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Systematic Literature Review of Smart Home Monitoring Technologies Based on IoT for the Elderly

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ABSTRACT Smart home technology implementation remains an essential aspect of Internet of Things (IoT). It provides needed living support and convenience for elderly people in society. Despite the remarkable achievements in smart home monitoring technology studies, a systematic literature review (SLR) on smart home technology implementation is lacking. There is a limited number of SLR studies on smart home monitoring technology. Therefore, the current study assesses the literature to collect the evidence regarding studies on smart home monitoring technology implantation. An SLR method involving a manual search was applied to review the articles published from January 2010 to December 2019. To carefully classify these articles accordingly, we applied certain quality assessment criteria. Out of 73 relevant primary studies, only 3% were identified to have applied comprehensive SLR guidelines. Seven percent of the relevant studies were identified to have applied the SLR guidelines in a strongly moderately acceptable manner, but they were not completely comprehensive, whereas 8% of the primary studies applied the SLR guideline in a fairly acceptable manner. This manuscript therefore encourages researchers working on SLR studies on smart home technology to apply comprehensive SLR guidelines that takes into account the quality standard.

INDEX TERMS Internet of Things, smart home technology, elderly people, systematic literature review, monitoring technologies.

I. INTRODUCTION

Smart home technologies are essential for improving living standards among the elderly. As times passes, the number of elderly people in various families and communities increases. For instance, [PS27] reported that the population of elderly people is likely to reach 21% of the world's population in 2040. However, some developed countries like the United States of America, Germany, France, Italy and Japan are concerned by the number of elderly people among their populations [1]. In 1995, the United States Census Bureau reported that the population of elderly people aged 65 and above accounted for 12.8 % of the total population. The forecast shows that by 2025, the population of the elderly in the United States is likely to amount to one fifth of the total population [1]. Similarly, in Japan, the population of the elderly aged 65 and above accounts for 16% of the total population as at 1999 [1].

As the number of elderly citizens increases, there is a likelihood that they will represent an increased burden on healthcare as well as on social services. As such, there will be increase in demand for services in terms of technologies to address the urgent needs of the aging population. These technologies, when implemented properly, will not only improve the quality of life among the elderly, but also assist the caregivers in providing adequate services to these elderly people in society. Undoubtedly, these senior citizens need attention as well as the means to aid their daily activities. With emphasis on health care, smart home technologies through the emergence of Information and Communication Technology (ICT) can provide conducive living environments for the elderly [PS51], [2]–[6].

Furthermore, with the increasing standard of evolution in aspects of IoT, there are reliable devices and sensors

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embedded in the emerging technologies to address the numerous needs of the elderly population [7]. These devices can competitively offer reliable services as well as functionalities that are appropriate in providing suitable health and social benefits to the elderly through a smart home. A smart home can be understood as an interaction between technology and services that can be achieved through a home network for better living conditions [8], [9]. Creating a smart home for the elderly populace will in turn create significant benefits for the inhabitants. For instance, (1) it creates an avenue for an easy lifestyle; a therapy for peace of mind among the elderly and those who take care of them. Through smart technology, one can be alerted in the case of an emergency, (ii) certain wireless communication devices such as Z-Ware and ZigBee have the ability to provide some energy efficiency savings such that these devices can automatically regulate their functionalities based on command for use, which in turn reduces the utility bills within the smart home [8], (iii) for the aging population, smart home technology has the ability to notify the inhabitants of the appropriate time for medication. In addition, most hospitals may be notified in case of emergency for immediate response, (iv) the smart home technology requires no formal training and can be easily operated by the end user. Notably, the smart home technology makes it possible for the elderly to live in the comfort of their homes, particularly those aged people with disabilities [9].

However, despite the remarkable achievements in smart home technology research, a comprehensive and standard record of studies on existing smart home health monitoring technologies is lacking. To fill this gap, the current SLR study is undertaken to discover the existing smart home health monitoring technologies being applied to improve the standard of living among elderly citizens. The purpose is to review the literature that followed a standard approach in their reporting of existing smart home health monitoring technologies for the elderly since January 2010 to December 2019, with a specific focus on SLR articles. This period of time was chosen to reveal the latest smart home technologies, if any, in the literature as well as to determine articles that followed a systematic reporting to support the decision making process for the implementation of smart home technologies to meet the needs of the elderly. Using articles that followed a systematic literature review (SLR) process, the current study performs a quality evaluation on these articles based on certain quality criteria.

To clarified more on the use of terminology. Notably, smart home as an interaction between technology and services which can be achieved through a home network for a better living condition as applied in the current SLR study mainly targeted towards the elderly people. And as means of providing long-term health monitoring as well as healthcare service delivery [10], [11]. However, there are certain smart home technology that serves both the elderly needs as well as a general smart living condition. For instance, the emergency detection and safety monitoring technology are of essence in smart homes. Therefore, both smart home monitoring technology and smart home health monitoring technology are used interchangeably, but refers to the same measure.

The methodology is described in section 2 and in section 3 we present our results. In section 4, we answer the four major research questions formulated in our SLR study, and we present our conclusions in section 5.

A. EXISTING SMART HOME HEALTH MONITORING TECHNOLOGIES

This section presents the existing smart home health monitoring technologies identified in the literature. Smart home health monitoring technology utilizes certain electrical devices, for instance, sensors as well as other gadgets connected to the Internet of Things (IoT) which can be accessed remotely and provide the needed feedback to satisfy the end user. Some of the existing smart home health monitoring technologies as reported by [9] includes: physiological monitoring, functional monitoring/emergency detection and response, safety monitoring and assistance, security monitoring and assistance, social interaction monitoring and assistance, and cognitive and sensory assistance, respectively.

1) PHYSIOLOGICAL MONITORING

This is a type of health monitoring technology that entails assembling, grouping and investigating facts regarding physiological conditions (the normal functioning of humans and their body parts). For instance, blood pressure, sugar level, respiration, body temperature and other vital signs that show the state of essential body functions [12]–[15].

2) FUNCTIONAL MONITORING/EMERGENCY DETECTION AND RESPONSE

This health monitoring technology involves accessing, grouping and measuring information regarding functional evaluation in the human body. For instance, a person's emotions, manner of walking, amount of food intake, as well as other daily activities [16]–[18]. On the other hand, emergency detection is necessary and involves monitoring information that may prompt an unusual or critical condition, such as falls, which may also cause serious injuries [19], [20].

3) SAFETY MONITORING AND ASSISTANCE

Safety monitoring and assistance involves analyzing data and measures regarding the detection of environmental dangers that may pose a potential threat to the surroundings and consequently result in an adverse effect on human health [21]–[24]. For instance, a gas leak or fire. When such situations arise, safety assistance is provided to ensure human safety at all times. A good example, as noted earlier, is the ability to turn off gas when a leak occurs.

4) SECURITY MONITORING AND ASSISTANCE

Security monitoring and assistance involves both security and event monitoring, which deals with detecting as well as analyzing information regarding human threats or suspicious movement within an environment [25]–[28]. In the event of

TABLE 1. Lists of smart home projects.

S/N	Project	Location	Technology	End User	Ref ID
1	Welfare Techno-House project	Japan	Sensory assistance	Aging population and people with disabilities	[35]
2	Vallgossen Project	Sweden	Security monitoring assistance	General public	[36]
3	Tiger Place	University of Missouri-Columbia	Sensory assistance	Assisted living residents	[37]
4	Smart Hone of the Netherlands	Tilburg, The Netherlands	Safety monitoring assistance	General public	[9]
5	SmartBo and SmartLab	Swedish Handicap Institute, Sweden	Safety monitoring assistance	People with disabilities	[38]
6	Smart Medical Home	University of Rochester, New York	Sensory assistance	General public and older adults	[39]
7	Duke's Smart Home	Duke University, North Carolina	Safety monitoring	General public	[40]
8	Seven Oaks	Londonery,Northern Ireland	Safety monitoring	People with dementia	[41]
9	Safe-at-Home Project	Northampton, United Kingdom	Safety monitoring		[42]
10	PROSAFE	Toulouse, France	Sensory assistance	People with Alzheimer	[43]
11	PlaceLab	Massachusetts Institute of Technology, USA	Sensory assistance	General public	[44]
12	Oatfield Estate	Oregon, USA	Sensory assistance	Aging population of an assisted living	[45]
13	Mav Home	University of Texas, USA	Safety assistance	General Population	[46]
14	Health Integrated Smart Home Information System	University Hospital Centre of Grenoble, France	Sensory assistance	Older adults	[47]
15	Gloucester Smart Home	United Kingdom	Sensory assistance	Person with dementia	[48]
16	Gator Tech Smart House	Rehabilitation Engineering Research Centre on Technology for Successful Aging University of Florida, USA	Sensory assistance	Older adults	[49]
17	Enable Project	England, Finland, Ireland, Lithuania, Norway	Safety monitoring	People with early dementia	[50]
18	ComHome	Sweden	Social interaction monitoring, cognitive assistance	People cognitive disabilities	[51]
19	BesTA Project	Norway	Safety monitoring	People with early dementia	[50]
20	Aware Home	Georgia Institute of Technology, USA	Social interaction monitoring, cognitive assistance and sensory monitoring	Aging and general population	[52]
21	Assisted Interactive Dwelling House	United Kingdom	Sensory assistance and safety monitoring	Elderly population ans people with disabilities	[53]

unauthorized behavior, the security monitoring system raises an alert for necessary measures to be taken while ensuring the safety of individuals.

5) SOCIAL INTERACTION MONITORING AND ASSISTANCE

Social interaction includes interaction with friends online, phone calls, and movies. The monitoring technology for social interaction provides the means to support these interactions in a more convenient manner for individuals. For instance, allowing the aging population to interact with their grandchildren via online video communication as well as to encourage independent living [29]–[31].

6) COGNITIVE AND SENSORY ASSISTANCE

Smart technology provides cognitive assistance to the elderly in such a way that an automated reminder is programmed to initiate a medication reminder or enable safe driving behaviors as reported by the authors of [26], [32] and [33]. Through machine learning techniques, these monitoring sensors can learn accurately while providing further assistance. For in- stance, if an item like a house key is missing, these sensors can precisely indicate the location of the lost item. Also, these monitoring tolls can provide sensitive instructions as well as guide on how to use a specific gadget or household appliances [34]. Other types of sensory assistance include; hearing aids, sense of sight as well as sense of touch.

The list of existing smart home projects, their locations, the type of monitoring technology applied as well as the target users are presented in Table 1. The need to present this list of existing smart home projects cannot be over-emphasized, because it is important to have a comprehensive number of existing smart homes in the domain investigated in the current study. In addition, it is important to aggregate the existing projects as evidence to encourage researchers working in

smart technology to report more smart home projects and the technology enhancements applied in these projects.

II. METHODOLOGY

To achieve the objectives of the current SLR study, we followed the standard and original guidelines proposed by Kitchenham [54]. This section presents the method used to undertake the current SLR of smart home technology implementation for the elderly. The stages of our methodology include:

(1). Planning
(2). Formulation of research questions
(3). Search process
(4). Inclusion and exclusion criteria
(5). Quality assessment
(6). Data collection
(7). Data analysis

A. THE PLANNING STAGE

During the planning phase, we identified the steps necessary for us to accomplish the objectives of the current study. At this initial stage, we ensured that both the strategic and technical plans were properly formulated. This would ensure that the other phases of the proposed methodology were properly carried out in an organized and standard manner. This planning stage formed the basis for a successful implementation of the proposed SLR methodology.

B. FORMULATION OF RESEARCH QUESTIONS AND THEIR MOTIVATIONS

In this subsection, we present the research questions investigated in the current SLR study as well as their motivations. The researchers' motivations come from the noteworthy achievements of the work done in the smart home technology domain. For instance [7], [55]–[57], [58], [59] have indicated that smart home technology is essential to improve living conditions for the elderly as well as those with disabilities. The research questions **RQs** investigated in our study are:

RQ1. How many **SLRs** with primary studies on smart home technology implementation for the elderly have there been since 2010?

***Motivation for RQ1**

It is important to investigate the number of studies on smart home technology systematically reported in the literature. Therefore, RQ1 is motivated by the need to aggregate the number of SLRs on smart home technology in the past decade that applied the comprehensive SLR guidelines.

RQ2. How do researchers working on smart home technology report the technology applied in smart homes for the elderly?

***Motivation for RQ2**

RQ2 is motivated by the need to discover the means by which the researchers conducted and reported the existing smart home technologies in the literature with emphasis on improving the standard of living among the aging population.

RQ3. How do the reported smart home technologies address the needs of the elderly?

***Motivation for RQ3**

The motivation for RQ3 is to address the achievement and results of existing studies on smart home technology to have a clearer understanding of how each of the reported studies on smart home technology addresses the needs of the elderly. This quest to have a clearer view of the implementation of smart home technologies motivated RQ3.

RQ4. What are the limitations of the current smart home technology research?

***Motivation for RQ4**

For RQ4, the motivation is the need to discover the shortcomings in SLR studies, if any, in the literature and in addition, to provide answers to the explicitly defined research questions (RQ4.1 and RQ4.2) which raise concerns about the lack of SLR studies in the current research domain.

To answer these research question, certain factors were considered. First, to address RQ1, the researchers carefully searched for SLR articles based on their topic areas related to smart home technology implementation and also identified other relevant information regarding such articles, including the year of publication and the journal title. Second, to address RQ2, the researchers focused on articles related to existing smart home technologies and their application. To address RQ3, we focused more on the output achieved in the related articles chosen in the current study. With respect to RQ4, the researchers were concerned with limitations of current smart home technology SLR studies. To accurately capture these concerns, RQ4 is split into two distinct subquestions:

RQ4.1. Are the existing SLR studies on smart home technology for the elderly limited in number?

RQ4.2. Is there evidence to support the claim that the existing SLR studies on smart home technology for the elderly are lacking?

C. SEARCH PROCESS

In this subsection, we describe how each article was identified for this study. For the purpose of extracting relevant SLR studies on smart home technology implementation for the elderly, a number of electronic databases were considered and accessed. The list of databases searched and their corresponding URL is presented in Table 1. Each article was extracted from an electronic database using the conventional manual search process from journals and conference proceedings respectively.

To search these electronic databases, the researchers formulated the following search string:

(Smart home OR smart homes) AND (technology OR technologies OR application OR applications) AND (monitoring OR tracking OR watching) AND (health OR healthy OR state of health) AND (IoT OR Internet of Things) AND (elderly OR advanced OR aging population OR senior OR seniors OR aged OR old OR older OR older people OR older citizens)

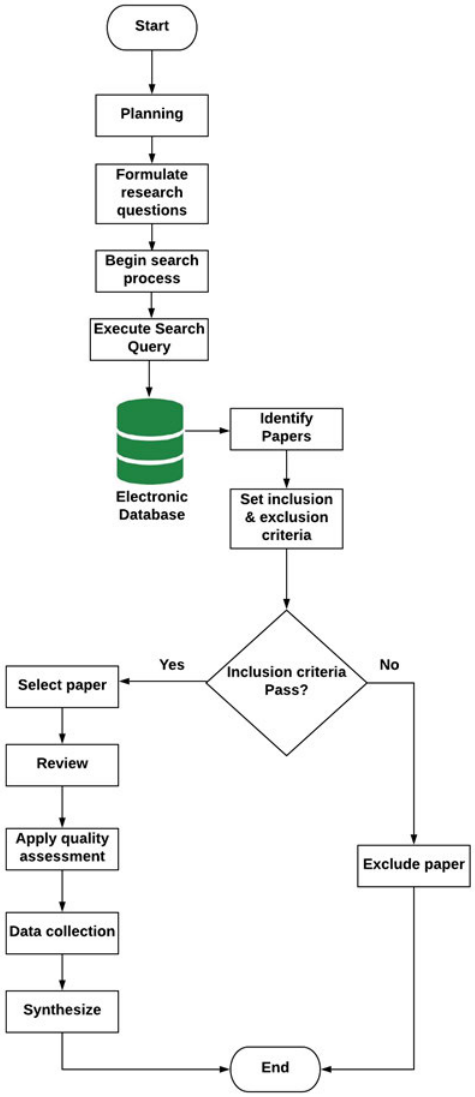

FIGURE 1. Search process flowchart.

D. INCLUSION AND EXCLUSION CRITERIA

The studies included in this SLR were based on certain criteria that determined whether a study met the condition for inclusion, otherwise such a study would be excluded. One of the important conditions each article was expected to meet was that each needed to be written in accurate and understandable English. Articles written in a different language were not included in the current study because such articles would be difficult to read and understand. The list of criteria for inclusion and exclusion is presented in Table 2

E. QUALITY ASSESSMENT

In line with the proposed methodology, this subsection presents the quality assessment approach applied to evaluate the quality of each article selected. The quality of each article included in the current study is important in order to ensure that high standard SLR studies related to smart home technology are made available and to avoid bias in terms

TABLE 2. Lists of electronic databases searched.

Electronic database	Url
Scopus	www.scopus.com
SpingerLink	www.link.springer.com
IEEE Explore	www.ieeexplore.ieee.org
Web of Science	www.webofknowledge.com
ACM Digital Library	www.dl.acm.org
Google scholar	www.scholar.google.com
ScienceDirect	www.sciencedirect.com
Wiley online library	www.onlinelibrary.wiley.com
IET software Digital Library	www.digital-library.theiet.org

TABLE 3. Inclusion and exclusion criteria.

Inclusion criteria (article must)	Exclusion criteria (article must **NOT**
(**a**). Each article must be written in a simple and understandable English reported in a publication article. (**b**). Each article must be published within January 2010 - December 2019 (**c**). Each article must be related to smart home technology for elderly. (**d**).Each article must report an approach to smart home technology implementation for elderly or proof of an empirical study addressing the research questions.	(**a**). Article must not be written in a different language than English. (**b**). Be published outside the period of time specified (**c**). Focus on Kids and teenagers. (**d**). Deviate from answering the research questions.

of the quality of existing studies available in the literature. In addition, it also encourages researchers to apply quality checks while conducting SLR studies to aid the decision making process. Using a quality assessment (QA) measure, it may be easier to identify articles with reliable information which can support the decision making process in smart home technology implementation projects. This study applied the York University Center for Reviews and Dissemination **CDR** Database of Abstracts of Reviews of Effect **DARE** criteria that has been applied in several in- formation technology SLR studies, for instance [54] and [60]. The (**DARE**) criteria was based on four quality assessment questions QA_{Qn} namely:

QA_{Q1} which deals with inclusion and exclusion criteria.

QA_{Q2} which deals with the relevant literature/database searched.

QA_{Q3} which deals with quality and/or validity of primary studies.

QA_{Q4} which deals with study/design and description.

Each of these quality assessments is described according to [54] as follows:

QA_{Q1}. Are the reviews inclusion and exclusion criteria described and appropriate?

QA_{Q2}. Is the literature search likely to have covered all relevant studies?

QA_{Q3}. Did the reviewers assess the quality|validity of the included studies?

QA_{Q4}. Were the basic data|studies adequately described?

To address these quality assessment questions, the researchers assigned respective scoring criteria as follows: First, we introduce Y which represents "YES", P which represents "Partial" and N which represents "NO". Further- more, the quality scoring was done as follows: YES = Y = 1, Partially = P = 0.5, No = N = 0. In relation to each question:

QA_{Q1} = Y, if the condition in QA_{Q1} which deals with the inclusion criteria are explicitly stated in the research study. Partially (P) if the condition in QA_{Q1} is not clearly met in the study and N = 0, if the condition is not met with no evidence reported in the study.

QA_{Q2}, Y = 1, provided an article is reported to have obtained relevant information from not less than 5 digital databases. P = 0.5 if the electronic databases searched is 3 to 4, N = 0, if electronic databases searched is less than 3.

QA_{Q3} = Y = 1, provided an article reports separately the quality criteria as well as the research questions. P = 0.5 if such an article does not report both research questions and quality assessment separately. N = 0, if no evidence of quality assessment is reported.

QA_{Q4} = Y = 1, if the study is properly presented with detailed description of basic data. P = 0.5 if partially presented and N = 0 if such an article lacks proper description of basic data/studies.

F. DATA COLLECTION

To avoid conflicts of interest, the authors of this manuscript explicitly and independently reviewed the studies included in the study. However, during the review process, in a situation where concerns were raised regarding an article, the authors collectively agreed and addressed the situation. It is important to note that much attention was given to articles which address the research questions investigated in this study as well those articles with conditions for both inclusion and exclusion criteria respectively. The authors placed more emphasis on the type of information extracted from each article, with more attention to information related to smart home technology implementation for the elderly as well as relevant information on existing smart home projects. Certain data were extracted from each article included in the study, including the following;

1. The author(s) details.
2. The topic area.
3. Their institutions and country.
4. The details of the response to our research questions.
5. Year of publication.
6. Details of the quality assessment contained in each article.
7. The type of publication and the number of primary studies reported in each article.

With the objective in mind, we ensured that the current SLR study applies the Preferred Reporting Items for Systematic Review and Meta Analysis (PRISMA). The

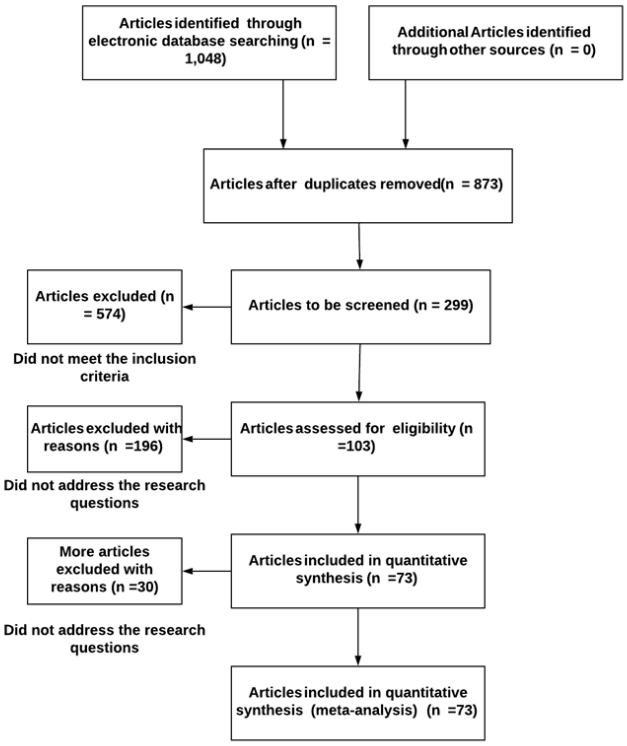

FIGURE 2. Prisma digram.

PRISMA is implemented in the current study as a measure to show detailed information concerning the total number of articles considered in the current study, as presented in Figure 2.

We focused on the specific information from each article related to data pre-processing, cleaning, preparation, purification and sanitization associated with the imbalanced existing data sets. Also, we considered articles that addressed some]state of the art data issues]including: class imbalance, data heterogeneity, high skewness, privacy, irrelevant and redundant features, continuous data, collinearity among metrics and noise in data. The data collected from each study includes:

a. The Journal or conference source
b. The research scope and topic areas
c. Author(s) details with their respective institutions and country where the paper was published
d. Summary of each study including the research questions and responses to each question.
e. Quality assessment of each paper
f. The number of primary studies applied in the paper.

G. DATA ANALYSIS

To ensure a clear understanding and presentation of the data obtained from relevant articles included in this study, the authors considered certain statistical tools. For instance, tables were used in the current study to present the information extracted from the primary studies, which attempts to address our RQ1 and RQ2 respectively. Through a clearer

TABLE 4. Primary studies.

Ref ID	Author(s)	Topic area & Type of technology	Institution	Country	Year	Publication
[PS15]	Djaja-Josko et al.	Safety monitoring & Architecture	Warsaw University of Technology	Poland	2015	Conference
[PS63]	Sun et al.	Physiological monitoring & Real-time implementation	University of Pittsburgh	United States	2014	Conference
[PS3]	Azimi et al.	Physiological monitoring & System examination	University of Turku	Finland	2016	Journal
[PS17]	Gagne et al.	Safety monitoring & Real-time implementation	Harvard medical school	United States	2012	Journal
[PS59]	Sharma et al.	Cognitive and sensory assistance & System examination	Nanyang Technological University	Singapore	2016	Conference
[PS8]	Cayla et al.	Functional monitoring & Real-time implementation	Pitié-Salpètrière University Hospital	France	2014	Journal
[PS9]	Cayla et al.	Functional monitoring & System examination	Universitaire Timone, Marseille	France	2016	Journal
[PS64]	Suryadevara et al.	Functional monitoring & Real-time implementation	Massey University	New Zealand	2012	Journal
[PS30]	Kim et al.	Safety monitoring & Real-time implementation	Chung-Ang University, Seoul	Korea	2013	Journal
[PS58]	Sharkey et al.	Safety monitoring & System examination	University of Sheffield	United Kingdom	2012	Journal
[PS36]	Maclure et al.	Safety monitoring & System examination	University of British Columbia	Canada	2012	Journal
[PS43]	Ou et al.	Cognitive and sensory assistance & Architecture	National Cheng Kung University	Taiwan	2013	Conference
[PS24]	Jackson et al.	Safety monitoring & system examination	University of Virginia	United States	2013	Journal
[PS10]	Cesta et al.	Functional monitoring & System examination	Orebro University	Sweden	2011	Journal
[PS57]	Rodrigues et al.	Functional monitoring & Real-time	Polytechnic Institute of Coimbra	Portugal	2013	Journal
[PS65]	van der Maarel-Wierink et al.	Safety monitoring & System examination	Radbound University	The Netherlands	2013	Journal
[PS14]	de Bruin et al.	Safety monitoring & System examination	Centre for Prevention and Health Services Research	The Netherlands	2012	Journal
[PS47]	Peek et al.	Cognitive and sensory asistance & System examination	Fontys University of Applied Sciences	The Netherlands	2014	Journal
[PS5]	Bemelmans et al.	Social interaction & System examination	Zuyd University	The Netherlands	2012	Journal
[PS39]	Miller et al.	Cognitive and sensory assistance & System examination	University of Arizona	United States	2015	Journal
[PS55]	Rebok et al.	Cognitive and sensory assistance & Real-time implementation	Johns Hopkins University	United States	2014	Journal
[PS34]	Lin et al.	Cognitive and sensory assistance & Real-time implementation	The Johns Hopkins School of Medicine	United States	2013	Journal
[PS69]	Warren et al.	Safety monitoring & Real-time	University of Auckland	New Zealand	2010	Journal
[PS31]	Kyriacos et al.	Physiological monitoring & System examination	University of Cape Town	South Africa	2011	Journal
[PS21]	Ha et al.	Physiological monitoring & System examination	University of California	United States	2014	Journal

presentation of studies related to smart home technology, it will easier to identify studies that followed the SLR standard. Also, the list of existing smart home technology projects is presented clearly using tables. Other statistical tools applied in the current study include: (i) a pie chart to demonstrate the percentage of publications with corresponding years and (ii) a bar chart to demonstrate clearly the number of primary studies published within the period selected for this study.

III. RESULTS

The authors present in this section the summary of the results of the current SLR study based on the following key factors: (i) search results, (ii) quality evaluation, and (iii) quality factors.

A. SEARCH RESULTS

The search results are based on the series of search strings presented in Section II. A total of 73 primary studies were systematically synthesized in the current SLR. This number was achieved after vigorous screening of the articles selected in the current study. Notably, the authors concentrated on studies that met the inclusion criteria as presented in Section II. The results obtained through our search process are presented in Table 4 and 5, respectively. In these tables are the lists of the primary studies included in the current SLR, which show the following: meta date, the study id, authors, topic area, their corresponding institutions, countries, year of publication as well as the publication type. Of the 73 included studies, 15 articles (21% of the total primary studies) were identified as conference articles, whereas 58 papers were identified as

TABLE 5. Primary studies.

Ref ID	Author(s)	Topic area & Type of technology	Institution	Country	Year	Publication
[PS20]	Graham et al.	Physiological monitoring & Real-time implementation	The Johns Hopkins Hospital, Maryland	United States	2010	Journal
[PS61]	Sparkes et al.	Physiological monitoring & System examination	Birmingham City University	United Kingdom	2010	Journal
[PS26]	Kang et al.	Physiological monitoring & System examination	Califonia State Polytechnic University	United States	2010	Journal
[PS7]	Brownsell et al.	Cognitive and sensory assistance & System examination	University of Sheffield	United States	2011	Journal
[PS62]	Steinman et al.	Safety monitoring & System examination	University of California	United States	2011	Journal
[PS6]	Bolton et al.	Safety monitoring & System examination	University of Nottingham	United Kingdom	2011	Journal
[PS16]	Fogli et al.	General & System examination	Universitá degli Studi Brescia	Italy	2016	Conference
[PS42]	Motti et al.	Safety monitoring & System examination	Université de Toulouse	France	2013	Conference
[PS18]	Genet et al.	Safety monitoring & System examination	NEVEL-Netherlands Istitute for Health Services Research	The Netherlands	2017	Journal
[PS23]	Jacelon & Allen	Safety Monitoring & System examination	University of Massatchusetts	United States	2013	Journal
[PS38]	McCrow et al.	Safety monitoring & System examination	Institute of Health and Biomedical Innovation, Brisbane	Australia	2013	Journal
[PS32]	Lê et al.	Safety monitoring & System examination	University of Tasmania	Australia	2012	Journal
[PS4]	Bakkes et al.	Safety monitoring & System examination	Amsterdam University of Applied Sciences	The Netherlands	2011	Conference
[PS60]	Shoaib et al.	Safety monitoring & Real-time implementation	Leibniz Universit ”a Hannover	Germany	2010	Conference
[PS19]	Gokalp & Clarke	Safety monitoring & System examination	Brunel University	United Kingdom	2013	Journal
[PS54]	Rashidi & Mihailidis	Safety monitoring & System examination	Northwestern University, Chicago	United States	2012	Journal
[PS22]	Hwang & Braun	Physiological monitoring & System examination	University of Hawai'i	United States	2015	Journal
[PS73]	Zwijsen et al.	Safety monitoring & System examination	VU University Medical Centre, Amsterdam	The Netherlands	2011	Journal
[PS50]	Peetoom et al.	Safety monitoring & System examination	Zuyd University of Applied Sciences	The Netherlands	2015	Journal
[PS41]	Rana Mostaghel	Safety monitoring & System examination	Linnaeus University	Sweden	2016	Journal
[PS27]	Khosravi et al.	Safety monitoring & System examination	Griffin University, Gold Coast	Australia	2016	Journal

articles in journals (79% of the studies). It it also important to report that of the 73 articles, only 2 articles ([PS35] and [PS47]) were identified as articles reported to to have applied a comprehensive SLR guidelines. These 2 articles represent 3 % of the total studies included in the current study. It therefore indicates a lack in SLR studies of smart home technology for the elderly. We also wish to report that our search strings produced articles that were excluded. The reason for exclusion is presented in the inclusion and exclusion criteria presented in Section II.

The articles excluded were based on the set criteria for exclusion. Note Articles written in a different language than English language is excluded, articles published before 2010 were also excluded, article that are not related to smart home technology or smart home health monitoring technology were also excluded. In addition, any article or articles which does not address any of the research questions were also excluded. Whereas articles that met the inclusion criteria were included.

B. QUALITY EVALUATION

As pointed out earlier, this SLR study applied the York University Center for Reviews and Dissemination (CDR) Database of Abstracts of Reviews of Effect (DARE) criteria to assess the quality of the studies. This quality evaluation criteria has been applied in previous studies, for instance [54] and [60]. The authors of the current manuscript accessed the individual quality scores of all 73 primary studies. The results obtained by each study are presented in Table 7. The results show that based on the 4 quality assessment questions, an article scores at least 0.5 out of 4. Of the 73 studies, only 2 studies scored a total of 4 in terms of quality. These 2 studies were found to have applied the SLR guidelines accordingly. Eleven studies achieved a score of 0.5, which represents 15.1% of the primary studies, 28 achieved a quality score of 1 representing 38.4% of the primary studies, 12 achieved a quality score of 1.5 representing 16% of the primary studies, 5 achieved a quality score of 2 representing 7% of the primary studies. 4 studies achieved a quality score of 2.5 representing 5.5%

TABLE 6. Primary studies.

Ref ID	Author(s)	Topic area & Type of technology	Institution	Country	Year	Publication
[PS56]	Robinson et al.	Cognitive and sensory assistance & System examination	The University of Auckland	New Zealand	2014	Journal
[PS13]	Annalisa Cocchia	General & System examination	University of Genoa	Italy	2014	Conference
[PS29]	Kim et al.	Cognitive and sensory assistance & System examination	Kyung Hee University, Seoul	Republic of Korea	2013	Journal
[PS46]	Pearce et al.	Safety monitoring & System examination	Deakin University, Melbourne	Australia	2012	Journal
[PS71]	Wong et al.	Safety monitoring & System examination	The Hong Kong Polytechnic University	Hong Kong	2016	Journal
[PS33]	Leeraphong et al.	Cognitive and sensory assistance & System examination	University of Technology Thonburi, Bangkok	Thailand	2015	Conference
[PS1]	Alsulami et al.	Safety monitoring& System examination	Shaqra University	Saudi Arabia	2017	Conference
[PS66]	Vassli et al.	Safety and Security monitoring & System examination	Trondheim Municipality	Norway	2018	Journal
[PS52]	Queiros et al.	Safety monitoring & System examination	University of Aveiro	Portugal	2017	Conference
[PS44]	Pal et al.	Cognitive and sensory assistance & System examination	University of Technology Thonburi, Bangkok	Thailand	2018	Journal
[PS37]	Marikyan et al.	Safety monitoring & System examination	Newcastle University Business School	United Kingdom	2019	Journal
[PS68]	Ward et al.	Safety monitoring & System examination	Coventry University	United Kingdom	2012	Journal
[PS70]	Wilson et al.	Functional monitoring & System examination	University of East Anglia	Uinted Kingdom	2015	Journal
[PS35]	Liu et al.	Functional monitoring & System examination	University of Alberta	Canada	2016	Journal
[PS25]	Kachouie et al.	Social Interaction monitoring and assistance & System examination	La Trobe University, Melbourne	Australia	2014	Journal
[PS40]	Morris et al.	Safety monitoring & System examination	La Trobe University, Melbourne	Australia	2013	Journal
[PS51]	Portet et al.	Safety monitoring & Real-time implementation	Laboratoire d'Information de Greboble	France	2013	Journal
[PS28]	Kim et al.	Safety and Functional monitoring & Architecture	POSTECH	Korea	2010	Conference
[PS72]	Yusif, Nian	Safety and Functional monitoring & System examination	University of Southern Queensland	Australia	2016	Journal
[PS53]	Queirós et al.	Safety monitoring & System examination	University of Aveiro	Portugal	2015	Journal
[PS48]	Peek et al.	Funtional monitoring & System examination	University of Applied Sciences	The Netherlands	2015	Journal
[PS12]	Cimperman et al.	safety monitoring & System examination	University of Ljubljana	Slovenia	2013	Journal
[PS49]	Peek et al.	Safety and Functional monitoring & System examination	Tilburg University	The Netherlands	2012	Journal
[PS2]	Arthanat et al.	Functional monitoring & System examination	University of New Hampshire	United States	2019	Journal
[PS67]	Vichitvanichphong et al.	Safety and Functional monitoring & System examination	University of the Sunshine Coast, Queensland	Australia	2013	Conference
[PS45]	Pal et al.	Safety and Functional monitoring & System examination	KMUTT, Bangkok	Thailand	2017	Conference
[PS11]	Chaudhuri et al.	Functional monitoring & System examination	University Washington	United States	2014	Journal

of the primary studies, 6 achieved a quality score of 3 representing 8% of the primary studies. 5 achieved a quality score of 3.5 representing 7% of the primary studies, as presented in Table 11. Figure 3 presents the number of publications with corresponding year. We then present the percentage of primary studies with corresponding years in Figure 4.

C. QUALITY FACTORS

Other quality factors evaluated in the current SLR include: the total quality score of publications with corresponding years, mean quality score, the standard deviation, percentage quality score of studies with corresponding years as well as the percentage of primary studies, with corresponding year of publications as presented in Table 8. In addition, the average quality score for studies according to use of comprehensive SLR guidelines is presented in Table 9. In Table 10, we present the number of studies and their percentages according to the type of publications.

As a major step towards quality assurance, researchers working on systematic literature review studies should implement the quality assessment criteria to ensure a high quality and reliable findings. Such reliable findings can assist

TABLE 7. Studies addressing research questions.

Reference id	Research question 1	Research question 2	Research question 3	Research question 4
[PS15]	×	✓	×	✓
[PS63]	×	✓	✓	✓
[PS3]	×	✓	×	✓
[PS17]	×	✓	✓	✓
[PS59]	×	✓	×	✓
[PS8]	×	✓	✓	✓
[PS9]	×	✓	×	✓
[PS64]	×	✓	✓	✓
[PS30]	×	✓	✓	✓
[PS58]	×	✓	×	✓
[PS36]	×	✓	×	✓
[PS43]	×	✓	×	✓
[PS24]	×	✓	×	✓
[PS10]	×	✓	✓	✓
[PS57]	×	✓	✓	✓
[PS65]	×	✓	✓	✓
[PS72]	×	✓	×	✓
[PS14]	×	✓	×	✓
[PS47]	×	✓	×	✓
[PS11]	×	✓	×	✓
[PS40]	×	✓	×	✓
[PS5]	×	✓	×	✓
[PS39]	×	✓	×	✓
[PS55]	×	✓	✓	✓
[PS34]	×	✓	✓	✓
[PS69]	×	✓	×	✓
[PS31]	×	✓	×	✓
[PS25]	×	✓	×	✓
[PS21]	×	✓	✓	✓
[PS20]	×	✓	×	✓
[PS61]	×	✓	×	✓
[PS26]	×	✓	×	✓
[PS7]	×	✓	×	✓
[PS62]	×	✓	×	✓
[PS6]	×	✓	×	✓
[PS16]	×	✓	×	✓
[PS42]	×	✓	×	✓
[PS18]	×	✓	×	✓
[PS23]	×	✓	×	✓
[PS38]	×	✓	×	✓
[PS32]	×	✓	×	✓
[PS4]	×	✓	×	✓
[PS60]	×	✓	×	✓
[PS19]	×	✓	×	✓
[PS54]	×	✓	×	✓
[PS35]	×	✓	×	✓
[PS22]	×	✓	×	✓
[PS73]	×	✓	×	✓
[PS50]	×	✓	×	✓
[PS41]	×	✓	×	✓
[PS27]	×	✓	×	✓
[PS56]	×	✓	×	✓
[PS13]	×	✓	×	✓
[PS29]	×	✓	×	✓
[PS46]	×	✓	×	✓
[PS71]	×	✓	×	✓
[PS33]	×	✓	✓	✓
[PS1]	×	✓	×	✓
[PS66]	×	✓	×	✓
[PS52]	×	✓	×	✓
[PS44]	×	✓	×	✓
[PS37]	×	✓	×	✓
[PS68]	×	✓	×	✓
[PS70]	×	✓	×	✓
[PS51]	×	✓	✓	✓
[PS28]	×	✓	×	✓
[PS53]	×	✓	×	✓
[PS48]	×	✓	×	✓
[PS12]	×	✓	×	✓
[PS49]	×	✓	×	✓
[PS2]	×	✓	✓	✓
[PS67]	×	✓	×	✓
[PS45]	×	✓	×	✓

stakeholders in decision making processes. In addition, a research finding based on quality criteria can build confidence on other researchers working on the same domain and as such, may lead to knowledge discovery. Another measures that can be applied to improve the quality assessment is by applying the existing standard quality assessment criteria which can lead to additional quality criteria while improving the standard of research work. Notably, the need to apply the York University Centre for Reviews and Dissemination (**CDR**) Database of Abstracts of Reviews of Effect (**DARE**) criteria is because of its vigorous and strict criteria which was initially based on clinical standards.

TABLE 8. Quality assessment evaluation.

Reference id	QA1	QA2	QA3	QA4	Total score	Initial rating score
[PS15]	N	N	P	Y	0.5	4
[PS63]	N	P	N	Y	1.5	4
[PS3]	N	P	N	Y	1.5	4
[PS17]	N	P	N	Y	1.5	4
[PS59]	N	P	N	P	1.0	4
[PS8]	Y	P	P	P	2.5	4
[PS9]	N	P	N	P	1.0	4
[PS64]	N	N	N	Y	1.0	4
[PS30]	N	N	N	Y	1.0	4
[PS58]	N	P	N	P	1.0	4
[PS36]	N	P	N	P	1.0	4
[PS43]	N	N	N	P	0.5	4
[PS24]	N	P	N	P	1.0	4
[PS10]	N	P	N	Y	1.5	4
[PS57]	N	N	N	P	0.5	4
[PS65]	N	P	N	P	1.0	4
[PS72]	Y	Y	N	P	2.5	4
[PS14]	P	Y	P	Y	3.0	4
[PS47]	Y	Y	Y	Y	4.0	4
[PS11]	P	Y	N	P	2.0	4
[PS40]	Y	Y	P	Y	3.5	4
[PS5]	N	Y	N	P	1.5	4
[PS39]	N	P	N	P	1.0	4
[PS55]	N	P	N	P	1.0	4
[PS34]	N	P	N	P	1.0	4
[PS69]	Y	Y	P	P	3.0	4
[PS31]	N	Y	N	P	1.5	4
[PS25]	Y	Y	P	P	3.0	4
[PS21]	N	Y	N	Y	2.0	4
[PS20]	N	N	N	P	0.5	4
[PS61]	Y	P	N	P	2.0	4
[PS26]	N	P	N	P	1.0	4
[PS7]	N	N	N	P	0.5	4
[PS62]	N	N	N	P	0.5	4
[PS6]	Y	P	P	P	2.5	4
[PS16]	P	Y	P	P	2.5	4
[PS42]	N	P	N	P	1.0	4
[PS18]	Y	Y	P	P	3.0	4
[PS23]	P	P	N	P	1.5	4
[PS38]	N	P	N	P	1.0	4
[PS32]	N	P	N	P	1.0	4
[PS4]	N	P	N	P	1.0	4
[PS60]	N	N	N	P	0.5	4
[PS19]	Y	Y	P	Y	3.5	4
[PS54]	N	Y	N	P	1.5	4
[PS35]	Y	Y	Y	Y	4.0	4
[PS22]	Y	Y	P	P	3.0	4
[PS73]	N	P	N	P	1.0	4
[PS50]	Y	Y	P	P	3.0	4
[PS41]	N	N	N	P	0.5	4
[PS27]	Y	Y	P	Y	3.5	4
[PS56]	N	Y	N	P	1.5	4
[PS13]	N	P	N	P	1.0	4
[PS29]	N	P	N	P	1.0	4
[PS46]	N	P	P	P	1.5	4
[PS71]	N	P	N	P	1.0	4
[PS33]	N	P	N	P	1.0	4
[PS1]	N	P	N	P	1.0	4
[PS66]	Y	Y	P	Y	3.5	4
[PS52]	N	P	N	P	1.0	4
[PS44]	Y	Y	P	Y	3.5	4
[PS37]	N	Y	N	P	1.5	4
[PS68]	N	P	N	P	1.0	4
[PS70]	N	P	N	P	1.0	4
[PS51]	N	P	N	P	1.0	4
[PS28]	N	N	N	P	0.5	4
[PS53]	P	Y	N	P	2.0	4
[PS48]	N	P	N	P	1.0	4
[PS12]	N	P	N	P	1.0	4
[PS49]	N	N	N	P	0.5	4
[PS2]	N	P	N	Y	1.5	4
[PS67]	N	Y	N	Y	2.0	4
[PS45]	N	N	N	P	0.5	4

IV. DISCUSSION

In this section, the authors present answers to the research questions formulated in Section II. Notably, four research questions were formulated in this study.

TABLE 9. Average quality scores of studies by year of publication.

	Year									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of primary studies	6	7	11	15	9	8	9	4	2	2
Total quality score	7.50	8.50	14.50	20.50	18.50	12.50	17.50	5.50	7.00	3.00
Mean quality score	1.25	1.21	1.31	1.37	2.00	1.56	1.90	1.37	3.50	1.50
Standard deviation	1.037	0.698	0.636	0.935	0.984	0.980	1.237	1.109	0.00	0.00
Percentage quality score	8%	9.6%	15%	21%	12%	11%	12%	5.4%	3%	3%
Percentage primary studies	6.5%	7.3%	12.6%	18%	16%	11%	15%	5%	6%	2.6%

TABLE 10. Average quality scores for studies according to use of comprehensive SLR guidelines.

	SLR guidelines	Non SLR guidelines
Number of studies	2	71
Percentage of studies	3%	97%
Mean quality score	4.00	1.50

TABLE 11. Number of studies according to publication.

	Conference	Journal
Number of studies	15	58
Percentage	21%	79%

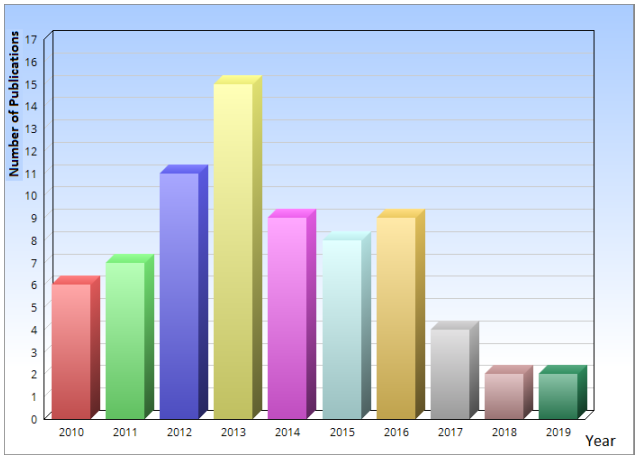

FIGURE 3. Number of publications with corresponding year.

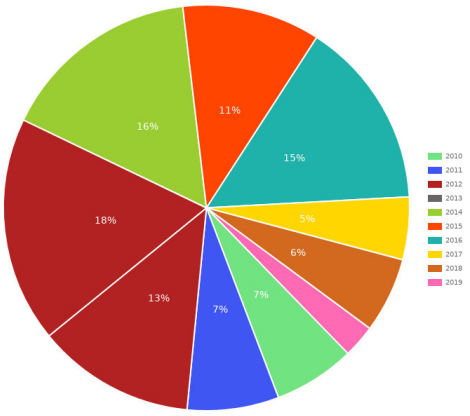

FIGURE 4. Percentage distribution of primary studies with corresponding years.

A. HOW MANY SLRs WITH PRIMARY STUDIES HAVE THERE BEEN ON SMART HOME TECHNOLOGY IMPLEMENTATION FOR THE ELDERLY SINCE 2010?

In this study, a total of 73 primary studies related to smart home technology implementation for the elderly were included. The authors obtained these primary studies from the list of the electronic databases searched. From the synthesized results obtained, only 3% of the primary studies was identified to have applied the comprehensive SLR guidelines originally proposed by the authors of [10]. Of the relevant studies, 7% was identified to have applied the SLR guidelines in a strongly moderately acceptable manner. This 7% were identified through their respective quality scores of 3.5 each, whereas 8% of the primary studies applied the SLR guideline in fairly acceptable manner with a quality score of 3 each. The details on the number of studies and their corresponding quality scores are presented in Table 11.

In addition, from the results obtained while answering RQ1, we can conclude based on the number of SLR studies on smart home technology since 2010 that the total number of SLR studies not encouraging. Among these primary studies included in the current review, we could not identify an article which reported its primary studies separately from the general references included in the paper. Therefore, we note that the number of studies that applied SLR guidelines while reporting smart home technology implementation for the elderly are very low and varies from year to year. However, the authors of the current manuscript encourage researchers working on smart home technology for the elderly to allocate more time to reporting their findings systematically to support decision making on smart home technology implementation for the elderly.

B. HOW DO RESEARCHERS WORKING ON SMART HOME TECHNOLOGY REPORT THE TECHNOLOGY APPLIED IN SMART HOMES FOR THE ELDERLY?

Based on the topic area, the 73 primary studies were selected according to the following smart home technologies: physiological monitoring, functional monitoring/ emergency detection and response, safety monitoring and assistance, security monitoring and assistance, social interaction monitoring and

TABLE 12. Quality scores with corresponding number of publications.

	Quality score							
	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
Number of studies	11	28	12	5	4	6	5	2
Percentage	15.1%	38.4%	16%	7%	5.5%	8%	7%	3%

assistance, and cognitive and sensory assistance, as presented in Table 4. The list of articles indicates how researchers working on smart home technology report the technology applied in smart homes for the elderly. Through these reported technologies, we identified six smart home health monitoring technologies discussed in the literature.

C. HOW DO THE REPORTED SMART HOME TECHNOLOGIES ADDRESS THE NEEDS OF THE ELDERLY?

The list of smart home technologies for the elderly has greatly improved the quality of life among elderly people. In terms of safety and independent living, the authors of [55], [56] and [61]] reported how smart home technology has impacted the lives of the elderly in their daily living conditions and pointed out the need to improve the available smart technologies to meet the demands of the elderly. Some of the reported technologies have also saved the lives of the elderly in the case of emergency assistance; the smart home technology has the ability to raise the alarm when such emergency cases arise [62]. In response to RQ3, the summary of existing smart home health monitoring technologies as presented in Section I explains how these technologies address the specific needs of the elderly.

D. WERE THE RESEARCH TOPICS LIMITED IN NUMBER?

There are two distinct sub-questions that comprise RQ4. The first, RQ4.1, deals with whether the existing SLR studies on smart home technology for the elderly are limited in number. The second, RQ4.2, deals with any evidence to support the claim that the existing SLR studies on smart home technology for the elderly is lacking. During our search process, a lot of articles on smart home technology implementation for the elderly were returned according to our search strings. However, not all of these articles were included as result of the set criteria in the current SLR study. Having analyzed the included primary studies, there is enough evidence to demonstrate that SLR studies of smart home technology are lacking. This evidence may be drowned out by that of the 73 primary studies, as only 3% of the studies have enough evidence that SLR guidelines were appropriately applied. This mere 3% of studies with evidence of SLR is certainly not encouraging. As such, more attention is required on issues regarding the elderly in society, and more emphasis on reports such as this SLR that will assist in the decision making process on smart technology implementation. The authors therefore encourage future researchers embarking on SLR to apply the preferred SLR guideline to ensure high quality SLR within the smart home technology domain.

V. CONCLUSION

To ensure high quality reporting of smart home technology implementation for the elderly, a total of 73 primary studies were identified in this study. Of the 73 primary studies, 3% applied comprehensive SLR guidelines with quality scores of 4. Only 7% of the relevant studies was identified to have applied the SLR guidelines in a strongly moderately acceptable manner, but, not completely comprehensively. This 7% of articles identified received respective quality scores of 3.5 each, whereas 8% of the primary studies applied the SLR guideline in a fairly acceptable manner with quality scores of 3 each. A better decision making process would be achieved if all SLR studies on smart home technology apply complete SLR guidelines that takes into account the quality standard. By so doing, it will be very helpful to both the stakeholders and decision makers working on smart homes to appropriately allocate the available smart home projects. By so doing, we strongly believe that the living conditions among the elderly will improve.

To allow room for future improvement, the authors of the current study report a number of limitations. For instance, during the search process, the authors limited the search articles to those from international journals and conferences. Also, while reporting on existing smart home projects, there may be more or even newer projects that not available to us and may have been omitted unintentionally. However, in future work, the authors hope to widen the search scope with an automated search included, to enable us receive alerts on newer publications. We hope to undertake a new study on smart home technology for the elderly before the end of 2020 to keep track of the number of SLR studies with comprehensive SLR guidelines on smart home technology for the elderly.

APPENDIX

PRIMARY STUDIES (PS)

[PS1] Majid H Alsulami, Anthony S Atkins, and Russell J Campion. Factors influencing the adoption of ambient assisted living technologies by healthcare providers in the kingdom of saudi arabia. In *International Conference on Advanced Information Technology, Services and Systems*, pages 3–11. Springer, 2017.

[PS2] Sajay Arthanat, John Wilcox, and Mackenzie Macuch. Profiles and predictors of smart home technology adoption by older adults. *OTJR: occupation, participation and health*, 39(4):247–256, 2019.

[PS3] Iman Azimi, Amir M Rahmani, Pasi Liljeberg, and Hannu Tenhunen. Internet of things for remote elderly monitoring: a study from user-centered perspective. *Journal of Ambient Intelligence and Humanized Computing*, 8(2):273–289, 2017.

[PS4] Sander Bakkes, Richard Morsch, and Ben Kröse. Telemonitoring for independently living elderly: Inventory of needs & requirements. In *2011 5th International Conference on Pervasive Computing Technologies for Healthcare (PervasiveHealth) and Workshops*, pages 152–159. IEEE, 2011.

[PS5] Roger Bemelmans, Gert Jan Gelderblom, Pieter Jonker, and Luc De Witte. Socially assistive robots in elderly care: A systematic review into effects and effectiveness. *Journal of the American Medical Directors Association*, 13(2):114–120, 2012.

[PS6] Charlotte E Bolton, Cerith S Waters, Susan Peirce, and Glyn Elwyn. Insufficient evidence of benefit: a systematic review of home telemonitoring for copd. *Journal of evaluation in clinical practice*, 17(6):1216–1222, 2011.

[PS7] Simon Brownsell, David Bradley, Steve Blackburn, Fabien Cardinaux, and Mark S Hawley. A systematic review of lifestyle monitoring technologies. *Journal of telemedicine and telecare*, 17(4):185–189, 2011.

[PS8] Guillaume Cayla, Thomas Cuisset, Johanne Silvain, Patrick Henry, Florence Leclercq, Didier Carrié, Christophe Saint Etienne, Loic Belle, Grégoire Rangé, Christophe Pouillot, et al. Platelet function monitoring in elderly patients on prasugrel after stenting for an acute coronary syndrome: design of the randomized antarctic study. *American heart journal*, 168(5):674–681, 2014.

[PS9] Guillaume Cayla, Thomas Cuisset, Johanne Silvain, Florence Leclercq, Stephane Manzo-Silberman, Christophe Saint-Etienne, Nicolas Delarche, Anne Bellemain-Appaix, Grégoire Range, Rami El Mahmoud, et al. Platelet function monitoring to adjust antiplatelet therapy in elderly patients stented for an acute coronary syndrome (antarctic): an open-label, blinded-endpoint, randomised controlled superiority trial. *The Lancet*, 388(10055):2015–2022, 2016.

[PS10] Amedeo Cesta, Gabriella Cortellessa, Riccardo Rasconi, Federico Pecora, Massimiliano Scopelliti, and Lorenza Tiberio. Monitoring elderly people with the robocare domestic environment: Interaction synthesis and user evaluation. *Computational Intelligence*, 27(1):60–82, 2011.

[PS11] Shomir Chaudhuri, Hilaire Thompson, and George Demiris. Fall detection devices and their use with older adults: a systematic review. *Journal of geriatric physical therapy (2001)*, 37(4):178, 2014.

[PS12] Miha Cimperman, Maja Makovec Brenčič, Peter Trkman, and Mateja de Leonni Stanonik. Older adults' perceptions of home telehealth services. *Telemedicine and e-Health*, 19(10):786–790, 2013.

[PS13] Annalisa Cocchia. Smart and digital city: A systematic literature review. In *Smart city*, pages 13–43. Springer, 2014.

[PS14] Simone R de Bruin, Nathalie Versnel, Lidwien C Lemmens, Claudia CM Molema, François G Schellevis, Giel Nijpels, and Caroline A Baan. Comprehensive care programs for patients with multiple chronic conditions: a systematic literature review. *Health policy*, 107(2-3):108–145, 2012.

[PS15] Vitomir Djaja-Josko and Jerzy Kolakowski. Uwb positioning system for elderly persons monitoring. In *2015 23rd Telecommunications Forum Telfor (TELFOR)*, pages 169–172. IEEE, 2015.

[PS16] Daniela Fogli, Rosa Lanzilotti, and Antonio Piccinno. End-user development tools for the smart home: a systematic literature review. In *International Conference on Distributed, Ambient, and Pervasive Interactions*, pages 69–79. Springer, 2016.

[PS17] Joshua J Gagne, Robert J Glynn, Jeremy A Rassen, Alexander M Walker, Gregory W Daniel, Gayathri Sridhar, and Sebastian Schneeweiss. Active safety monitoring of newly marketed medications in a distributed data network: application of a semi-automated monitoring system. *Clinical Pharmacology & Therapeutics*, 92(1):80–86, 2012.

[PS18] Nadine Genet, Wienke GW Boerma, Dionne S Kringos, Ans Bouman, Anneke L Francke, Cecilia Fagerström, Maria Gabriella Melchiorre, Cosetta Greco, and Walter Devillé. Home care in europe: a systematic literature review. *BMC health services research*, 11(1):207, 2011.

[PS19] Hulya Gokalp and Malcolm Clarke. Monitoring activities of daily living of the elderly and the potential for its use in telecare and telehealth: a review. *TELEMEDICINE and e-HEALTH*, 19(12):910–923, 2013.

[PS20] Kelly Creighton Graham and Maria Cvach. Monitor alarm fatigue: standardizing use of physiological monitors and decreasing nuisance alarms. *American Journal of Critical Care*, 19(1):28–34, 2010.

[PS21] Sohmyung Ha, Chul Kim, Yu M Chi, Abraham Akinin, Christoph Maier, Akinori Ueno, and Gert Cauwenberghs. Integrated circuits and electrode interfaces for noninvasive physiological monitoring. *IEEE Transactions on Biomedical Engineering*, 61(5):1522–1537, 2014.

[PS22] Phoebe Woei-Ni Hwang and Kathryn L Braun. The effectiveness of dance interventions to improve older adults' health: a systematic literature review. *Alternative therapies in health and medicine*, 21(5):64, 2015.

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