Tech Science Press

Systematic Analysis of Safety and Security Risks in Smart Homes

Habib Ullah Khan[1, *], Mohammad Kamel Alomari[1], Sulaiman Khan[2], Shah Nazir[2], Asif Qumer Gill[3], Alanoud Ali Al-Maadid[4], Zaki Khalid Abu-Shawish[1], Mostafa Kamal Hassan[1]

[1]Department of Accounting and Information Systems, College of Business and Economics, Qatar University, Doha, Qatar

[2] Department of Computer Science, University of Swabi, Swab, Pakistan

[3] University of Technology Sydney, Australia

[4] Department of Finance & Economics, College of Business & Economics, Qatar University, Doha, Qatar

[*]Corresponding Author: Habib Ullah Khan. Email: habib.khan@qu.edu.qa

Abstract: The revolution in the Internet of Things (IoT) based devices and applications has inspired the world by providing smart applications for humans. These applications are ranging from healthcare to traffic flow management, communication devices to smart security devices, and many others. In particular, government and private organizations are showing significant interest in IoT-enabled applications for smart homes . Despite the perceived benefits and interest, there is also a key concern of human safety. This research aims to systematically analyze the available literature on smart homes and identify areas of concerns or risks with a view to support designing safe and secure smart homes. For this systematic review process, this paper analyzed the relevant work in the most reputed journals published during the period 2016 – 2020 (a section of 2020 is included). A final set of 99 relevant articles (journal articles, book sections, conference papers, and survey papers) is analyzed in this study. This analysis is focused around three research questions and relevant keywords. This systematic analysis results and key insights will help the researchers and practitioners to make more informed decisions when dealing with the safety and security risks of smart homes - especially in emergency situations.

1 Introduction

During the last decade, IoT-enabled smart applications have been increasingly integrated into our daily life and related activities such as; healthcare, home, manufacturing and transport [1]. These applications are connected through Internet to enhance and facilitate the way we live, work, and play [2]. IoT-enabled smart home is one of the important area, which is discussed in this paper [2]. A smart home has technologies that facilitate sensing and monitoring of people and home appliances. In short, smart homes are used to monitor and control home surrounded operations and their continuous adaptation. In the last few years, concepts from smart homes have been applied to other areas such as smart healthcare systems [3], energy systems [4], security and emergency management systems [5], comfort and entertainment systems [6].

The smart living environment's automatic transformation mechanism is controlled by the arguing system, which is considered as the brain of the smart living architectures. The smart home arguing system (SHAS) is used to accurately decide for ensuring the security, safety, and comfort of the inhabitants and their surroundings. Keeping this in mind, the researchers significantly explored and studied multiple

artificial intelligence (AI) based systems and their uses for ambient assisted living (AAL) systems. However, there is no systematic mechanism is proposed that investigates the decision support systems (DSS) incorporated in the smart living environments. Chan et al., [7] and Calvaresi et al. [8] reported a review of of the smart living environments. Some others such as; Zaidan et al., [9] and Brand et al., [10] studied the smart homes from a single application domain perspectives such as; IoT based communication components, and privacy concerns of the IoT components in the living environments. Furthermore, Wilson et al., [11] reported on smart home residents and their uses of the underlying infrastructure from socio-technical perspectives. To the best of our knowledge, there is lack of comprehensive systematic literature review work in the current context of human safety and security in smart homes.

This paper presents a systematic literature review (SLR) that examines the aforementioned domain of smart homes from following perspectives:

- Find out the main goal of smart living systems;
- Deliver a new understanding and new knowledge about human safety in a rapidly evolving smart built environment;
- Identify and characterize the key features and requirements of smart livings to ensure safety and security during emergencies;
- Catalogue the tools and features that provide the abilities to monitor, collect, and process real-time human sensors and building data for efficient and effective decision making.

The remainder of the paper is organized as follows; section 2 describes the proposed SLR process adapted for the literature search and analysis. SLR results are reported and discussed in section 3. The limitations of the proposed research work are outlined in section 4 followed by the conclusion and future work in section 5.

2 Review Process

SLR is a well-known process to identify and evaluate the available research work relevant to a particular subject or event of interest. SLR aims to present a fair evaluation of a particular research topic using a rigorous, trustworthy, and auditable methodology [12]. The SLR studies are reported in many fields such as : networking PMIPV6 domains [13] and healthcare big data analytics [14]. The main reasons for performing an SLR are:

- to explore and summarize the existing research work about a particular technology;
- to find the gaps in the available technology that will ultimately lead to future investigations.

In the proposed research work, the SLR process is conducted by following the guidelines suggested by Kitchenham et al., [15, 16]. The proposed review process protocol is depicted in Fig. 1. It consists of three main phases: (1) planning the review process, (2) performing the review process, and (3) reporting the results of the review process. All these steps are discussed in detail in Fig. 1.
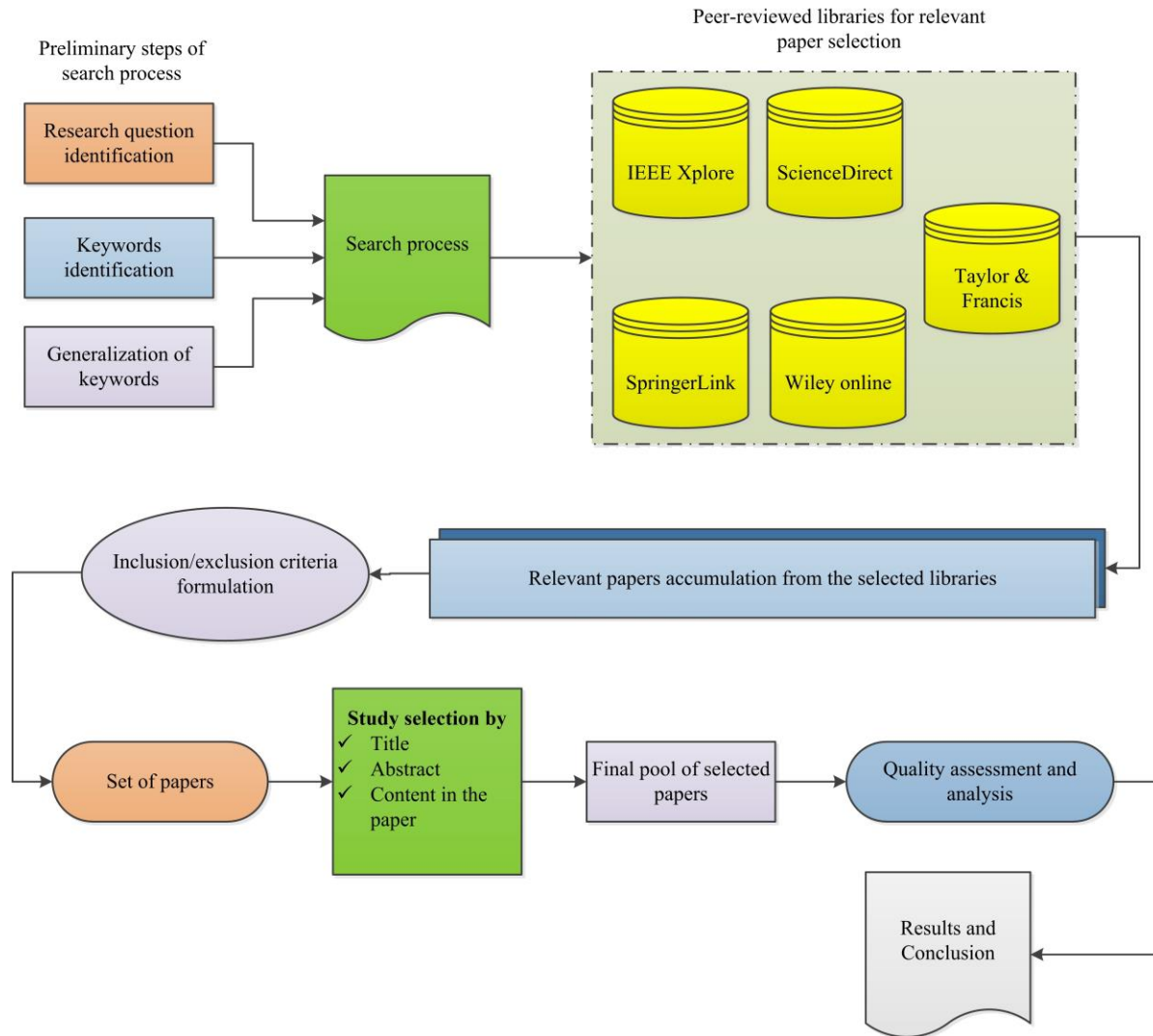
Figure 1: Research protocol of the proposed SLR work

2.1 Planning the Review Process

The proposed systematic review process is performed using the guidelines provided by Kichenham [16, 17]. Based on these guidelines, the researchers must explore the existing evidence on a topic of interest and determine the need for a review process. Furthermore, the study outlines the key pre-review activities: *formulation of the research questions, identification of the keywords and query formulation, selection of the peer-reviewed online digital libraries for the accumulation of the relevant primary articles for the review process, and the inclusion/exclusion criteria.* Accordingly, this systematic review was performed due to the recent increasing research interest in smart homes and smart living environments. We noted that there is a lack of systematic literature review study in the specific context of smart home safety and security risks, in particular during emergency situations.

2.1.1 Formulating the Research Questions

As discussed earlier, research question formulation is an essential activity in conducting the SLR. For defining the most relevant research questions, we followed the Goal-Questions-Metrics approach from Van Solingen et al. [18], and consequently formulated following three research questions as shown in Tab. 1.

Table 1: Set of research questions

S.No	Research questions	Descriptions
RQ1	What are state of the art approaches proposed for the development of smart buildings?	This question summarizes the different state of the art techniques suggested for the development of smart buildings in the smart cities.
RQ2	What hardware components are used for early alarming mechanism in emergency situations?	This question aims to uncover the hardware devices or applications reported in the literature for the early alarming purposes in the case of emergencies.
RQ3	What proactive approaches are developed to reduce life loss or injuries in the smart buildings during emergency situations?	Based on the literature work, this research question aims to accumulate knowledge about various proactive approaches that have been developed to reduce human life loss or injuries in emergency situations by providing guidance, communications, and monitoring facilities.

2.1.2 Identification of Keywords and Query Formulation

After formulating the research questions, the next and most important activity of the SLR is to identify keywords and formulate query to systematically select the most relevant articles from the selected online digital libraries. Keywords and research query is shown in Tab. 2.

Table 2: Keywords and query for the search process

("SMART BUILDINGS" OR "SMART HOME" OR "SMART HOMES" OR "SMART LIVING ENVIROMENTS") AND ("SECURITY" OR "SAFETY" OR "RISKS" OR "THREATS") AND ("EMERGENCY SERVICES" OR "EMERGENCY EVACUATION" OR "COMMUNICATION DEVICES" OR "AUTO CONTROL DEVICES" OR "IOT DEVICES")

2.1.3 Online Digital Libraries Selection

We selected the five well-known online digital libraries to identity relevant research, which are shown in Tab. 3.

Table 3: Online digital libraries for articles accumulation

S.No	Digital library	Hyperlink	Access date
1.	Wiley online	https://onlinelibrary.wiley.com	July 28, 2020
2.	IEEE Xplore	https://ieeexplore.ieee.org/Xplore/home.jsp	July 26, 2020
3.	SpringerLink	https://link.springer.com/	July 27, 2020
4.	ScienceDirect	https://www.sciencedirect.com	July 27, 2020
5.	Taylor & Francis	https://www.tandfonline.com	July 28, 2020

The primary articles are selected and downloaded from these digital libraries based on the defined query. After downloading, these papers are further analyzed and explored to remove the redundant and irrelevant papers, if any. We also removed the irrelevant papers that did discuss the smart building or smart homes. Then the finalized primary articles were merged into a single set or directory. These are the papers that address at least one of the research questions. In summary, 99 research articles are selected as most relevant primary research articles for the purpose of this SLR study.

2.1.4 Inclusion/Exclusion Criteria

Defining inclusion/exclusion is the most challenging job of the SLR research process. This is the main

activity of the SLR process, it ensures the selection of the most relevant primary articles for the final pool of the papers for further quality assessment. Tab. 4 represents the inclusion/exclusion criteria of the primary studies relevant to the proposed research questions in hand.

Table 4: Inclusion or exclusion criteria

Inclusion criteria	
1)	Include only those papers that are reported in English language
2)	Only primary studies are included
3)	Include the papers that are published between 2016 - 2020
4)	Is the paper's title reflects enough knowledge about smart homes, smart living environments, and contains information for emergency exit and safety precautions?
5)	Whether the abstract provides enough information about the smart buildings and safety measures during emergency situations?
6)	Do the contents in the paper provide a proper validation?
Exclusion criteria	
1)	Exclude the papers that are written in other than English language
2)	Ambiguous papers are excluded
3)	Research papers contain less than three pages are excluded
4)	Those papers are excluded that fail to satisfy the inclusion criteria

The selected primary research articles are thoroughly checked and analyzed by all the authors to ensure research validity and avoid any possible omission. Significant attention is given to the last three questions, which are defined for the inclusion of a paper for this study. A voting mechanism is considered for this step. If more than half of the authors agreed to the inclusion of the paper, then the paper was added to the final set of the most relevant articles; otherwise, the paper was excluded. This voting mechanism is based on the paper's title, the abstract, and the contents presented in the research article. The summary of the overall inclusion process is shown in Tab. 5. A final pool of 99 relevant primary articles are selected for the assessment process.

Table 5: Selection of the primary studies for the final pool

Digital library	Articles selected based on			
	Query	Title	Abstract	Content provided
IEEE	1035	546	216	51
ScienceDirect	1399	312	77	10
SpringerLink	2106	276	107	22
Wiley online	883	131	39	9
Taylor & Francis	172	91	37	7
Total				**99**

2.2 Performing the Review Process

After performing the preliminary steps of selecting the online digital libraries, identifying research questions, selecting keywords, and inclusion/exclusion criteria, the next phase is to perform the review process using the research protocol selected in Fig. 1. This activity includes: defining final pool selection, data synthesis, monitoring, and quality assessment processes. All these steps are discussed in detail below.

2.3 Final Pool of Relevant Articles

After sorting the selected digital libraries for the relevant primary articles and performing the inclusion and exclusion process, a final set of 99 relevant articles are selected for the SLR. Final pool of papers includes: workshop papers, conference proceedings, book sections, journal articles, and review/survey articles. Tab. 6 contains details for the selected finalized pool of research articles.

Table 6: Evolution of the final set of relevant papers

Digital library	Journal articles	Conference papers	Book sections	Review papers
IEEE Xplore	[19-25]	[26-66]		[67-69]
ScienceDirect	[70-75]	[76-78]		
SpringerLink	[4, 79-89]	[90-95]	[96-99]	[9-11, 100, 101]
Taylor & Francis	[102-106]			
Wiley online	[107-110]		[111-117]	

The mapping of paper sources is shown in Fig. 2. From Fig. 2, it is concluded that IEEE Xplore contains more papers when compared to other sources . It may reflect the interest of researchers to publish their research work in IEEE Xplore.
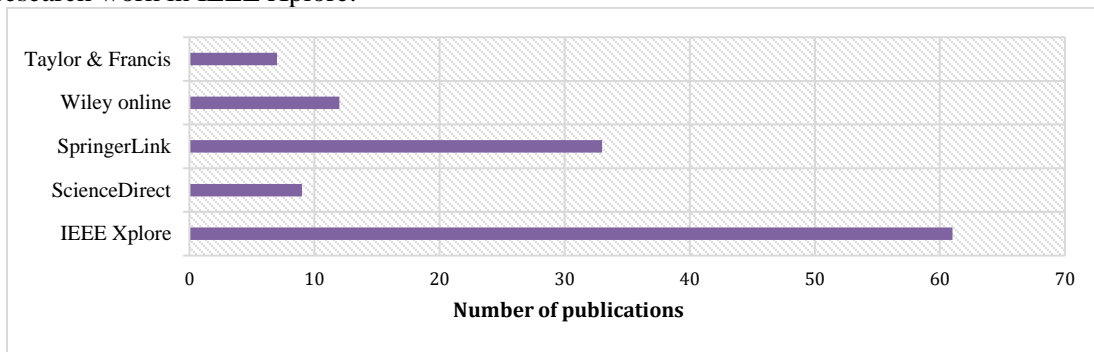

Figure 2: Contribution of each library in the final set of relevant papers

The final paper set is also sorted based on year and publication sources.. It has been observed that the number of publications are increasing with the passage of time, which may reflect the growing interest among research community in the proposed area of research. Fig. 3 shows the sorting results.
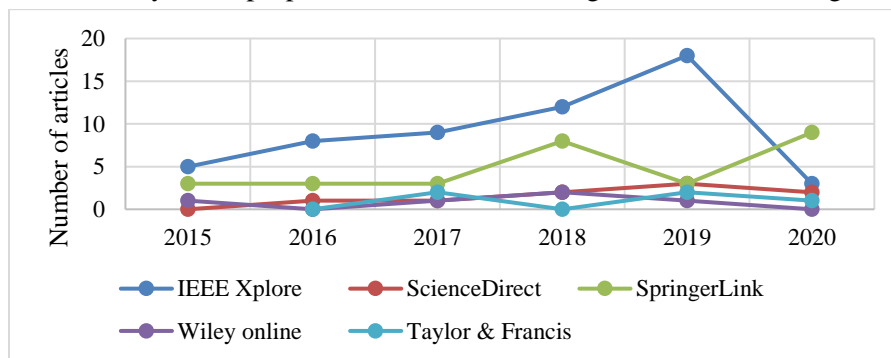

Figure 3: Number of papers in the final set based on the year and online library

Further, the final set of relevant papers is sorted based on the digital library, reference list, the type of the papers, and the publication year as depicted in Fig. 4. In Fig. 4, the outer-shell represents the references

to the primary articles, while the medium shell represents the type of the paper, and most inner-shell represents the date of publication.
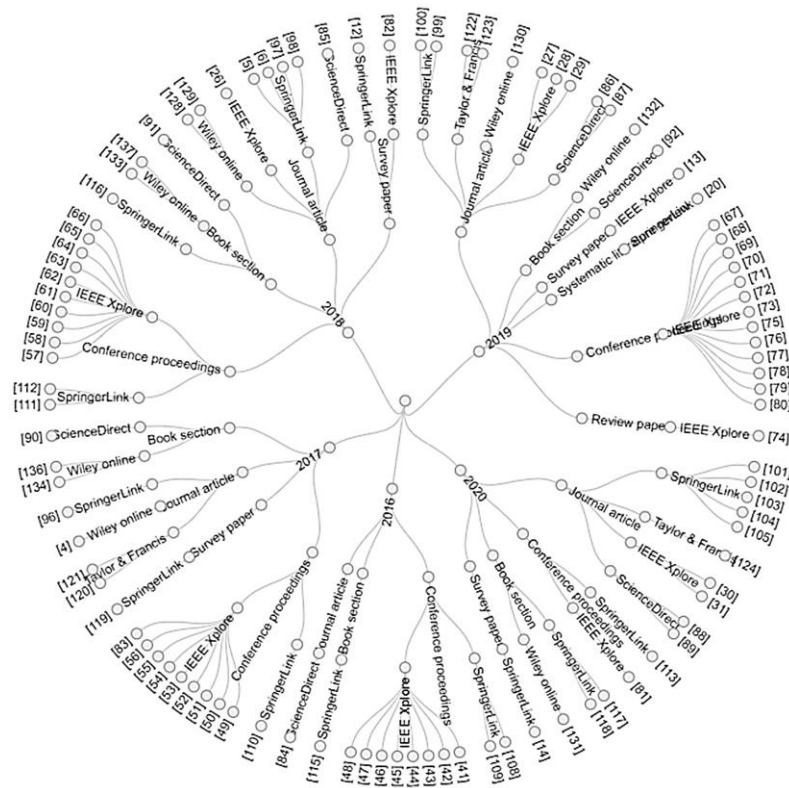

Figure 4: Evolution of the final selected papers

2.4 Quality Assessment

The quality of the selected relevant articles is assessed using the criteria defined in the SLR protocol. The set of relevant articles are reviewed and assessed against each of the research questions and corresponding criteria (QC) depicted in Tab. 7.

Table 7: Quality criteria for the assessment process

Quality criteria	Description of the criteria
QC1	Whether the paper provides detailed information about architecture or design followed for the development of smart buildings in smart cities?
QC2	The paper emphasizes on whether a paper provides in-depth knowledge and understandings about human's safety in rapidly evolving smart environment.
QC4	The paper provides a proactive approach to reduce the life loss and injuries in the emergency situations by providing proper guidance, communication, and monitoring facilities.

This assessment ensured the quality of each selected paper for this SLR. Further, weights are assigned to all research questions based on the following criteria:

- 0 if a paper has no information for the selected research question.

- 0.5 if a paper has a piece of partial but satisfactory information about a research question.
- 1 if a paper contains a full and complete description for the research question.

After performing the quality assessment, the most relevant articles are depicted in Fig. 5.
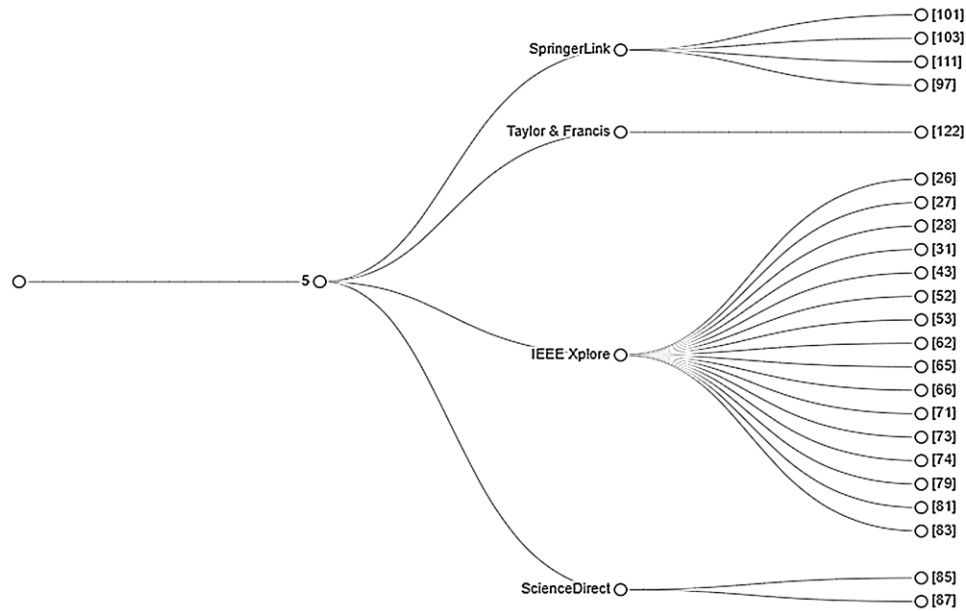

Figure 5: Most relevant research articles

3 Results and Discussions

The results and discussion section is organized into into three sections. Each section provides details to the related research question, which was formulated for this proposed SLR research work.

3.1 RQ1 - What Are State of the Art Approaches Proposed For the Development of Smart Buildings?

This question synthesizes the literature from 2016 – 2020 that discusses the approaches for developing the smart building architectures. Tab. 8 outlines the different approaches proposed for the smart building architectures.

Table 8: List of approaches proposed for smart living environments

S.No	Smart buildings architectures	Descriptions
1.	Smart home, smart office	This book chapter [115] introduces a case study for the smart home or smart office living environments.
2.	High performance building design	This chapter [116] introduces multiple efforts to simulations and emissions that help realize the mitigation goals. It also explains the effects of varying climate conditions and procedures for climate resiliency planning .

3.	Hierarchical combinatorial reliability model	This research article [109] presents a hierarchical and combinatorial mechanism to model and evaluate a smart living system's reliability. The proposed system especially encapsulates a multi-variant decision diagram-based mechanism to address standby sparing, phased-mission, and functional dependence behaviors in the physical layer. The combinatorial strategies are developed using the total probability theorem.
4.	Smart home architecture	These research articles [11] outlines the challenges faced by the researchers in the available designs and architectures of smart livings. Based on the challenges, it presents an optimal solution for smart homes.
5.	Smart home using embedded technology	These research articles [102], [81] proposed a smart home architecture using embedded technology to ensure safety and basic needs of relevant objects.
6.	ambient assisted living (AAL) smart environments	This research article [104] proposed a new mechanism named "Ambient assisted living" smart environments for the South Korean people. As it is believed that South Korea is anticipated to be a super-aged society by the end of 2025. Persistent steps and efforts are made to reduce the burden of maintaining and promoting a productive and healthy lifestyle for elderly people.
7.	Conjugated smart home environment	This paper [106] presents a conjugated single-chip-based controlling unit for controlling the daily tasks (morning wake-up calls, cooking timings), intrusion detection and event control. This also ensures the security and safety of residents in smart environments.
8.	Efficient energy management based smart home interface	This research work [83] aims to develop an IoT-based smart home security system for real-time health monitoring technologies in telemedicine architecture.

3.2 RQ2 - What Hardware Components are Used for Early Alarming Mechanism in Emergency Situations?

Smart homes or smart living environments are developed to facilitate living with high standards and resiliency in normal and emergency situations. Table 9 lists multiple hardware devices or applications that are proposed for early alarming purposes during emergency situations.

Table 9: List of hardware components used for alarming purposes

S.No	Early alarming devices	Descriptions
1.	Energy meter sensor	This book chapter [117] introduces the energy meter sensor-based application for a personal assistant and baby monitoring.
2.	X10, Insteon, ZigBee and Universal Plug-and-Play	Zigbee has gained a significant attention due to pervasive access of embedded devices over the Internet and increasing penetration of wireless protocols in smart living environments. Aburukba et al. [26] suggested ZigBee for aged or disabled person's wellbeing in smart cities.
3.	TRI 2.0, consumer engagement, and perceived risk and trust	This research work [105] contributes new ideas for consumers' preparedness in smart home technology adoption. This combines three significant frameworks – consumer

		engagement, the technology readiness index (TRI) 2.0, and perceived risk and trust. This mechanism aims to learn about humans 'intentions for adopting smart home living environments and living styles.
4.	Infra-red rays, IPCAM's	This paper [106] presents single-chip controlling unit for controlling the daily tasks (morning wake-up calls, cooking timings) for intrusion detection and event control.
5.	IEEE 802.11-series components and heterogeneous sensors	This study [84] characterized IEEE 802.11-enabled wireless networks under jamming attacks and proposed a safe and secure model for smart homes.
6.	LoRaWAN	LoRaWAN is considered a long-range secure communication technology. This research work [87] proposed LoRaWAN for security and communication purposes in smart homes.
7.	Robotbased integrated smart home	This is a robot integrated smart home [71] developed to provide healthcare facilities for the aged persons at a smart home. This is a layered architecture to perform the different tasks of guidance, healthcare, and other facilities for the elderly people.
8.	Fire detection system	This research work [43] proposed an IoT based fire detection system in smart buildings. The system was designed using MQ-135 (CO2), MQ-7 (CO), MQ-2 (smog), and DHT-11 (temperature) sensors that were integrated with Arduino board for accurately sourcing information for fire events .

3.3 RQ3 - What Proactive Approaches are Developed to Reduce Life Loss or Injuries in the Smart Buildings During Emergency Situations?

Smart living environments are developed to ensure human healthcare and security, however, there are still concerns or emergency situations which need to be addressed such as short circuit or other fire issues and earthquake etc. that may adversely impact the smart living environments. This SLR study uncovered a number of approaches, which are listed in Tab. 10.

Table 10: List of proactive approaches to counter emergency situations

S.No	Proactive approaches	Description
1.	Wireless sensor network	This book chapter [113] addressed the common healthcare issues and suggested a wireless sensor-based network architecture to monitor the air quality for carbon dioxide in complex indoor smart living environments. The research articles [29] [35] proposed a wireless sensor network for elderly healthcare purposes in smart living environments.
2.	Smart bed	This paper [108] discusses the test bed using real-time datasets, which is aimed to observe the system's efficiency through different parameters such as: time consumption, response times for attack detection, and storage requirements of the proposed approach.
3.	Remote Health Monitoring of Triage and Priority System	This research work [83] developed an IoT-based smart living security mechanism for telemedicine systems, which intends to support real-time health monitoring.
4.	Observing and restricting the wireless jamming attacks	This study [84] characterized IEEE 802.11-enabled wireless networks' efficiency by proposing a safe and secure model for the smart homes in relation to jamming attacks.

5.	Smart dust surveillance	This chapter [98] introduces multiple smart dust mesh perspectives based on the Internet of Everything and Everywhere (IoEE). It has numerous applications in the field of military and security such as people and product monitoring, eHealth monitoring and environment surveillance.
6.	Nexus services	In this research work [89], researchers proposed a nexus model for smart cities that focuses on collaboration and teamwork services.
7.	RiSH	This is a robot integrated smart home [71] developed to provide healthcare support for the aged persons. This is a layered architecture, which is aimed to support different guidance and healthcare functions for the elderly people.
8.	Heterogeneous mechanism	This study [72] proposed a heterogeneous approach for evidence identification in IoT networks. A case study is performed to validate the solution proposed in their research work.
9.	Business model in European standard	Furszyfer Del Rio et al. [74] proposed a business model for the smart home in Europe. They critically reviewed the available literature with a view to identify and address common problems of security, emergency situations and healthcare in their new business model.
10.	acoustic surveillance system	This research work [19] explores machine learning and their application to acoustic surveillance of abnormal situations. The proposed system's main objective is to help an authorized person to take appropriate actions to prevent life/property loss before or during an emergency.

4 Limitations

The limitations of the proposed research work are listed below:

- Only five digital libraries are selected for this SLR study. However, these libraries provide broader coverage for the peer-reviewed and high-quality research articles.
- A specific range of years (2016 – 2020 (a portion of 2020 is included in the review process)) is selected for this SLR study,. This was done to ensure the inclusion of recent trends and studies relevant to the current context of smart homes. This is also important to set the further research options based on the recent work reported in this SLR study.
- Google Scholar is another informal source of literature, thus it was omitted from this SLR study since the focus was on the systematic selection of only peer-reviewed articles.
- We also excluded the papers that contain the word "smart home" in their title, however, their contents were not meaningful or relevant to the research questions in hand . In other words, papers with only definitions were omitted from this study.

5 Conclusion and Future Work

During the last decade, the IoT device inspired the world by providing state of the art and smart applications for humans. These applications range from smart urban management to smart transportation management, smart healthcare devices, smart electrical and home devices, and many others. One of the most inspiring applications is smart homes that aim to support contemporary living needs of humans. One of the researchers' major concern and challenge is the security and safety of smart home. Embedding security in IoT-based applications has been identified as an opportunity for realizing the vision of smart and energy-efficient homes and buildings. To address this problem, a SLR study is performed to investigate

the available literature published during the period 2016 – 2020 (a portion of 2020 is included in the systematic mapping). This was achieved using the SLR guidelines provided by Kichenham [16], [17].

Five different peer-reviewed online digital libraries are used for sourcing the primary research articles. A total of 99 relevant articles (journal articles, book sections, conference proceedings, and survey papers) are identified for analysis and assessment purposes. This systematic synthesis and analysis of the existing research work will serve as a knowledge-base for researchers and designers who have interest in designing safe and secure smart homes of the future. Further, the results from this SLR study will inform the community about recent research trends in smart homes, which are important for formulating the future research options.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

References

[1]   S. Naoui, M. E. Elhdhili and L. A. Saidane, "Lightweight and secure password based smart home authentication protocol: LSP-SHAP," *Journal of Network and Systems Management*, vol. 27, pp. 1020-1042, 2019.

[2]   G. Lindsay, B. Woods and J. Corman, "Smart homes and the internet of things: Atlantic Council", 2016.

[3]   N. Falcionelli, P. Sernani, A. Brugués, D. N. Mekuria, D. Calvaresi et al., "Indexing the event calculus: towards practical human-readable personal health systems," *Artificial intelligence in medicine*, vol. 96, pp. 154-166, 2019.

[4]   J. Yu, N. Lee, C.-S. Pyo and Y. S. Lee, "WISE: web of object architecture on IoT environment for smart home and building energy management," *The Journal of Supercomputing*, vol. 74, pp. 4403-4418, 2018.

[5]   M. Schneps-Schneppe, A. Maximenko, D. Namiot and D. Malov, "Wired smart home: energy metering, security, and emergency issues," *in 2012 IV International Congress on Ultra Modern Telecommunications and Control Systems*, pp. 405-410, 2012.

[6]   J. R. Velasco, I. Marsá-Maestre, A. Navarro, M. A. López-Carmona, A. J. de Vicente et al., "Location-aware services and interfaces in smart homes using multiagent systems," *PSC*, vol. 5, pp. 104-110, 2005.

[7]   M. Chan, D. Estève, C. Escriba and E. Campo, "A review of smart homes—Present state and future challenges," *Computer methods and programs in biomedicine*, vol. 91, pp. 55-81, 2008.

[8]   D. Calvaresi, D. Cesarini, P. Sernani, M. Marinoni, A. F. Dragoni et al., "Exploring the ambient assisted living domain: a systematic review," *Journal of Ambient Intelligence and Humanized Computing*, vol. 8, pp. 239-257, 2017.

[9]   A. A. Zaidan, B. B. Zaidan, M. Y. Qahtan, O. S. Albahri, A. S. Albahri et al., "A survey on communication components for IoT-based technologies in smart homes," *Telecommunication Systems*, vol. 69, pp. 1-25, 2018.

[10]   D. Brand, F. D. DiGennaro Reed, M. D. Morley, T. G. Erath and M. D. Novak, "A Survey Assessing Privacy Concerns of Smart-Home Services Provided to Individuals with Disabilities," *Behavior Analysis in Practice*, vol. 13, pp. 11-21, 2020.

[11]   C. Wilson, T. Hargreaves and R. Hauxwell-Baldwin, "Smart homes and their users: a systematic analysis and key challenges," *Personal and Ubiquitous Computing*, vol. 19, pp. 463-476, 2015.

[12]   B. Kitchenham, "Procedures for performing systematic reviews," Keele, UK, Keele University, vol. 33, pp. 1-26, 2004.

[13]   A. Hussain, S. Nazir, S. Khan and A. Ullah, "Analysis of PMIPv6 extensions for identifying and assessing the efforts made for solving the issues in the PMIPv6 domain: A systematic review," *Computer Networks*, vol. 179, 2020.

[14]   S. Nazir, S. Khan, H. U. Khan, S. Ali, I. García-Magariño et al., "A comprehensive analysis of healthcare big data management, analytics and scientific programming," *IEEE Access*, vol. 8, pp. 95714-95733, 2020.

[15]   S. Keele, "Guidelines for performing systematic literature reviews in software engineering," *Technical report*, Ver. 2.3 EBSE Technical Report. EBSE2007.

[16]   B. Kitchenham, R. Pretorius, D. Budgen, O. P. Brereton, M. Turner, M. Niazi et al., "Systematic literature reviews in software engineering–a tertiary study," *Information and software technology*, vol. 52, pp. 792-805, 2010.

[17]   B. Kitchenham, Charters and S, "Guidelines for performing systematic literaturereviews in software engineering," *In: Evidence-Based Software Engineering*., 2007.

[18]   R. Van Solingen, V. Basili, G. Caldiera and H. D. Rombach, "Goal question metric (gqm) approach," *Encyclopedia of software engineering*, 2002.

[19]   S. Ntalampiras, I. Potamitis and N. Fakotakis, "Probabilistic novelty detection for acoustic surveillance under real-world conditions," *IEEE Transactions on Multimedia*, vol. 13, pp. 713-719, 2011.

[20]   S. Chiou and Z. Liao, "A real-time, automated and privacy-preserving mobile emergency-medical-service network for informing the closest rescuer to rapidly support mobile-emergency-call victims," *IEEE Access*, vol. 6, pp. 35787-35800, 2018.

[21]   S. Khatoon, S. M. M. Rahman, M. Alrubaian and A. Alamri, "Privacy-preserved, provable secure, mutually authenticated key agreement protocol for healthcare in a smart city environment," *IEEE Access*, vol. 7, pp. 47962-47971, 2019.

[22]   S. A. Shah, D. Z. Seker, M. M. Rathore, S. Hameed, S. B. Yahia et al., "Towards disaster resilient smart cities: can internet of things and big data analytics be the game changers?," *IEEE Access*, vol. 7, pp. 91885-91903, 2019.

[23]   D. Shin, K. Yun, J. Kim, P. V. Astillo, J. Kim et al., "A Security Protocol for Route Optimization in DMM-based smart home iot networks," *IEEE Access*, vol. 7, pp. 142531-142550, 2019.

[24]   X. Luo, L. Yin, C. Li, C. Wang, F. Fang et al., "A lightweight privacy-preserving communication protocol for heterogeneous iot environment," *IEEE Access*, vol. 8, pp. 67192-67204, 2020.

[25]   M. Wazid, A. K. Das, V. Odelu, N. Kumar and W. Susilo, "Secure remote user authenticated key establishment protocol for smart home environment," *IEEE Transactions on Dependable and Secure Computing*, vol. 17, pp. 391-406, 2020.

[26]   R. Aburukba, A. R. Al-Ali, N. Kandil and D. AbuDamis, "Configurable ZigBee-based control system for people with multiple disabilities in smart homes," *in 2016 International Conference on Industrial Informatics and Computer Systems (CIICS)*, pp. 1-5, 2016.

[27]   E. Bajramovic, K. Waedt, A. Ciriello and D. Gupta, "Forensic readiness of smart buildings: preconditions for subsequent cybersecurity tests," *in 2016 IEEE International Smart Cities Conference (ISC2, pp. 1-6)*, 2016.

[28]   S. Escolar, D. Villa, F. J. Villanueva, R. Cantarero and J. C. López, "An adaptive emergency protocol for people evacuation in high-rise buildings," *in 2016 IEEE Symposium on Computers and Communication (ISCC)*, pp. 364-371, 2016.

[29]   R. Gnanavel, P. Anjana, K. S. Nappinnai and N. P. Sahari, "Smart home system using a wireless sensor network for elderly care," *in 2016 Second International Conference on Science Technology Engineering and Management (ICONSTEM)*, pp. 51-55, 2016.

[30]   P. Gupta and J. Chhabra, "IoT based Smart Home design using power and security management," *in 2016 International Conference on Innovation and Challenges in Cyber Security (ICICCS-INBUSH)*, pp. 6-10, 2016.

[31]   X. Hong, C. Yang and C. Rong, "Smart home security monitor system," *in 2016 15th International Symposium on Parallel and Distributed Computing (ISPDC)*, pp. 247-251, 2016.

[32]   J. Nicklas, M. Mamrot, P. Winzer, D. Lichte, S. Marchlewitz, and K. Wolf, "Use case based approach for an integrated consideration of safety and security aspects for smart home applications," *in 2016 11th System of Systems Engineering Conference (SoSE)*, pp. 1-6, 2016.

[33]   S. A. Salami, J. Baek, K. Salah and E. Damiani, "Lightweight encryption for smart home*," in 2016 11th International Conference on Availability, Reliability and Security (ARES)*, pp. 382-388, 2016.

[34]   S. Dharur, C. Hota, and K. Swaminathan, "Energy efficient IoT framework for Smart Buildings," *in 2017 International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC)*, pp. 793-800, 2017.

[35]   R. Fischer, K. Lamshöft, J. Dittmann and C. Vielhauer, "Advanced issues in wireless communication security: Towards a security-demonstrator for smart-home environments," *in 2017 International Carnahan Conference on Security Technology (ICCST)*, pp. 1-6, 2017.

[36]   D. Geneiatakis, I. Kounelis, R. Neisse, I. Nai-Fovino, G. Steri et al., "Security and privacy issues for an IoT based smart home*," in 2017 40th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO)*, pp. 1292-1297, 2017.

[37]   J. E. Hachem, T. A. Khalil, V. Chiprianov, A. Babar and P. Aniorte, "A model driven method to design and analyze secure architectures of systems-of-systems," *in 2017 22nd International Conference on Engineering of Complex Computer Systems (ICECCS)*, pp. 166-169, 2017.

[38]   M. Hajjem, H. Bouziri, E. Talbi and K. Mellouli, "Intelligent indoor evacuation guidance system based on ant colony algorithm*," in 2017 IEEE/ACS 14th International Conference on Computer Systems and Applications (AICCSA)*, pp. 1035-1042, 2017.

[39]   S. Krishnan, M. S. Anjana and S. N. Rao, "Security considerations for IoT in smart buildings," *in 2017 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC)*, pp. 1-4, 2017.

[40]   M. A. Raja, G. R. Reddy, and Ajitha, "Design and implementation of security system for smart home*," in 2017 International Conference on Algorithms, Methodology, Models and Applications in Emerging Technologies (ICAMMAET)*, pp. 1-4, 2017.

[41]   D. A. R. Wati and D. Abadianto, "Design of face detection and recognition system for smart home security application," *in 2017 2nd International conferences on Information Technology, Information Systems and Electrical Engineering (ICITISEE),* pp. 342-347, 2017.

[42]   T. Adiono, S. Harimurti, B. A. Manangkalangi and W. Adijarto, "Design of smart home mobile application with high security and automatic features," *in 2018 3rd International Conference on Intelligent Green Building and Smart Grid (IGBSG),* pp. 1-4, 2018.

[43]   S. K. Bhoi, S. K. Panda, B. N. Padhi, M. K. Swain, B. Hembram et al., "FireDS-IoT: A fire detection system for smart home based on IoT data analytics," *in 2018 International Conference on Information Technology (ICIT),* pp. 161-165, 2018.

[44]   M. Botticelli, L. Ciabattoni, F. Ferracuti, A. Monteriù, S. Pizzuti et al., "A smart home services demonstration: monitoring, control and security services offered to the user," *in 2018 IEEE 8th International Conference on Consumer Electronics - Berlin (ICCE-Berlin)*, pp. 1-4, 2018.

[45]   E. Ertugrul, U. Kocaman and O. K. Sahingoz, "Autonomous aerial navigation and mapping for security of smart buildings," *in 2018 6th International Istanbul Smart Grids and Cities Congress and Fair (ICSG)*, pp. 168-172, 2018.

[46]   V. Haţegan, V. T. Dădarlat, A. Peculea and E. Cebuc, "Secure and extensible smart home template," *in 2018 17th RoEduNet Conference: Networking in Education and Research (RoEduNet),* pp. 1-6, 2018.

[47]   C. C. Li, P. Wu, H. Wang, E. T. H. Chu and J. W. S. Liu, "Building/environment data/information system for fine-scale indoor location specific services," *in 2018 IEEE 2nd International Conference on Fog and Edge Computing (ICFEC)*, pp. 1-8, 2018.

[48]   P. K. Madupu and B. Karthikeyan, "Automatic service request system for security in smart home using IoT," *in 2018 Second International Conference on Electronics, Communication and Aerospace Technology (ICECA)*, pp. 1413-1418, 2018.

[49]   S. Pawar, V. Kithani, S. Ahuja and S. Sahu, "Smart home security using IoT and face recognition," *in 2018 Fourth International Conference on Computing Communication Control and Automation (ICCUBEA)*, pp. 1-6, 2018.

[50]   L. Rafferty, F. Iqbal, S. Aleem, Z. Lu, S. Huang et al., "Intelligent multi-agent collaboration model for smart home iot security," *in 2018 IEEE International Congress on Internet of Things (ICIOT)*, pp. 65-71, 2018.

[51]   Y. Wang, H. Lv, Q. Zhang, P. Wang, D. Yan et al., "Research on smart home security system based on bp neural network information fusion*," in 2018 Chinese Automation Congress (CAC)*, pp. 1381-1384, 2018.

[52]   Y. N. Aung and T. Tantidham, "Ethereum-based emergency service for smart home system: smart contract implementation," *in 2019 21st International Conference on Advanced Communication Technology (ICACT)*, pp. 147-152, 2019.

[53]   T. Chaurasia and P. K. Jain, "Enhanced smart home automation system based on internet of things*," in 2019 Third International conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC)*, pp. 709-713, 2019.

[54]   B. Cui, Z. Lan and X. Bai, "Research on role-based access control in IPv6 smart home," *in 2019 IEEE 9th International Conference on Electronics Information and Emergency Communication (ICEIEC)*, pp. 205-208, 2019.

[55]   H. Hsu, G. Jong, J. Chen and C. Jhe, "Improve IoT security system of smart-home by using support vector machine," *in 2019 IEEE 4th International Conference on Computer and Communication Systems (ICCCS)*, pp. 674-677, 2019.

[56]   K. Karimi and S. Krit, "Smart home-smartphone systems: threats, security requirements and open research challenges," *in 2019 International Conference of Computer Science and Renewable Energies (ICCSRE)*, pp. 1-5, 2019.

[57]   V. Krundyshev and M. Kalinin, "Prevention of false data injections in smart infrastructures," *in 2019 IEEE International Black Sea Conference on Communications and Networking (BlackSeaCom)*, pp. 1-5, 2019.

[58]   V. Nguyen, H. Nguyen, Q. Huynh, N. Venkatasubramanian and K. Kim, "A scalable approach for dynamic evacuation routing in large smart buildings," *in 2019 IEEE International Conference on Smart Computing (SMARTCOMP)*, pp. 292-300, 2019.

[59]   U. Osisiogu, "A review on cyber -physical security of smart buildings and infrastructure," *in 2019 15th International Conference on Electronics, Computer and Computation (ICECCO)*, pp. 1-4, 2019.

[60]   E. Pramunanto, M. Muhtadin and W. Febrian, "Integrated smart safety home system based on wireless sensor network and internet of things as emergency preventive efforts in settlement areas," *in 2019 International Conference on Computer Engineering, Network, and Intelligent Multimedia (CENIM)*, pp. 1-7, 2019.

[61]   H. Qusa, H. Allam, F. Younus, M. Ali and S. Ahmad, "Secure smart home using open security intelligence systems," *in 2019 Sixth HCT Information Technology Trends (ITT)*, pp. 12-17, 2019.

[62]   S. Ramapatruni, S. N. Narayanan, S. Mittal, A. Joshi and K. Joshi, "Anomaly detection models for smart home security," *in 2019 IEEE 5th Intl Conference on Big Data Security on Cloud (BigDataSecurity), IEEE Intl Conference on High Performance and Smart Computing, (HPSC) and IEEE Intl Conference on Intelligent Data and Security (IDS)*, pp. 19-24, 2019.

[63]   J. Tang and Q. Jia, "A simulation platform for sensing system selection for occupant distribution estimation in smart buildings," *in 2019 IEEE 15th International Conference on Automation Science and Engineering (CASE)*, pp. 985-990, 2019.

[64]   T. Tantidham and Y. N. Aung, "Emergency service for smart home system using ethereum blockchain: system and architecture," *in 2019 IEEE International Conference on Pervasive Computing and Communications Workshops (PerCom Workshops)*, pp. 888-893, 2019.

[65]   V. Zhmud, A. Liapidevskiy, H. Roth and J. Nosek, "The concept of a smart home: security, additional features and augmented reality*," in 2019 International Multi-Conference on Industrial Engineering and Modern Technologies (FarEastCon)*, pp. 1-8, 2019.

[66]   A. K. Ray and A. Bagwari, "IoT based Smart home: Security aspects and security architecture," *in 2020 IEEE 9th International Conference on Communication Systems and Network Technologies (CSNT)*, pp. 218-222, 2020.

[67]   V. Subbarao, K. Srinivas and R. S. Pavithr, "A survey on internet of things based smart, digital green and intelligent campus," *in 2019 4th International Conference on Internet of Things: Smart Innovation and Usages (IoT-SIU)*, pp. 1-6, 2019.

[68]   X. Feng, Y. Wang, L. Jiang, Y. Huang and T. Li, "A Survey on internet of things security based on smart home," *in 2018 5th Asia-Pacific World Congress on Computer Science and Engineering (APWC on CSE)*, pp. 84-91, 2018.

[69]   W. Ali, G. Dustgeer, M. Awais and M. A. Shah, "IoT based smart home: security challenges, security requirements and solutions," *in 2017 23rd International Conference on Automation and Computing (ICAC)*, pp. 1-6, 2017.

[70]   A. Jacobsson, M. Boldt and B. Carlsson, "A risk analysis of a smart home automation system," *Future Generation Computer Systems*, vol. 56, pp. 719-733, 2016.

[71]   H. M. Do, M. Pham, W. Sheng, D. Yang and M. Liu, "RiSH: A robot-integrated smart home for elderly care," *Robotics and Autonomous Systems*, vol. 101, pp. 74-92, 2018.

[72]   N. Akatyev and J. I. James, "Evidence identification in IoT networks based on threat assessment," *Future Generation Computer Systems*, vol. 93, pp. 814-821, 2019.

[73]   P. Bhoyar, P. Sahare, S. B. Dhok and R. B. Deshmukh, "Communication technologies and security challenges for internet of things: A comprehensive review," *AEU - International Journal of Electronics and Communications*, vol. 99, pp. 81-99, 2019.

[74]   D. D. Furszyfer Del Rio, B. K. Sovacool, N. Bergman and K. E. Makuch, "Critically reviewing smart home technology applications and business models in Europe," *Energy Policy*, vol. 144, p. 111631, 2020.

[75]   P. P. Ray, D. Dash and N. Kumar, "Sensors for internet of medical things: State-of-the-art, security and privacy issues, challenges and future directions," *Computer Communications*, vol. 160, pp. 111-131, 2020.

[76]   L. Vadillo Moreno, M. L. Martín Ruiz, J. Malagón Hernández, M. Á. Valero Duboy and M. Lindén, "Chapter 14 - The role of smart homes in intelligent homecare and healthcare environments," *in Ambient Assisted Living and Enhanced Living Environments, C. Dobre, C. Mavromoustakis, N. Garcia, R. Goleva, and G. Mastorakis, Eds., ed: Butterworth-Heinemann*, pp. 345-394, 2017.

[77]   L. J. Fennelly and M. A. Perry, "150 things you should know about security," *in 150 Things You Should Know About Security (Second Edition), L. J. Fennelly and M. A. Perry, Eds., ed: Butterworth-Heinemann*, pp. 1-218, 2018.

[78]   R. Saini and D. Mishra, "Chapter 4 - Privacy-aware physical layer security techniques for smart cities," *in Smart Cities Cybersecurity and Privacy, D. B. Rawat and K. Z. Ghafoor, Eds., ed: Elsevier*, pp. 39-56, 2019.

[79]   W. M. Kang, S. Y. Moon and J. H. Park, "An enhanced security framework for home appliances in smart home," *Human-centric Computing and Information Sciences*, vol. 7, p. 6, 2017.

[80]   M. Amiribesheli and H. Bouchachia, "A tailored smart home for dementia care," *Journal of Ambient Intelligence and Humanized Computing*, vol. 9, pp. 1755-1782, 2018.

[81]   E. Park, S. Kim, Y. Kim and S. J. Kwon, "Smart home services as the next mainstream of the ICT industry: determinants of the adoption of smart home services," *Universal Access in the Information Society*, vol. 17, pp. 175-190, 2018.

[82]   H. Xu, L. König, D. Cáliz and H. Schmeck, "A generic user interface for energy management in smart homes," *Energy Informatics*, vol. 1, p. 55, 2018.

[83]   M. Talal, A. A. Zaidan, B. B. Zaidan, A. S. Albahri, A. H. Alamoodi et al., "Smart home-based IoT for real-time and secure remote health monitoring of triage and priority system using body sensors: multi-driven systematic review," *Journal of Medical Systems*, vol. 43, p. 42, 2019.

[84]   X. Wei, T. Wang and C. Tang, "Throughput Analysis of smart buildings-oriented wireless networks under jamming attacks," *Mobile Networks and Applications*, 2019.

[85]   D. R. dos Santos, M. Dagrada and E. Costante, "Leveraging operational technology and the Internet of things to attack smart buildings," *Journal of Computer Virology and Hacking Techniques*, 2020.

[86]   N. Guhr, O. Werth, P. P. H. Blacha and M. H. Breitner, "Privacy concerns in the smart home context," *SN Applied Sciences*, vol. 2, p. 247, 2020.

[87]   S. Naoui, M. E. Elhdhili and L. Azouz Saidane, "Novel Enhanced LoRaWAN Framework for Smart Home Remote Control Security," *Wireless Personal Communications*, vol. 110, pp. 2109-2130, 2020.

[88]   S. Naoui, M. E. Elhdhili and L. A. Saidane, "Collaborative and verifiable key derivation protocol for smart home security: CV-KDP," *Information Technology and Management*, vol. 21, pp. 115-129, 2020.

[89]   P. Tsoutsa, P. Fitsilis, L. Anthopoulos and O. Ragos, "Nexus services in smart city ecosystems," *Journal of the Knowledge Economy*, 2020.

[90]   F. McCreary, A. Zafiroglu and H. Patterson, "The contextual complexity of privacy in smart homes and smart buildings," *in HCI in Business, Government, and Organizations: Information Systems, Cham*, pp. 67-78, 2016.

[91]   J. R. C. Nurse, A. Atamli and A. Martin, "Towards a usable framework for modelling security and privacy risks in the smart home," *in Human Aspects of Information Security, Privacy, and Trust, Cham*, pp. 255-267, 2016.

[92]   R. Chowdhury, H. Ould-Slimane, C. Talhi and M. Cheriet, "Attribute-based encryption for preserving smart home data privacy," *in Enhanced Quality of Life and Smart Living, Cham*, pp. 185-197, 2017.

[93]   M. Buf, B. Guerra and M. Manso, "Smart Devices for Automated Emergency Calls," *in Interoperability, Safety and Security in IoT, Cham*, pp. 27-37, 2018.

[94]   P. K. Sharma, B. W. Kwon and J. H. Park, "DSS-SL: dynamic signage system based on SDN with LiFi communication for smart buildings," *in Advances in Computer Science and Ubiquitous Computing*, Singapore, 2018, pp. 805-810.

[95]   P. S. Ramya and D. Nandan, "Analysis of security issues and possible solutions in the internet of things for home automation system," *in Soft Computing: Theories and Applications*, Singapore, pp. 825-836, 2020.

[96]   V. Varadharajan and S. Bansal, "Data security and privacy in the internet of things (IoT) environment," *in Connectivity Frameworks for Smart Devices: The Internet of Things from a Distributed Computing Perspective, Z. Mahmood, Ed., ed Cham: Springer International Publishing*, pp. 261-281, 2016.

[97]   M. Manso, B. Guerra, C. Carjan, E. Sdongos, A. Bolovinou et al., "The application of telematics and smart devices in emergencies," *in Integration, Interconnection, and Interoperability of IoT Systems, R. Gravina, C. E. Palau, M. Manso, A. Liotta, and G. Fortino, Eds., ed Cham: Springer International Publishing*, pp. 169-197, 2018.

[98]   R. M. Aileni, G. Suciu, M. Serrano, R. Maheswar, C. A. Valderrama Sakuyama et al., "The perspective of smart dust mesh based on ioee for safety and security in the smart cities," *in Integration of WSN and IoT for Smart Cities, S. Rani, R. Maheswar, G. R. Kanagachidambaresan, and P. Jayarajan, Eds., ed Cham: Springer International Publishing*, pp. 151-179, 2020.

[99]   R. T. Kreutzer and M. Sirrenberg, "Fields of application of artificial intelligence—energy sector, smart home, mobility and transport," *in Understanding Artificial Intelligence: Fundamentals, Use Cases and Methods for a Corporate AI Journey, R. T. Kreutzer and M. Sirrenberg, Eds., ed Cham: Springer International Publishing*, pp. 195-210, 2020.

[100]   D. N. Mekuria, P. Sernani, N. Falcionelli and A. F. Dragoni, "Smart home reasoning systems: a systematic literature review," *Journal of Ambient Intelligence and Humanized Computing*, 2019.

[101]   J. Dahmen, D. J. Cook, X. Wang and W. Honglei, "Smart secure homes: a survey of smart home technologies that sense, assess, and respond to security threats," *Journal of Reliable Intelligent Environments*, vol. 3, pp. 83-98, 2017.

[102]   H. Ai and T. Li, "A smart home system based on embedded technology and face recognition technology," *Intelligent Automation & Soft Computing*, vol. 23, pp. 405-418, 2017.

[103]   J. E. Kim, T. Barth, G. Boulos, J. Yackovich, C. Beckel et al., "Seamless integration of heterogeneous devices and access control in smart homes and its evaluation," *Intelligent Buildings International*, vol. 9, pp. 23-39, 2017.

[104]   D. Choi, H. Choi and D. Shon, "Future changes to smart home based on AAL healthcare service," *Journal of Asian Architecture and Building Engineering*, vol. 18, pp. 190-199, 2019/05/04 2019.

[105]   R. Mulcahy, K. Letheren, R. McAndrew, C. Glavas and R. Russell-Bennett, "Are households ready to engage with smart home technology?," *Journal of Marketing Management*, vol. 35, pp. 1370-1400, 2019/10/13 2019.

[106]   M.-C. Chiu, W.-D. Lai and C.-M. Chiu, "A smart home system with security and electrical appliances," *Journal of Information and Optimization Sciences*, pp. 1-17, 2020.

[107]   B. Mbarek, A. Meddeb, W. Ben Jaballah and M. Mosbah, "A secure electric energy management in smart home," *International Journal of Communication Systems*, vol. 30, p. e3347, 2017.

[108]   S. Sicari, A. Rizzardi, D. Miorandi and A. Coen-Porisini, "Securing the smart home: A real case study," *Internet Technology Letters*, vol. 1, p. e22, 2018.

[109]   G. Zhao, L. Xing, Q. Zhang and X. Jia, "A hierarchical combinatorial reliability model for smart home systems," *Quality and Reliability Engineering International*, vol. 34, pp. 37-52, 2018.

[110]   F. Ghasemi, A. Rezaee and A. M. Rahmani, "Structural and behavioral reference model for IoT-based elderly healthcare systems in smart home," *International Journal of Communication Systems*, vol. 32, p. e4002, 2019.

[111]   A. Ali, M. Ahmed, M. Imran and H. A. Khattak, "Security and Privacy Issues in Fog Computing," *in Fog Computing: Theory and Practice*, ed, 105-137, 2020.

[112]   M. Wills, "Network and Communications Security," *in The Official (ISC)2 SSCP CBK Reference*, ed, pp. 467-647, 2019.

[113]   P. Spachos and K. Plataniotis, "Environmental monitoring for smart buildings," *in Transportation and Power Grid in Smart Cities*, ed, pp. 327-354, 2018.

[114]   S. Wendzel, J. Tonejc, J. Kaur, A. Kobekova, H. Song et al., "Cyber security of smart buildings," *in Security and Privacy in Cyber-Physical Systems*, ed, pp. 327-351, 2017.

[115]   H. F. Rashvand and J. M. A. Calero, "Smart Home, Smart Office," in *Distributed Sensor Systems: Practice and Applications* , Wiley, pp.189-219, doi: 10.1002/9781119941354, ed, 2012.

[116]   S. Gunasingh, N. Wang, D. Ahl and S. Schuetter, "Climate resilience and the design of smart buildings," *in Smart Cities: Foundations, Principles, and Applications,*, ed, pp. 641-667, 2017.

[117]   S. Kolhe, S. Nagpal, P. Makwana and C. Bhatt, "Smart Home: Personal Assistant and Baby Monitoring System," *in Emerging Technologies for Health and Medicine: Virtual Reality, Augmented Reality, Artificial Intelligence, Internet of Things, Robotics, Industry 4.0*, ed, pp. 259-284, 2018.