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A Systematic Review of Usability Engineering Management Studies for the Aging Population-UEM4Aging

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Abstract

Usability management is one of the core elements of any software to make it efficient and effective. Unfortunately, most of the time usability as well as its management is neglected while developing software that may result as ineffective and inefficient software design. In different eras different researchers performed studies to highlight the management of usability and to show its importance. Due to the increase in the aging population, the concern for the aging population assistances of each equipment becomes to be necessary. Number of Steps has been taken so far to help out the aging population but remained limited to visual considerations, such as stronger contrasts or larger characters on the displays and printing, or such physical characteristics as the ease for pressing buttons. In this paper, our focus is to perform a systematic review (SR) of usability management specifically for the aging population/senior citizens and its limitations. The systematic review aims to address three research questions**: 1)** What is the current status of usability management/usability engineering management research for the aging population/senior citizen around the globe? As we found that the literature on usability management for the aging population began in 1992 and increased thereafter, there is a lack of organized research teams and dedicated usability management journals for researching the aging population. High-impact theoretical studies are scarce. On the application side, no original and systematic research frameworks have been developed.

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The understanding and definition of usability and usability management is not well synchronized with international norms. **2)** What are the existing methods, approaches, frameworks and practices that are currently being used in usability engineering management for the aging population? **3)** What are the limitations of usability engineering management for the aging population/senior citizen? Purpose of this study is to identify the current research problems, existing studies for providing valid solution to these problems and will find out the limitations of existing work for covering the existing problems in usability engineering management specifically for the aging population. This will be done by performing quantitative literature of different databases and all the results will be gathered by analyzing and summarizing the statistical data using "R Studio". Remedial techniques for handling the limitation of usability engineering management will be planned in future for the aging population.

Keywords: Usability Management; Systematic review; Usability Engineering; SS, Usability for older age; Old aging; Aging population; Human computer Interaction; UEM4Aging; User Centered Design; older adults; User Interfaces; Software Usability Management; Usability management for senior citizens.

1. Introduction

Management plays a vital role in every field of life and as far as the software usability is concerned its management is quite emerging in today's industry of software development as far as the effective and efficient software design is concerned. Usability applications are gaining great attention of today's scientist, designers, and industry professionals in developed countries where there are active study populations, comprehensive theories, methods, practices, practical results, and mature industrial and professional organizations. Traditionally, Human Computer Interaction (HCI) bridges Natural Sciences as Psychology and Engineering like Informatics/Computer Science, whilst Usability Engineering (UE) is anchored in Software Technology and supports the actual implementation. By keeping together Human Computer Interaction and Usability Engineering ,it can result in an impactful technology a little bit more attractive accessible, useful, useable and enjoyable for everyone. In most developed countries demographic developments move towards more and more aging population in single households. To improve the quality of life for the aging population is an emerging issue within our information society. Nowadays, the aging population and latest technologies are one of the important research and development areas [1], where accessibility, usability and lifelong learning play a vital role. There are number of application such as Intelligent User Interfaces (IUI) for Ambient Assisted Living (AAL) to facilitate the aging population [2,3]. These applications are design to support the demands and special needs of end users to provide them benefits from different aspect either in a physical, medical, emotional, motivational or educational respect. In developed countries, the aging population (senior citizen) are the last Internet frontier as every other age group is already online in vast numbers but unfortunately in developing countries its inverse to developed countries. Given this context, one question we would like to answer is as follows. What is the current status of usability engineering management research for the aging population? In this paper, through the systematic review of the literature published around the world and applying a combined qualitative and quantitative approach, we present the current status and existing problems of usability management research and practice around the globe in the aging population field. In study, in systematic review research questions are built according to the "***PICOC***" structure against research question research strings are

built for different search strings including, **IEEE, ACM, GOOGLE SCHOLAR and SCIENCE DIRECT**. Databases are created against each search strings and search protocol is applied on the databases for final selection of papers, with help of *"data extraction forms"* data from each selected paper is extracted and reviewed statistically

2. Protocol for Search Process

After specifying research questions a review protocol is developed, it includes the following:

- The Search Process
- Inclusion and Exclusion Criteria
- The Selection Process
- The Data Extraction Process
- Data Synthesis

3. Sources for Literature Search

Usability engineering management is a broad and interdisciplinary field with inconsistent terminologies. We searched Google Scholar, IEEE, Science Direct and ACM for primary studies

4. Literature Search Strategy

4.1. Research Question in PICOC Structure

I. RQ1: What is the current status of usability management/usability engineering management research for the aging population/senior citizen around the globe?

- *Population: Aging population/Senior Citizen*
- *Intervention: Usability Engineering Management*
- *Outcome: Status of Usability Management around the globe*

1) Search Strings/Second Step: Synonyms

a) Population

"Elder age people", "Elderly age 60 years", "For Aging", "Elderly people", "Old age people" , "Senior Citizen" , "Retired People", "older people" , "Elderly" , "Aging", "Elderly age"

b) Intervention

"Aging in Usability management", "Usability management approaches" , "Usability management Evaluation", "Usability engineering management in software development approaches" "Usability software development and management techniques", "Software usability management measurement", "Usability engineering",

"Usability management Analysis", "Usability management methodologies", "Usability software engineering methodologies", "Usability Essentials", "Usability engineering and management in software development process", "Usability software engineering methods", "Usability software development processes", "Usability management software engineering practices", "Usability management approaches" , "Usability Practices and management", Usability design techniques" , "Usability guidelines", "Usability engineering aspects", "Usability management techniques", "Usability management guidelines"

c) Outcome

"Usability Management trends in Pakistan" , "Software Usability Management Status", "Status of Usability Management", "Current Usability Management Status", "Software Usability status", Current Usability Management trends", "Software Usability Management trends", "Software Usability Tends and Status"

2) Strings Used for Primary Studies Search of Research Question 1

Table 1

Database	***Search String***
IEEE	Aging in Usability management", "Usability management approaches" , "Usability management Evaluation", "Usability engineering management in software development approaches" "Usability software development and management techniques", "Software usability management measurement", "Usability engineering", "Usability management Analysis", "Usability management methodologies", "Usability software engineering methodologies", "Usability Essentials", "Usability engineering and management in software development process", "Usability software engineering methods", "Usability software development processes", "Usability management software engineering practices", "Usability management approaches" , "Usability Practices and management", Usability design techniques" , "Usability guidelines", "Usability engineering aspects", "Usability management techniques", "Usability management guidelines"))
ACM	Aging in Usability management", "Usability management approaches" , "Usability management Evaluation", "Usability engineering management in software development approaches" "Usability software development and management techniques", "Software usability management measurement", "Usability engineering", "Usability management Analysis", "Usability management methodologies", "Usability software engineering methodologies", "Usability Essentials", "Usability engineering and management in software development process", "Usability software engineering methods", "Usability software development processes", "Usability management software engineering practices", "Usability management approaches" , "Usability Practices and management", Usability design techniques" , "Usability guidelines", "Usability engineering aspects", "Usability management techniques", "Usability management guidelines"))
Science Direct	Aging in Usability management", "Usability management approaches" , "Usability management Evaluation", "Usability engineering management in software development approaches" "Usability software development and management techniques", "Software usability management measurement", "Usability engineering", "Usability management Analysis", "Usability management methodologies", "Usability software engineering methodologies", "Usability Essentials", "Usability engineering and management in software development process", "Usability software engineering methods", "Usability software development processes", "Usability management software engineering practices", "Usability management approaches" , "Usability Practices and management", Usability design techniques" , "Usability guidelines", "Usability engineering aspects", "Usability management techniques", "Usability management guidelines"))
Google Scholar	Aging in Usability management", "Usability management approaches" , "Usability management Evaluation", "Usability engineering management in software development approaches" "Usability software development and management techniques", "Software usability management

	measurement", "Usability engineering", "Usability management Analysis", "Usability management methodologies", "Usability software engineering methodologies", "Usability Essentials", "Usability engineering and management in software development process", "Usability software engineering methods", "Usability software development processes", "Usability management software engineering practices", "Usability management approaches" , "Usability Practices and management", Usability design techniques" , "Usability guidelines", "Usability engineering aspects", "Usability management techniques", "Usability management guidelines"))

II. RQ2: What are the existing methods, approaches, frameworks and practices are currently using in usability engineering management for the aging population?

1) Search Strings/Second Step: Synonyms

a) Population

"Elder age people", "Elderly age 60 years", "For Aging", "Elderly people", "Old age people" , "Senior Citizen" , "Retired People", "Older people" , "Elderly" , "Aging", "Elderly age"

b) Intervention

"Aging in Usability management", "Usability management approaches" , "Usability management Evaluation", "Usability engineering management in software development approaches" "Usability software development and management techniques", "Software usability management measurement", "Usability engineering", "Usability management Analysis", "Usability management methodologies", "Usability software engineering methodologies", "Usability Essentials", "Usability engineering and management in software development process", "Usability software engineering methods", "Usability software development processes", "Usability management software engineering practices", "Usability management approaches" , "Usability Practices and management", Usability design techniques" , "Usability guidelines", "Usability engineering aspects", "Usability management techniques", "Usability management guidelines"

c) Outcome

"Usability Management trends in Pakistan" , "Software Usability Management Status", "Status of Usability Management", "Current Usability Management Status", "Software Usability status", Current Usability Management trends", "Software Usability Management trends", "Software Usability Tends and Status"

2) Strings Used for Primary Studies Search of Research Question 2

III. RQ3: What are the limitations of usability engineering management for the aging population?

1) Search strings/Second Step :Synonyms

a) Population

"Elder age people", "Elderly age 60 years", "For Aging", "Elderly people", "Old age people" , "Senior

Citizen" , "Retired People", "Older people" , "Elderly" , "Aging", "Elderly age"

b) Intervention

"Aging in Usability management", "Usability management approaches" , "Usability management Evaluation", "Usability engineering management in software development approaches" "Usability software development and management techniques", "Software usability management measurement", "Usability engineering", "Usability management Analysis", "Usability management methodologies", "Usability software engineering methodologies", "Usability Essentials", "Usability engineering and management in software development process", "Usability software engineering methods", "Usability software development processes", "Usability management software engineering practices", "Usability management approaches" , "Usability Practices and management", Usability design techniques" , "Usability guidelines", "Usability engineering aspects", "Usability management techniques", "Usability management guidelines"

Table 2

Database	***Search String***
IEEE	Aging in Usability management", "Usability management approaches" , "Usability management Evaluation", "Usability engineering management in software development approaches" "Usability software development and management techniques", "Software usability management measurement", "Usability engineering", "Usability management Analysis", "Usability management methodologies", "Usability software engineering methodologies", "Usability Essentials", "Usability engineering and management in software development process", "Usability software engineering methods", "Usability software development processes", "Usability management software engineering practices", "Usability management approaches" , "Usability Practices and management", Usability design techniques" , "Usability guidelines", "Usability engineering aspects", "Usability management techniques", "Usability management guidelines"))
ACM	Aging in Usability management", "Usability management approaches" , "Usability management Evaluation", "Usability engineering management in software development approaches" "Usability software development and management techniques", "Software usability management measurement", "Usability engineering", "Usability management Analysis", "Usability management methodologies", "Usability software engineering methodologies", "Usability Essentials", "Usability engineering and management in software development process", "Usability software engineering methods", "Usability software development processes", "Usability management software engineering practices", "Usability management approaches" , "Usability Practices and management", Usability design techniques" , "Usability guidelines", "Usability engineering aspects", "Usability management techniques", "Usability management guidelines"))
Science Direct	Aging in Usability management", "Usability management approaches" , "Usability management Evaluation", "Usability engineering management in software development approaches" "Usability software development and management techniques", "Software usability management measurement", "Usability engineering", "Usability management Analysis", "Usability management methodologies", "Usability software engineering methodologies", "Usability Essentials", "Usability engineering and management in software development process", "Usability software engineering methods", "Usability software development processes", "Usability management software engineering practices", "Usability management approaches" , "Usability Practices and management", Usability design techniques" , "Usability guidelines", "Usability engineering aspects", "Usability management techniques", "Usability management guidelines"))
Google Scholar	Aging in Usability management", "Usability management approaches" , "Usability management Evaluation", "Usability engineering management in software development approaches" "Usability software development and management techniques", "Software

	usability management measurement", "Usability engineering", "Usability management Analysis", "Usability management methodologies", "Usability software engineering methodologies", "Usability Essentials", "Usability engineering and management in software development process", "Usability software engineering methods", "Usability software development processes", "Usability management software engineering practices", "Usability management approaches" , "Usability Practices and management", Usability design techniques" , "Usability guidelines", "Usability engineering aspects", "Usability management techniques", "Usability management guidelines"))

c) Outcome

"Usability Management trends in Pakistan" , "Software Usability Management Status", "Status of Usability Management", "Current Usability Management Status", "Software Usability status", Current Usability Management trends", "Software Usability Management trends", "Software Usability Tends and Status"

Table 3

Database	***Search String***
IEEE	Aging in Usability management", "Usability management approaches" , "Usability management Evaluation", "Usability engineering management in software development approaches" "Usability software development and management techniques", "Software usability management measurement", "Usability engineering", "Usability management Analysis", "Usability management methodologies", "Usability software engineering methodologies", "Usability Essentials", "Usability engineering and management in software development process", "Usability software engineering methods", "Usability software development processes", "Usability management software engineering practices", "Usability management approaches" , "Usability Practices and management", Usability design techniques" , "Usability guidelines", "Usability engineering aspects", "Usability management techniques", "Usability management guidelines"))
ACM	Aging in Usability management", "Usability management approaches" , "Usability management Evaluation", "Usability engineering management in software development approaches" "Usability software development and management techniques", "Software usability management measurement", "Usability engineering", "Usability management Analysis", "Usability management methodologies", "Usability software engineering methodologies", "Usability Essentials", "Usability engineering and management in software development process", "Usability software engineering methods", "Usability software development processes", "Usability management software engineering practices", "Usability management approaches" , "Usability Practices and management", Usability design techniques" , "Usability guidelines", "Usability engineering aspects", "Usability management techniques", "Usability management guidelines"))
Science Direct	Aging in Usability management", "Usability management approaches" , "Usability management Evaluation", "Usability engineering management in software development approaches" "Usability software development and management techniques", "Software usability management measurement", "Usability engineering", "Usability management Analysis", "Usability management methodologies", "Usability software engineering methodologies", "Usability Essentials", "Usability engineering and management in software development process", "Usability software engineering methods", "Usability software development processes", "Usability management software engineering practices", "Usability management approaches" , "Usability Practices and management", Usability design techniques" , "Usability guidelines", "Usability engineering aspects", "Usability management techniques", "Usability management guidelines"))

Google Scholar	Aging in Usability management", "Usability management approaches" , "Usability management Evaluation", "Usability engineering management in software development approaches" "Usability software development and management techniques", "Software usability management measurement", "Usability engineering", "Usability management Analysis", "Usability management methodologies", "Usability software engineering methodologies", "Usability Essentials", "Usability engineering and management in software development process", "Usability software engineering methods", "Usability software development processes", "Usability management software engineering practices", "Usability management approaches" , "Usability Practices and management", Usability design techniques" , "Usability guidelines", "Usability engineering aspects", "Usability management techniques", "Usability management guidelines"))

2) Strings Used for Primary Studies Search of Research question 3

4.2. Literature Publication Search Strategy

As usability is with diverse terminology so we decided to use the search string with different synonyms of usability such as user satisfaction, user experience, user centered design, usefulness. We only searched the tittle and keywords fields in the literature published between 2004-2018.

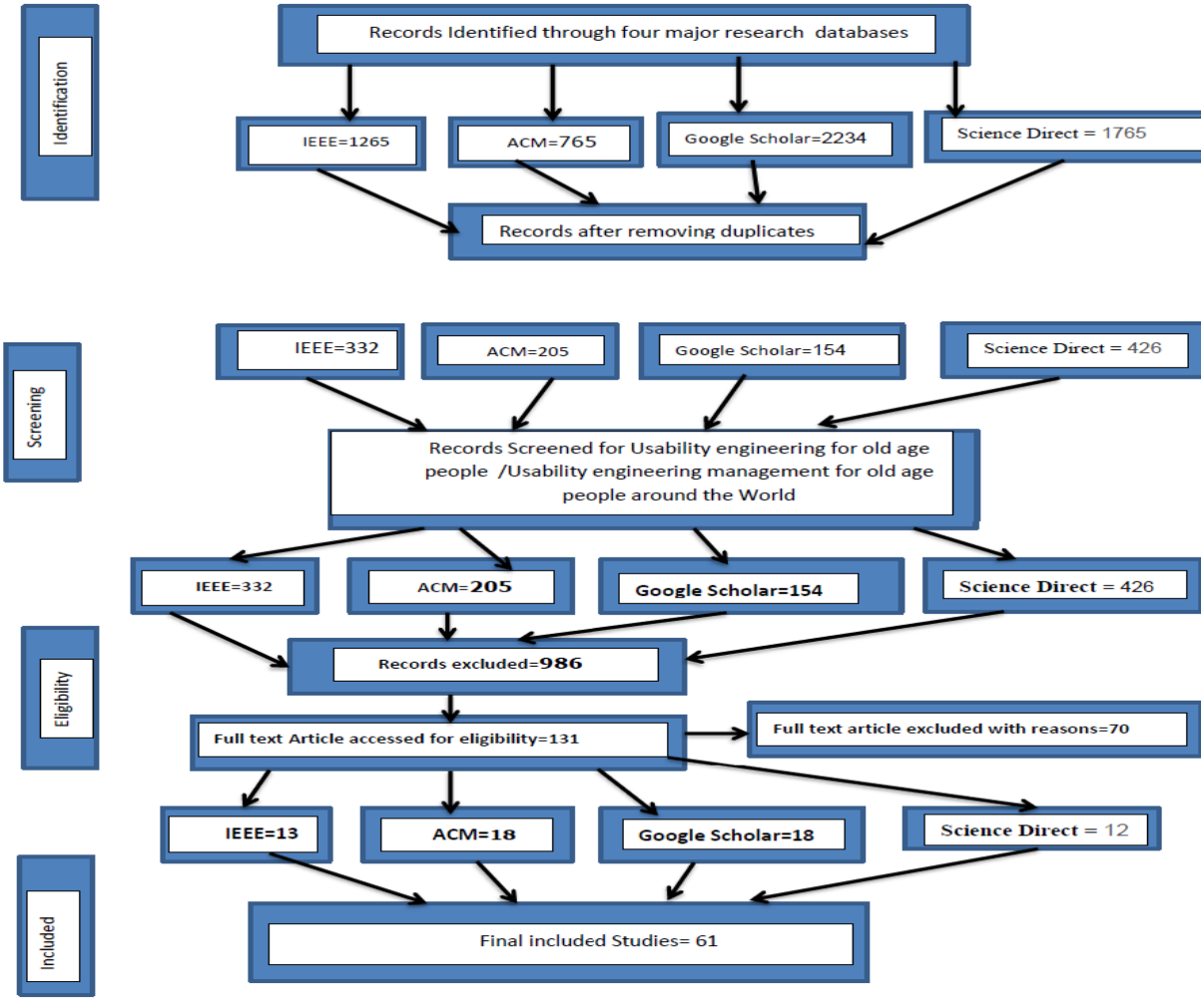

Figure 1: PRISMA flowchart of Literature study selection and inclusion process

4.3. Inclusion and Exclusion Criteria of Literature

Inclusion criteria include

(1) screened out the Literature for Usability management trends and status for the aging population

Exclusion criteria include

(1) Excluding research literature about Usability Management trends and status in other fields
(2) Excluding duplicate entries, excluding those without complete information.

Excluding those without full text.

5. Data Extraction / Publication Quality Assessment

The summary sheet of literature information was designed to extract data from the selected literature. That will extract the finally selected papers assessing their quality and searching answers for research questions.

Quality Assessment Detail 1-5

1. Study provides detailed description of usability engineering and usability management trends for the aging population/senior citizen?

The possible answers to this question are: "Yes (+1)" if the paper provides detail description of Usability engineering/usability management trends for the aging population; "partially (0)" if the paper provides partial or not detail information about Usability engineering /Usability management trends for the aging population; and ''No (_1)'' if the paper does not provide any information about Usability Engineering/Usability management trends or the aging population.

2. The study provides the guideline as how the usability engineering management techniques are used for the aging population/senior citizen?

The possible answers to this question are: ''Yes (+1)'' if the paper provides information as how the usability engineering management techniques helped out the aging population; ''partially (0)'' if the paper provides partial or not detail information as how the usability engineering management techniques helped out the aging population; and ''No (_1)'' if the paper does not provide any information as how the usability engineering management techniques helped out the aging population

3. The study provides clear results after application of Usability engineering management status for the aging population/senior citizens across the world?

The possible answers to this question are: "Yes (+1)'' if the paper provides clear results; "partially (0)'' if the paper provides partial or not detail results; and "No (_1)'' if the paper does not provide any results.

4. The study has been published in a relevant journal or conference proceedings?

The possible answers to this question are: “Very relevant (+1)”; “Relevant (0)”, and “Not so relevant (_1)”

This question will be rated by considering the order of relevance provided by the digital library, the CORE conference ranking (A, B and C conferences), and the Journal Citation Reports (JCR) lists.

5. The study has been cited by other authors?

The possible answers to this question are: “Yes (+1)” if the paper has been cited by more than five authors; “partially (0)” if the paper has been cited by 1–5 authors; and “No (_1)” if the paper has not been cited. This question was rated by considering the Google scholar citations count

Table 4

Paper/Publication Tittle:		
Authors:	Year of Publication:	
Reference Type: Journal/Conference/Thesis/Unpublished	Publisher: IEEE/ACM/Google Scholar/Science Direct	
Quality Assessment	**(1)**	**(0)** **(-1)**
Study provides detailed description of usability engineering management for the aging population/senior citizen?		
The study provides the guideline as how the usability engineering management techniques are used for the aging population?		
The study provides clear results after application of Usability engineering management status for the aging population?		
The study has been published in a relevant journal or conference proceedings?		
The study has been cited by other authors?		
Data extraction for Questions	**Answers**	
What are the usability influencing factors and problems encountered in usability management for the aging population?		
Which usability evaluation methods commonly used for evaluation?	Questionnaires User/researcher usability test Following existing guidelines Eye movement analysis and DIT theory and other methods Observation and interviews Heuristic evaluation Statistical analysis through system log files Cognitive walkthrough	
How many types of usability evaluation methods are used to assess the usability management status in the paper?	Single evaluation method Two evaluation methods Three or more evaluation methods	
Which usability management technique/method has been reported in this study?	Technique /Method	

Which kind of case study discussed in the paper?	Network application for the aging population Mobile Technology for the aging population Computer Software for the aging population Computer hardware and others for the aging population
Data characteristics	Academia Mixed Industrial Government
What are the limitations of usability engineering management for the aging population/senior citizens?	Human factor design Care Communication & Listening Perception variation Distributed Environment Coordination Test Setting and preparation(TSP) Others
Empirical Validation of the usability management techniques applied for the aging population	Case Study Experiment Survey experience reports observational study, survey action research Others
Which classification of theoretical studies are mentioned here?	Design principles and ideas of usability management Evaluation method of usability management Development and influencing factor of usability management Design principles, ideas, and evaluation methods Development, influencing factor, and evaluation method of usability management Development, influencing factor, and design principles, ideas of usability management
Remarks:	

VI. Publication's General Information

Table 1 represent the general information of publications in the SS review process all these papers were finalized to gather the information according to our designed questions.

Through searching of the literature for fourteen years in the four databases, we obtained a total of 6029 publications. After applying our inclusion and exclusion criteria, 61 publications were included in our analysis

Reasons for the high exclusion rate are as follows.

(1) It happens commonly that repetition of same publication occurs in databases.

(2) Unrelated field of study retrieved commonly.

(3) Search function limitation by databases.

Table 5

Sr. No	***General Information regarding publication***				
	Tittle	**Author**	**Database (Digital Library)**	**Journal/ Conference/ Workshop**	**Year**
1	User centered management system for oldly people Empowering older people with interactive technologies to manage their activities at the retirement home	Otjacques Benoit, Krier Marc, Feltz Femand, Ferring Dieter, Hoffmann Martine	IEEE	Conference	2009
2	Proper Use of Web Technology to Teach Older People: A Case Study	Chandrima Chatterjee, Arunasish Acharya	IEEE	Conference	2016
3	Users' Perspective of Smartphone Platforms Usability: An Empirical Study	Amira Ahmed, Arif Raza, Sarmad Sadik	IEEE	Conference	2014
4	Teaching Older People using Web Technology: A Case Study	Nahdatul Akma Ahmad, Azaliza Zainal, Saliyah, Fariza Hanis Abdul Razak, Wan Adilah Wan Adnan	IEEE	Conference	2013
5	Metric Based Usability Evaluation for Adoption and Usage of Mobile Devices and Services by Oldly Population	Ruchika Singh, Sanjay Kumar Dubey	IEEE	Conference	2016
6	Performance of Daily Activities by Older Adults with Dementia: The Role of an Assistive Robot	Momotaz Begum, Rosalie Wang, Rajibul Huq, Alex Mihailidis	IEEE	Conference	2013
7	Older Adult Perceptions of Smart Home Technologies: Implications for Research, Policy & Market Innovations in Healthcare	J.F Coughlin, L.A. D'Ambrosio, B. Reimer, M. R. Pratt	IEEE	Conference	2007
8	Touch- and Audio-based Medication Management Service Concept for Vision Impaired Older People	Mari Ervasti, Minna Isomursu, Igone Idigoras Leibar	IEEE	Conference	2011
9	Acceptability and usability of a computer-based cognitive training program: an exploratory study with community-dwelling older adults	Daniela Figueiredo, Adriana Sousa, Marisa Lousada	IEEE	Conference	2017
10	Designing Brain Training Games and Evaluating the Usability between Young and Oldly	Jung-Ying Wang	IEEE	Conference	2013
11	Qualitative Findings on the Use of Mobile Phones by Malaysian Older People	Sofianiza Abd Malik, Muna Azuddin	IEEE	Conference	2013
12	Interface Design of a Central Monitoring Device Taking Cognitive Aging into Account	Keiji Ogata, Takatsune Kumada, Satoru Suto, Katsumi Watanabe,	IEEE	Conference	2011

		Toru Ifukube			
13	Comparison of Game Experience and Preferences between Young and Oldly	Jung-Ying Wang	IEEE	Conference	2014
14	Seniors' usage of mobile social network sites: Applying theories of innovation diffusion and uses and gratifications	Myung Ja Kim, Choong-Ki Lee, Noshir S. Contractor	Science Direct	Journal	2018
15	Personal and other factors affecting acceptance of smartphone technology by older Chinese adults	Qi Ma, Alan H.S. Chan, Ke Chen	Science Direct	Journal	2015
16	The limits of participatory technology development: The case of service robots in care facilities for older people	Diego Compagna, Florian Kohlbacher	Science Direct	Journal	2014
17	Open data and the needs of older people for public transport information	N. B. Hounsell, B. P. Shrestha, M. McDonald, A. Wong	Science Direct	Journal	2016
18	An approach to vehicle design: In-depth audit to understand the needs of older drivers	Sukru Karali, Neil J. Mansfield, Diane E. Gyi	Science Direct	Journal	2017
19	Personalising web page presentation for older people	S.H. Kurniawan, A. King, D.G. Evans, P.L. Blenkhorn	Science Direct	Journal	2006
20	The impact of age on website usability	Nicole Wagner, Khaled Hassanein, Milena Head	Science Direct	Journal	2014
21	A framework to design a human-centred adaptive manufacturing system for aging workers	Margherita Peruzzini, Marcello Pellicciari	Science Direct	Journal	2017
22	Characteristics and usage patterns of older people in a 3D online multi-user virtual environment	Panote Siriaraya, Chee Siang Ang	Science Direct	Journal	2012
23	Development and usability of a decision support App for nurses to facilitate aging in place of people with dementia	T. Thoma-Lürken, M.A.S. Lexis, M.H.C. Bleijlevens, J.P.H. Hamers	Science Direct	Journal	2018
24	Design of a Smart Building Control with View to the Senior Citizens' Needs	J. Vanus, J. Koziorek, R. Hercik	Science Direct	Conference	2013
25	Adapting a Psychosocial Intervention for Smartphone Delivery to Middle-Aged and Older Adults with Serious Mental Illness	Karen L. Whiteman, Matthew C. Lohman, Lydia E. Gill, Martha L. Bruce, Stephen J. Bartels	Science Direct	Journal	2017
26	ICT and Older People: Beyond Usability	Eula` lia Hern_andez-Encuentra Modesta Pousada Beni G_omez-Zu´ n˜ iga	Google Scholar	Journal	2009
27	The effect of previous exposure to technology on acceptance and its importance in usability and accessibility engineering	Andreas Holzinger Gig Searle Michaela Wernbacher	Google Scholar	Journal	2010

28	A Study of Web Usability for Older Adults Seeking Online Health Resources	Shirley Ann Becker	Google Scholar	Journal	2004
29	Use of Experimental Pain to Compare Psychometric Properties and Usability of Selected Pain Scales With Younger Adults	Keela A. Herr, Kevin Spratt, Paula R. Mobily, Giovanna Richardson,	Google Scholar	Journal	2004
30	Older adults' attitudes towards and perceptions of 'smart home' technologies: a pilot study	George Demiris, Marilyn J Rantz, Myra A Aud, Karen D Marek, Harry W Tyrer, Marjorie Skubic, Ali A Hussam	Google Scholar	Journal	2004
31	Increasing the Usability of Online Information for Older Users: A Case Study in Participatory Design	R. Darin Ellis, Sri H. Kurniawan	Google Scholar	Journal	2009
31	Learning to use new technologies byolder adults:Perceived difficulties,experimentation behaviour and usability	Yvonne Barnard, Mike D. Bradley, Frances Hodgson, Ashley D. Lloyd	Google Scholar	Journal	2013
32	Usability Testing by Older Adults of a Computer-Mediated Health Communication Program	Carolyn A. Lin, Patricia J. Neafsey, Zoe Strickler	Google Scholar	Journal	2009
33	Usability of Health Web Sites for Older Adults A Preliminary Study	Eun-shim Nahm, Jennifer Preece, Barbara Resnick, Mary etta Mills	Google Scholar	Journal	2004
34	Senior Citizens and E-commerce Websites: The Role of Perceived Usefulness, Perceived Ease of Use, and Web Site Usability	Terry J. Smith	Google Scholar	Journal	2008
35	Requirements engineering for e-Government services: A citizen-centric approach and case study	Lex van Velsen, Thea van der Geest, Marc ter Hedde, Wijnand Derks	Google Scholar	Journal	2009
36	Ambient Assisted Living Spaces Validation by Services and Devices Simulation	Carlos Fern´andez-Llatas, Juan Bautista Mochol´ı, Pilar Sala, Juan Carlos Naranjo, Salvatore F. Pileggi, Sergio Guill´en, Vicente Traver	Google Scholar	Conference	2011
37	Design ,implementation and wide pilot deployment of fit for all:an easy to use programming platform improving physical fitness and life quality of senior citizen	E. I. Konstantinidis, A. S. Billis, C. A. Mouzakidis, V. I. Zilidou, P. E. Antoniou P. D. Bamidis	Google Scholar	Journal	2014
38	Senior Citizens' Acceptance of Information Systems: A Study in the Context of e-Government Services	Chee Wei Phang, Juliana Sutanto, Atreyi Kankanhalli, Yan Li,	Google Scholar	Journal	2006

		Bernard C. Y. Tan, Hock-Hai Teo			
39	Senior-Friendly Technologies: Interaction Design for Senior Users	Henry Been-Lirn Duh, Ellen Yi-Luen Do, Mark Billinghurst, Francis Quek, Vivian Chen Hsueh-Hua	Google Scholar	Workshop	2010
40	Oldly-technology interaction: accessibility and acceptability of technological devices promoting motor and cognitive training	Tiziana C. Callari, Silvia Ciairano, Alessandra Re	Google Scholar	Workshop	2012
41	Usability of Touch-Panel Interfaces for Older Adults	Atsuo Murata, Hirokazu Iwase	Google Scholar	Journal	2005
42	Experiences from User Centric Engineering of Ambient Assisted Living Technologies in the Living Lab Schwechat	Paul Panek, Walter Hlauschek, Manfred Schrenk, Katharina Werner, Wolfgang L. Zagler	Google Scholar	Conference	2011
43	Knowledge-Based System for Web Interface Design	Maxim A. Bakaev, Tatiana V. Avdeenko	Google Scholar	Journal	2013
44	Redesigning Web Sites for Older Adults	Evelina Patsoule, Panayiotis Koutsabasis	Google Scholar	Journal	2012
45	An Age-Old Problem: Examining the Discourses of Ageing in HCI and Strategies for Future Research	John Vines, Gary Pritchard, Peter Wright, Patrick Olivier, Katie Brittain	ACM	Journal	2015
46	Never Too Old: Engaging Retired People Inventing the Future with MaKey MaKey	Yvonne Rogers, Jeni Paay, Margot Brereton, Kaite Vaisutis, Gary Marsden, Frank Vetere	ACM	Conference	2014
47	Avaliação de interface de um aplicativo para uso em telefone celular e voltado para a terceira idade	Artur Martins Mol, Lucila Ishitani	ACM	Conference	2010
48	Interactive Multimodal Social Robot for Improving Quality of Care of Oldly in Australian Nursing Homes	Rajiv Khosla, Mei-Tai Chu, Reza Kachouie, Keiji Yamada, Fujita Yoshihiro, Tomoharu Yamaguchi	ACM	Conference	2012
49	Utilisabilité d'un système de stimulation cognitive	Melissa Brun, Gabriel Michel, Eric Brangier	ACM	Conference	2012
50	WISE: a Wizard Interface Supporting Enhanced Usability	Joshua M. Hailpern	ACM	Conference	2006
51	How Universal is Good Design for Older Users?	Dan Hawthorn	ACM	Conference	2003
52	Utilisabilité et discrimination : étude préliminaire des machines à voter françaises	Gabriel Michel, Mathieu Klein	ACM	Conference	2008
53	The Potential of Adaptive Interfaces as an Accessibility	David Sloan, Matthew Tylee	ACM	Conference	2010

	Aid for Older Web Users	Atkinson, Colin Machin, Yunqiu Li			
54	Being Old Doesn't Mean Acting Old: How Older Users Interact with Spoken Dialog Systems	Maria Wolters, Kallirroi Georgila, Johanna D. Moore, Sarah E. Macpherson	ACM	Conference	2009
55	The Impact of User Research on Product Design Case Study: Accessibility Ecosystem for Windows Vista	Annuska Perkins, Tira Cohene	ACM	Conference	2006
56	A New Tourist Audio Guide Service for Oldly People Integrated in the Mobile Phone: Preliminary Results	Unai Díaz, Álvaro García, Alejandro de Felipe	ACM	Conference	2010
57	Can Cognitive and Functional Measures explain Interactions between Oldly People with Different Levels of Cognitive Decline and an Avatar on TV?	Unai Díaz, Aitziber Etxaniz, Mari Feli González, Cristina Buiza, Elena Urdaneta, Javier Yanguas	ACM	Conference	2011
58	Web Usability and Age: How Design Changes Can Improve Performance	Ann Chadwick-Dias, Michelle McNulty , Tom Tullis	ACM	Conference	2003
59	Engaging Older People using Participatory Design	Stephen Lindsey, Danial Jacklson, Guy Schofield, Patrick Olivier	ACM	Conference	2012
60	Evaluating a Pen-based Computer Interface for Novice Older Users	Dante Arias Torres	ACM	Conference	2006
61	About the relevance of accessibility barriers in the everyday interactions of older people with the web	Sergio Sayago, Josep Blat	ACM	Conference	2009

All above details and graphical results regarding publications are gathered from the references [4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41, 42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,6162,63,64,65]

VII. Graphical Representation of analyzed data Results and Specific Information Regarding Research Paper

Q.6: Source of Publication		
Options	Response Percentage	Responses
Conference	52.45	32
Journal	44.26	27
Thesis	0	0
Workshops	3.27	2
Unpublished	0	0
Total Responses= 61	Answered Responses= 61	Skipped=0
Mean=1.51		
Standard Deviation=0.566		
Variance=0.321		
Standard Error=0.073		

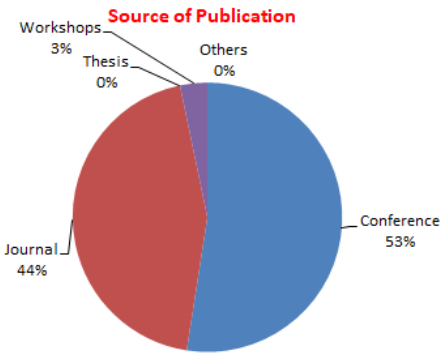

Figure 2: Source of Publication

Q.7: Publisher		
Options	Response Percentage	Responses
ACM	29.5	18
IEEE	21.3	13
GOOGLE SCHOLAR	29.5	18
SCIENCE DIRECT	19.67	12
Total Responses= 61	Answered Responses= 61	Skipped Response = 0
Mean = 2.393 Standard Deviation =0.143 Variance = 1.243 Standard Error =1.115		

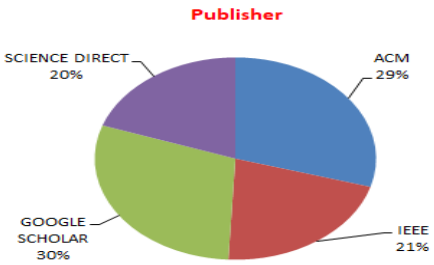

Figure 3: Publisher

Q.8: Study provides detailed description of usability engineering for old age people/senior citizen?		
Options	Response Percentage	Responses
1	77.04%	47
0	22.9 %	14
-1	0%	0
Total Responses= 61	Answered Responses=61	Skipped=0
Mean= 0.770 Standard Deviation =0.424 Variance= 0.179 Standard Error=0.054		

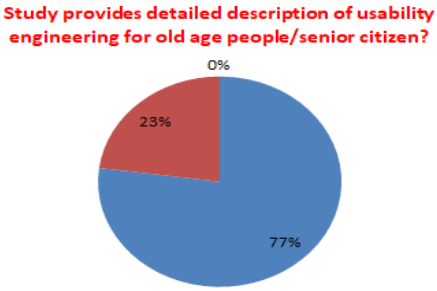

Figure 4: Study provides detailed description of usability engineering for the aging population/senior citizen?

Q.9: The study provides the guideline as how the usability engineering techniques are used for elder age people		
Options	Response Percentage	Responses
1	70.49%	43
0	29.50%	18
-1	0%	0
Total Responses= 61	Answered Responses= 61	Skipped=0
Mean= 0.705 Standard Deviation = 0.459 Variance= 0.211 Standard Error=0.059		

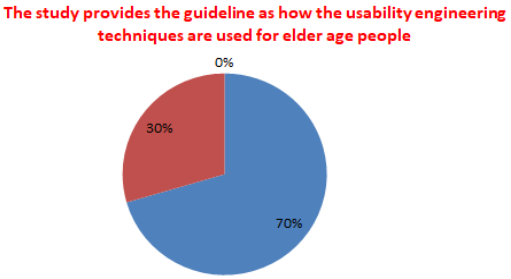

Figure 5: The study provides the guideline as how the usability engineering techniques are used for the aging population

Q.10: The study provides clear results after application of Usability engineering status for elder age people/senior citizens across the world?		
Options	Response Percentage	Responses
1	80.3%	49
0	19.67%	12
-1	0%	0%
Total Responses= 61	Answered Responses= 61	Skipped=0
Mean= 0.803 Standard Deviation = 0.401 Variance= 0.161 Standard Error=0.051		

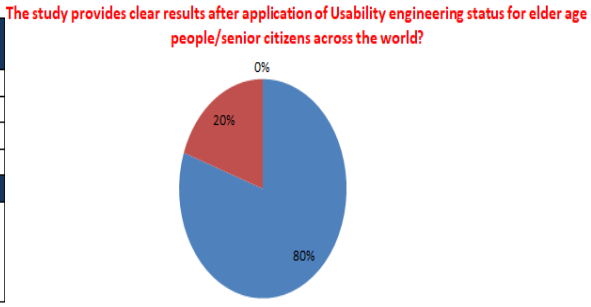

Figure 6: The study provides clear results after application of Usability engineering status for the aging population/senior citizens across the world?

Q 11: The study has been published in a relevant journal or conference proceedings?		
Options	**Response Percentage**	**Responses**
1	93.44	57
0	6.55%	4
-1	0%	0
Total Responses= 61	**Answered Responses= 61**	**Skipped=61**
Mean= 0.9344262		
Standard Deviation = 0.2495898		
Variance= 0.6229508		
Standard Error=0.0319567		

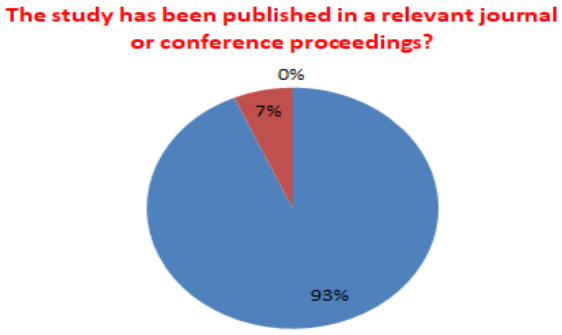

Figure 7: The study has been published in a relevant journal or conference proceedings?

Q 12: The study has been cited by other authors?		
Options	**Response Percentage**	**Responses**
1	98%	60
0	1.63%	1
-1	0%	0
Total Responses=61	**Answered Responses= 61**	**Skipped=0**
Mean= 0.983		
Standard Deviation =0.128		
Variance= 0.016		
Standard Error =0.016		

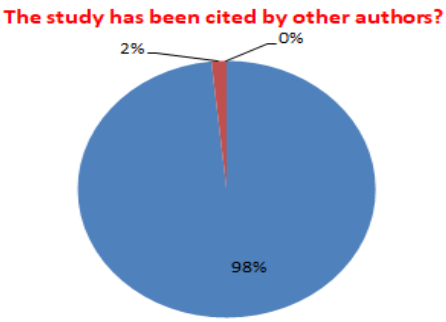

Figure 8: The study has been cited by other authors?

Q13: Empirical Validation of the usability techniques applied for elder age people?		
Options	**Response Percentage**	**Responses**
Case Study	13.11%	8
Observation Study	31.1%	19
Experiment	29.5%	18
Survey	11.47%	7
Experience Report	9.83%	6
Action Research	3.27%	2
Others	1.63%	1
Total Responses= 61	**Answered Responses= 61**	**Skipped =0**
Mean= 3.327		
Standard Deviation =1.630		
Variance=2.657		
Standard Error=0.209		

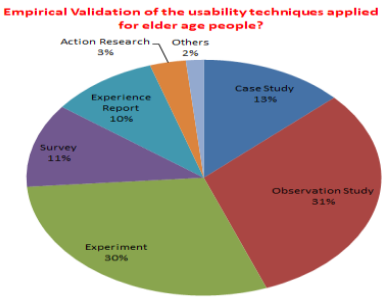

Figure 9: Empirical Validation of the usability techniques applied for the aging population?

6. Conclusion

In this systematic review (SR) performed on usability management and usability engineering management for the aging population, three research questions were established and research strings were designed using PICOC structure to extract research papers from different database, including ACM, IEEE, Google Scholar, and Science Direct. Search protocol was designed for setting studies rules regulations to follow for summarize and concrete results after analysis. On the basis of set protocols how the usability engineering techniques are used for the aging population while only 30 percent studies partially describe the techniques applications. In SR 80 percent

study provides clear results of usability management engineering status for the aging population/senior citizens across the world, 20 percent are partially providing results of applications. Research detect the limitations of usability management and usability engineering management for the aging population. This question was answered by different researchers, with 19 percent researchers said Care Communication and Listening "CCL" is a limitation for UEM4Aging, 23 percent indicated perception variation as a limitation for UEM4Aging, and 32 percent indicated Test Setting and Preparation ''TSP" while testing usability management software for the aging population. In SR conducted, 33 percent discussed team coordination issues and 16 percent indicated that distributed environment are creating limitation for usability engineering management for the aging population. From these results, it is clear that researchers are working on usability management engineering for senior citizen. They are trying to find the existing limitations as faced by usability management engineering for the aging population. They are also working on remedial techniques for usability management engineering for the aging population. The aim of this systematic review was performing a detailed analysis of the limitations of UE4Aging and analyzing the existing remedial work and its limitations. From here we extract detail problems analysis, current strategies presents their limitations. We are statistically able to judge the problems, their nature and affect for the aging population. Inclusion and exclusion criteria was applied on selected data bases. Papers were selected iteration wise against each research question from these finalized data bases 61 papers were selected, these selected papers were analyzed, reviewed and data was extracted based according to data extraction form. The study summarized that different researchers made efforts for usability engineering management for the aging population/senior citizens. Different techniques of usability management were applied for covering usability limitations for the aging population. The collected data is statistically analyzed by Statistical software **"R Studio"** and according to this analysis, research papers selected for this study were taken between 2004-2018, out of 100 percent 44 percent papers were published in journal 53 percent in conference and 3 percent were workshops publications.

7. Future Work

In future on the basis of these detailed limitations identified in SR (Systematic review) faced by usability management engineering some remedial techniques has to be proposed to handle the highlighted limitations

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