-in-place" and "aging in-place" with frequencies of 6 each demonstrates a specific focus on the concept of enabling elderly individuals to live independently in their own homes through the use of smart home technology. Additionally, the term "assistive technology" appears 5 times, highlighting the integration of technological solutions to support individuals with disabilities or age-related limitations.

The inclusion of terms such as "attitudes," "barriers," "behavioural intention," "care," and "challenges" further emphasizes the multidimensional nature of the research. These terms indicate a comprehensive investigation into the attitudes of users, barriers to adoption, behavioural intentions towards using smart home technology, care-related considerations, and challenges associated with implementation.

Overall, the data suggests a significant research focus on understanding the acceptance and adoption of smart home technology, particularly in the context of aging-in-place and assistive technology. The presence of these terms reflects a comprehensive approach to examining user perspectives, barriers, and challenges in order to facilitate the successful integration of smart home solutions in improving the quality of life for individuals in need. Such as Fig.3.

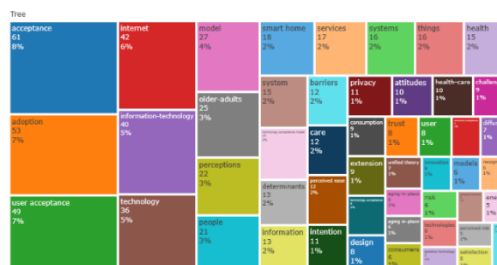


Figure 3. Most Frequent Keywords for Acceptance of Smart Home

B. Network Analysis

Overall, the data suggests a diverse and international collaboration landscape, with countries coming together to pool their expertise and resources in advancing research on the topic. These collaborations not only enhance the collective knowledge and understanding but also promote cross-cultural exchange and mutual learning, ultimately contributing to the global development of the field. The retail of research is in Figure 4.



Figure 4. Country Collaboration Network

It can be observed that there are a total of 16 clusters of collaborating scholars in the research. These clusters represent groups of researchers who have worked closely together on the topic, indicating a strong network of collaboration within the research community.

Overall, the presence of 16 collaborative clusters reflects a dynamic and collaborative research landscape, promoting knowledge sharing and the advancement of the research topic. Continued collaboration within and between these clusters can contribute to the growth and development of the field, leading to valuable insights and advancements in the acceptance and adoption of smart home technology. As Fig.5

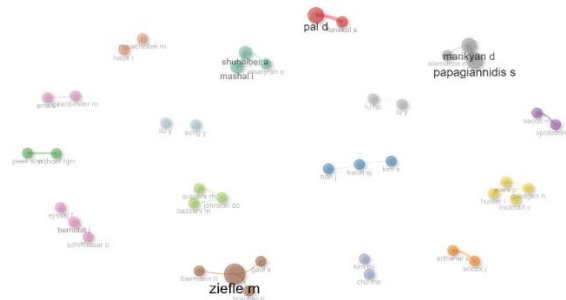


Figure 5. Author Collaboration Network

## Conclusions

This article conducts a scientific analysis of the web of science database from 1999 to June 2023, visualizes the research on the acceptance direction of smart home, and evaluates and makes statistics on future development trends and research feasibility. It provides some basis and help for future related development trends and the use of scientific analysis software.

Looking ahead, it is anticipated that the research on the acceptance of smart home technology will continue to expand. As technology advances and becomes more integrated into our daily lives, further investigations are expected to explore emerging topics such as the impact of artificial intelligence, privacy and security concerns, user experience design, and the development of customized solutions for diverse user groups.

Moreover, there is a need for interdisciplinary research collaborations that bring together experts from various fields such as engineering, computer science, psychology, gerontology, and healthcare. This collaborative approach can lead to comprehensive in-sights into the complex dynamics of acceptance and adoption, facilitating the development of user-centered and socially responsible smart home technologies.

In conclusion, the analysis of the data underscores the significance of acceptance and adoption of smart home technology, particularly in the context of aging-in-place and assistive technology. The findings highlight the need for ongoing research, international collaboration, and interdisciplinary approaches to drive innovation and create user-centric solutions that enhance the quality of life for individuals and communities.

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