

Giuseppe Di Bucchianico
Pete Kercher *Editors*

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Proceedings of the AHFE 2016 International Conference on Design for Inclusion, July 27–31, 2016, Walt Disney World®, Florida, USA

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Research Methods Applied to Studies with Active Elderly: A Literature Review

Laura Martins, João Baptista and Pedro Arezes

Abstract In almost every developed and in developing countries, the elderly population is increasing. It is assumed that environments, products and services must be appropriate and accessible to them as many people, regarding their characteristics, abilities and limitations. The purpose of this paper is to establish an outlook about the methods that are usually applied in research involving active elderly at the development stages of products designed for that specific segment of the Society.

Keywords Research • Methods • Elderly • Literature review

1 Introduction

Elderly population is increasing, both in developed and in development countries. According to the “Perspectives on World’s Population: 2012 review” report of the United Nations, it is expected that, world’s population increase from 7.2 to 9.6 billion by 2050, with life expectation increasing to the prediction of 76 years old between 2045 and 2050 and 82 years old between 2095 and 2100 [1].

The World Health Organization (WHO) declared that world’s population over 60 years old will increase from the current 841 million to 2 billion in 2050 [2]. This new social situation had led to discussions about the necessity to meet the needs of this stage of life, fostering researches directed to this social segment.

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Assuming this scenario, it is relevant that environments, products and services must be adequate and accessible to many people as possible, regarding their characteristics, abilities and limitations.

The challenge imposed is to develop a proposition of methodological procedures that can capture the voice of older users in order to collect facilities and difficulties when using and environment, a product and a service and seeking possible solutions. Although this approach is consensual, few scientific studies indicate methods and target instruments involving the elderly in planning and controlling a significant part of the development phases of a project. Which can be performed with their knowledge and empowering them to influence both process as results and establishing desirable goals.

As the final user, the elderly must analyze, explain and offer information capable to identify their real needs providing a comprehension of the use context and functional requirements, therefore, contribute to decision-making process in their everyday living. The scientific community, in several articles published in journals, has discussed such approach.

Participatory design is a design approach characterized by the concern to improve the relation between those involved in the design process. It was developed on a political framework of democracy and it was initially applied to introducing new technologies in the workplace in Scandinavia. The key-principles are that the designer act as a facilitator, the user is raised to a position of expert within its own domain and technology should be applied to improve existing skills [3].

Throughout time, participatory design became “a set of theories, practices and studies related to users as full participants in activities that lead to computer software, products hardware and computer based activities” [4], although it is applied in many other settings.

There are some tools and methods that have been developed by researchers to support the principles of the participatory design, with particular emphasis to observation and interviews with end user in a determined context or real environment, according to the nature of the project.

The purpose of this paper is to provide an overview of methods applied in research involving elderly people in designing stages of products for this segment of society.

2 Materials and Methods

A literature review was performed through a systematic search in SCOPUS, a bibliographic database of a very wide scope, which was accessed in February, 2016, as well as through the Google search engine. The criteria included the works published after 2000 with the following search strings keywords “older” OR “elderly” OR “old people”, and simultaneously related to:

- “participatory design”. The final search resulted in 179 articles;
- “development of products and services” resulted in 1 article;

- “development of products” resulted in 17 articles;
- “development of services” resulted in 70 articles;
- “methods and techniques” resulted in 85 articles.

Combined keyword search was also performed, “participatory design AND methods and techniques” resulted in 1 article; and “participatory design AND evaluation” resulted in 25 articles. Thus, 378 articles were found, with 31 duplicated, resulting in a partial total of 347 articles.

In searching the keywords “older OR elderly OR old people” related to “participatory design AND development of products and services”, “participatory design AND development of products” and “participatory design AND development of services”, no articles were found. The 70 articles found from the search with “development of services”, were discarded because the main subject was the provision of services, such as urban cleaning, telephone, etc. Thus, only a total of 277 articles were selected.

Initially, a careful analysis of the articles was conducted from reading all the abstracts. The first layer criteria for articles’ selection were the premise of the use of methods in which elderly participation was decisive for survey and data analysis, development of concepts, project’s criteria definition or evaluation and validation of projects that contribute to life quality in old age. The following criteria were also considered relevant to the articles’ selection in this first assessment: articles published in indexed journal, available to download as, full texts, written in one of the languages accessible to the authors (Portuguese, English and Spanish). The second layer criterion was a stricter one, since it was select for the final inclusion only those works in which an active involvement of the elderly was registered during the study.

3 Results

From the carried out search, only 40 articles met the first layer selection criteria after analysis of all of the selected abstracts, but only 30 of them had available the full-text version available for download.

Thirty of the studies identified were classified as eligible for the first layer criterion:

- 5 articles addressed the needs of the elderly, but the research was carried out through the participation of family member and/or caregivers;
- 8 articles mentioned participatory design, but the elderly only participated in data collection answering questionnaires;
- 2 articles dealt with elderly people with dementia, with no conditions, therefore, to participate actively in the research;
- 6 articles did not address to product designing, but exploratory research about abilities and/or behavior;

- 1 article presented a comparative analysis of methodology;
- 8 articles were selected to compose the analysis of the methods applied in researches involving elderly people in the designing stages of environments, products and services for the specific public.

Based on that, only the last 8 papers were considered to be eligible for the second layer criterion and were selected to be included in this review.

As a guideline of this analysis, the Bonsiepe's Experimental Methodology [5] was adopted, being the methodology focused in product design, widely disseminated. According to the author, the design process can be schematically subdivided in the following steps or stages:

- (i) problematization;
- (ii) analysis;
- (iii) problem definition;
- (iv) project development: preliminary draft and generation of alternatives;
- (v) evaluation, decision, choice;
- (vi) achievement;
- (vii) and final analysis of the solution.

This systematic review shows the 8 selected studies that contemplate the effective participation of the elderly in product development targeted to this audience and that are briefly presented in Table 1, with some basic characteristics about each of the main applied methodologies. In this table, the indicated stages correspond to the same items mentioned in the previous list, from (i) to (vii).

The article of Bossen et al. [6] the objective was “to develop technologies capable of helping a collaborative practice between the elderly and their families and professionals/caregivers in order to control activities performed by the seniors

Table 1 Reviewed papers and main characteristics of the participatory approach

Heading level	Stages in the research method	No. of participants	Age range	Type of methodology
Bossen et al. [6]	i, iv, v	14 [i] + 24 [v]	30–75	Participatory design
Keith [7]	i, iii	200 [i] + 8 [iii]	50–85	Participatory design
Iacono et al. [8]	i, v	6	Average 83.17	Participatory design
Colonus et al. [9]	i, iii, iv, v	21	Not specified	Participatory design with user-centred approach
McGee-Lennon et al. [10]	iii, iv, v	25	>60	Co-design
Demirbilek et al. [11]	i, iii, v	13	>65	Combination participatory design and USAP
Flinn et al. [12]	i, iv	26	>65	Not specified
Abeele et al. [13]	i, iv	10	68–80	User-centred design

with no intention of establishing dependency”, focusing on developing a software that assist the performance of daily living activities, called CareCoor.

This article points out participatory design as a guidance approach tracing three steps for product designing: problematization, where an ethnographic research was conducted to preliminarily define the methodological tools; development of the project, covering the stages of draft and generating alternatives to develop the software; and evaluation to review and analyze CareCoor software. In the step of problematization—an ethnographic research was conducted, lasting 9 months, being conducted 12 semi structured interviews of 1 h each with 7 family members and 7 caregivers (5 men, 9 women aged between 30 and 75 years); 4 workshops were also performed, the first with 3 members of the elderly family, the second with 5 caregivers and then two conjoint workshops with both. In the project development stage—based on the previous stage, it is developed a software for assistance of everyday activities for the elderly, named CareCoor. In the stage of Evaluation, Decision and Choice—the CareCoor software was applied in two pilot testes: the first lasted a week and included 3 seniors, their family members and the caregivers, the second lasted 6 weeks, with the participation of 5 seniors, their families and caregivers.

In the article of Keith [7] the goal was to “analyze the different strategies to help older people to identify the problems with a significant activity—driving—in order to identify the variety of driving experiences and explore potential opportunities and difficulties of in-car driving assistance systems”. In particular, explore methodologies that emphasize the user’s role as a design partner—“designing with the user rather than for the user”—in this sense, the established goal was to understand the needs of elderly users regarding cars and its interfaces, focusing on the task of driving. The article indicates participatory design as a guiding approach and, even though the final product being a methodological approach, it followed in its development two methodological steps: problematization, to delimit the practical and subjective requirements of older users regarding the task of driving; and the definition of the problem to determine the most latent needs. The Problematization stage—consisted of a questionnaire with at least 200 elderly people (between 50 and 80 years); still in order to define potential problems, focus groups were conducted (7 groups of 2–4 participants each) and individual sessions, that lasted 18 months, with participants aged between 55 and 85 years. As a result of Problematization, the authors noted two specific needs: speeding and parking, and later held the state of art. Defining the problem—focusing on the issue of speed, a test-research was conducted on the most latent needs identified in the previous phase and in the state of art stage, low-fidelity prototypes were built in order to promote the visualization and evaluation of users. These prototypes followed three display types: static, dynamic and interactive (using games). The next phase of the process, focused on the parking issue, involved elderly participants, therefore, without familiarity with new technologies of “smart cars”. The participants of this stage were 8 (eight) elderly users, 3 (three) women and 5 (five) men aged from 50 to 80 years old. Next, evaluative tests were conducted with low-fidelity prototypes, such as toy cars, printed layouts of roads and the use of drawing so that the users

could register their considerations. Still in order to define problems, the users were requested that using their own cars, parked in a determined space and narrated the experience to the researchers, specifying strategies and difficulties. Subsequent to this step, the same action was taken, but this time using “smart cars” with new technologies, in order to understand the user’s familiarity with the task as opposed to the facilities and difficulties of new technologies.

In the article of Iacono et al. [8] the objective was “to develop a graphical interface with elderly users to control a robotic system of a “smart home”, proposing a system to facilitate the lives of elderly people living alone. The system includes a tablet software, which works as a remote control, and a robot that receives, encodes information and perform tasks as the user’s needs and desires”. The paper discuss the participatory design as the guiding approach and highlight two stages of the product designing: problematization, that the authors name familiarization, composed by videos of the design functioning (software and robot), interacting with an elderly user, to promote understanding of the overall functioning; and evaluation, that authors name visualization and evaluation, to reaffirm the understanding of the software functioning and evaluate its effectiveness in the elderly user opinion. In Problematization step—composed of videos of the operating design project (software and robot) interacting with an elderly user to promote the fully understand of the system. In this step, participants wrote down their comments and perceptions about the products, highlighting its positives and negatives aspects. In the step of Evaluation, Decision and Choice—participants were exposed to the functioning product, but with the aid of storyboards and colored pens where the goal was to reinsure the overall comprehension of the software and evaluate its efficacy in the perception of the elderly. Once the understanding of the interface, its functions and possibilities was stablished, participants were invited to explore potentialities of the interface design, visualizing the possibilities and performing positive and negative evaluations of those potentialities.

In the article of Colonius et al. [9] the objective was to “develop a ‘smart’ assistance device for elderly people suffering from cognitive impairment arising from diseases. The research was developed from a Project named SHARE-it, that aims to improve life quality and Independence of elderly people with cognitive problems”.

The research combines two different methods of participatory development in order to involve both the designing team as well as the real end user. It is noticed the challenging nature in proposing a user-centered design approach, given the specific audience. However, it is emphasized that the methodology can be applied in accordance with the application of domain experts, which means that the paper proposes not only the participation of the users, but also of experts from the medical and elderly care fields, in favor of a collective and cooperative experience about the specific need of the public. The project contains four stages for product design: problematization, with professionals from medical areas to address potential need of the elderly; the definition of the problem, defining the needs of the elderly; the project development with generation of alternatives; and evaluation, decision and choice from prototyping and its evaluation. The first phase,

Problematization—narrative scenarios are used to maximize the communication between method and experts. This phase also includes the medical professionals as representatives of elderly users, describing their potential needs and requirements. The second phase: Definition of the problem—the elderly participate in an evaluative way, assuring if their needs were effectively described and defined, helping defining the problem. The third stage: Development of the Project (preliminary project and generation of alternatives)—in this step, a high-fidelity prototype system is developed where the elderly, the potential users, conduct the evaluation of the interface, observing its positive and negative aspects. Fourth stage: Evaluation, Decision and Choice—prototyping step is conducted again with the elderly, with several projectual alternatives and with the participation of the researcher as an observer, analyzing in details the process of evaluation.

In the article of McGee-Lennon et al. [10] the objective was “to develop a multimodal system of reminders for elderly people in the house environment, with application in mobile devices that can be highly configured by the end user in a comfortable way. Considering that the end users of the product would be elderly, concepts of Inclusive Design—forcing designers to consider the public’s real problems associated with sensory, physical and cognitive disabilities—and Design for All were considered in the research”. The article indicates co-design as a method that guided the research, although this approach in practice, presents concepts and steps similar to the participatory design approach. It is also presented three stages for the product design: definition of the problem, in order to investigate and analyze the best techniques for reminders configuration and user interaction with the product; the project development stage, that even though it is not explained in the article, presents dynamics that fits into this stage; and evaluation, decision and choice, involving the creation for evaluation and definition of reminders prominently in multimodal functions. Definition of the problem—6 co-design sessions were held with 25 users over 60 years to investigate the best methods and techniques for reminders settings and user interaction with the product. These sessions involved questionnaire tools, evaluation through “Keep, Lose, Change” and interactions with the prototypes, individually and collectively. Participants were selected in two contexts: “active elderly” (over 65 years old, but active and independent) and users over 75 years with sensory weakness. The stage of Project Development—the development of the prototypes were based on another study conducted in the MultiMemoHome (www.multimemohome.com) Project, which involved a questionnaire; a series of focus groups with elderly and adults with sensory impairments (25 participants); and Home Tour sessions guided by the user to understand the everyday experience of space and Technologies that could be used in a reminder system in their own environment. The stage of Evaluation, Decision and Choice—this step involved designing a variety of low-fidelity reminder interfaces prototypes with emphasis on multimodal functions (the ability to choose how to receive the reminder); and a series of high-fidelity prototypes in mobile devices to evaluate the interaction.

In the article of Demirbilek et al. [11] the objective was “to use the USAP (Usability, Safety, Attractiveness Participatory) design model to establish a matrices

system of quality deployment. In order to illustrate the research, a case study was performed for development of doors and door accessories with participatory design sessions to test the conceptual design phase of the proposed model". The method chosen for the article is the USAP design model. In this particular process, hybrid from the participatory design, five phases of the method are defined proposing a relationship of interaction and cooperation with the end user: concept development; concept refinement; prototyping; user's tests and production. Although the methodological procedures performed by the researchers correspond to these five steps, as described in the paper "as product definition, three design projects were presented: door handles that could be operated with the elbow and hands and developed in comfortable materials; a shelf attached to the wall in the main entrance so that the user can support what they have in their hands while looking for keys or even to rest groceries; and a door with a glass screen attached so that the elderly are able to see who is on the other side of the door, identifying the person in a safe way", implying, according to the text, that the development of the concept corresponds to the problematization step [5], concept refinement to the step of problem definition [5], prototyping, user testing and production to the step of evaluation, decision and choice [5]. The stage of Problematization—in order to develop the concept, techniques of scenario construction, non-structured interviews and questionnaires about the topic were performed, it was also an encouragement for brainstorm with the information and materials available. At the end of this phase, all answers and ideas obtained were grouped in several topics to begin structuring of the matrices of quality implementation, which means the "definition of the problem". In the step of definition of the problem—the designer presented drawings, developed from the first part of the study, in the form of sketches, from that, the participants received a copy of those drawings and were asked to critique and redesign them, expressing their ideas and making corrections, all the results from that phase were also grouped for structuring the matrices. In the step of Evaluation, Decision and Choice—crucial points explained by the elderly were introduced in the matrices with three different categories of relevance: relevant, moderate and less important, and were used in the development of projetual drawings presented in the second phase of the study.

In the article by Flinn et al. [12] the objective was to "investigate the participatory experiences of older women with manual limitations, reduced handling, in creative activities to improve usability when opening bottles". The selection criteria included: women with 65 years or older with difficulty opening bottles or products with twist caps, who have presented hand pain and had the ability to follow verbal instructions. The paper does not specify the methodology, but it was selected due to the active participation of the user in all the steps of the project. In addition, the authors acknowledge, "the objective of the paper was fruitful, especially considering that there was an important engagement of participation of the elderly as well as the productive results while implementation of the participatory approach".

Regarding the methodological stages, the described phases correspond to the following steps: problematization and development of the project [5]. The step of Problematization—an analysis with 42 different types of bottles, available in the

common marker, were conducted in a focus group with duration of 1 h. The participants evaluated their preferences in the matters of size, shape and texture of the lids. Then, the focus group initiates a manual activity with toolkits with soft and colorless modeling clay, modeling clay tools and two empty plastic containers in order to build what they considered “the best lid possible” considering possible hand limitations and using sizes, shapes and textures of their choice. The sequential phase was divided in two parts: in the first one participants were encouraged to make “the best lid design that you believe that could be in the market in at least two years”; in the second part they were instructed to make “the craziest or out of reality lid, of any size, format that they envision in the future”; after those creation phases, they were invited to present and explain their ideas and concepts for the rest of the group, being questioned about usability, marketing possibilities, etc. In the step of development of the project—the prototypes created by the participants were catalogued along with audio and video of the previous part, and, the researchers made detailed notes about the experience. Prototyping phase resulted in 36 lid design created by the elderly participants. In the step of Evaluation, Decision and Choice—from the 36 prototypes developed, four categories were created based in qualitative analysis and in the descriptions provided by the elderly women: incorporation of textures on the surfaces of the lids; lever feature by change of the format or diameter of the lid; increased surface contact area with the palm/fingers by the redesigns of side shapes and heights of the lids; and new lid designs to help different types of grip handling.

In the article of Abeele et al. [13] the objective was “To define game concepts following a “passion” model of the elderly, and, in order to achieve that some participatory methodologies where applied”. The study points out the user centered design methodology for innovation in game context, using ethnographic principles and participatory design as the methodological approach, presented in two steps of product designing: problematization, with ethnographic questionnaires with elderly; and development of the project, with preliminary project and generation of alternatives. Problematization step—ethnographic questionnaires were performed with elderly people, next, seniors and researchers performed a brainstorm of ideas and converted those ideas in game concepts, during the period of one week, elderly were observed, interviewed in their own homes. In the development of the project step—session of participatory design was held with one elderly and a designer. The purpose was to perform a brainstorm, from a contextual story, where many of the elderly passions appear as potential ideas; from that stage, the group was encouraged to develop low fidelity prototypes in paper as an aid to visualize ideas. The combination of detailing of passions, brainstorm and prototyping generated concepts, although preliminary, very rich with Strong presence of multi-player components and diversity of game genres, such as adventure, puzzle, RPG, etc.

Regarding the methodologies used for and with the participation of elderly people, the researchers show the following results: Bossen et al. [6], Keith [7] and Iacono et al. [8] used Participatory Design methods; Colonius et al. [9] and Abeele et al. [13] used and approach of Participatory Design associated with User Center Design; Demirbilek et al. [11] used a combination of Participatory Design

and USAP (Usability, Safety, Attractiveness Participatory) design model; McGee-Lennon et al. [10] used Co-designing; and Flinn et al. [12] did not specify a method, despite all phases of the research contemplating the participation of the elderly user.

Concerning the nature of the developed product with and for the elderly people, the focus of the researches were: Bossen et al. [6] CareCoor, software of elderly assistance in performing everyday activities; Keith [7] elaboration of methodological strategies to understand the role of the elderly user as a partner while designing a project; Iacono et al. [8] Software, graphic interface in a robotic system of a “smart house” to facilitate the everyday activities of elderly people who live alone; Colonius et al. [9] “intelligent” assistance device for seniors who suffer from cognitive impairments from diseases; McGee-Lennon et al. [10] multimodal system of reminders with mobile applicability for elderly in the home environment, considering problems of the public associated to cognitive, sensorial and physical impairments; Demirbilek et al. [11] system of quality implementation matrices, in order to achieve that, a case study was performed to develop doors and door accessories with the goal to trial the conceptual design phase of the purposed model; Flinn et al. [12] investigate participative experiences from elderly women with hand limitations, diminished handling, in the analysis and project generation phases of designing bottle lids, focusing in a make tool inspired activity to improve the ability of opening of the container and verify the utility of the results of this approach; and Abeele et al. [13] development of game concept for the elderly and with their participation, the goal was to define game concepts according to a “passion” model from the elderly.

Regarding the methods and tools used in the stages of development of the researches related to the subjects of the sample and the steps: Problematicization—ethnographic research involving interviews (family and caregivers), unstructured interviews (elderly), questionnaires (elderly), workshops (family and caregivers), focus group (elderly), brainstorm (elderly), videos with reality simulation (elderly), narrative scenarios (health care professionals), dynamics with manual work/creativity exercises with modelling clay (elderly); Definition of the problem—interviews (elderly), questionnaires (elderly), low fidelity prototype (elderly), keep-lose technique (elderly), drawings (elderly), tests in real situations (elderly), tests with new technologies (elderly); Development of the project: preliminary project, generation of alternatives—questionnaires (elderly), focus group (elderly), brainstorm (elderly), home tour sessions (elderly), low fidelity prototype with paper and pictures (elderly), evaluation with high fidelity prototypes involving scenario simulation, software evaluation (elderly), audios and videos (elderly); Evaluation, Decision and Choice—pilot-test (elderly, family and caregivers), tests with storyboard and pens, with the projected product, high and low fidelity prototype evaluation (elderly), drawings (elderly), meetings (elderly).

4 Discussion and Considerations

What is observed is an active participation of the elderly in all stages. Seniors participated in almost all the dynamics of the problematization step, having also participated family members, caregivers and health professionals, all of them directly related to each elderly participant as a support, answering questions related to their needs and helping define the elderly profile.

In the stages of problem definition, project development, evaluation, decision and choice, the elderly participated actively, suggesting, giving ideas, participating in testing and evaluations, and that was acknowledged in all evaluated articles. In the pilot-test for CareCoor software, families and caregivers participation was designed to promote elderly-family-caregiver interaction.

It was also observed a variety of tools that could be used with elderly people, which should be used in a creative and playful way, supporting the use of paper, colored pens, modeling clay and everyday objects, creating a better understanding of the activity and interactivity. Regarding the tools applied in the steps of problematization, problem definition, development of the project, evaluation, decision and choice, it was observed that the use of dynamics, such as manual works, creating exercises and drawing in the stages 1, 2 and 4; structured and non-structured interviews were observed in steps 1, 2 and 3; focus group in steps 1 and 3; brainstorm in steps 1 and 3; and evaluation with high and low fidelity prototypes in steps 2, 3, and 4.

It is important to highlight that the stages of “analysis”, “realization” and “final analysis of the solutions” of Bonsiepe’s methodology [5] were not presented in the analyzed texts. This was due to the fact that this method was developed for designers’ use and, as the analysis stage was already performed in the context of user participation, and the actual analysis may have occurred in finalizing the stage of problematization or problem definition. Relating to the steps of realization and final analysis of the solution, they remained unobserved probably because these products must also be in the final analysis phase.

Relating the papers selected with the methodological steps of Gui Bonsiepe methodology [5], the methods and techniques used in the development of the research and the sample of elderly participants demonstrate an overview of possibilities where elderly participation is crucial to the research with data analysis, to formulate concepts, defining projects criteria or evaluation or validation of projects whose nature contributes to life quality in old age.

Based on what has been achieved on this literature review, it may be concluded that bring elderly user to the early stages of the design process may enable a better assessment of activities and offers great opportunities to expand and improve the understanding of implicit and latent needs of this specific type of users. This will, hopefully, result in better informed designers and engineers and in a potential redefinition of the prerequisites in a design project. In addition, it should be considered an integrated approach involving all users, since it recognizes a cooperative

network among the elderly, families and caregivers, and this integration is, most likely, the best approach in favor of a good final product.

The results of the literature review in this paper corroborate the importance of active participation of elderly users in the product design process.

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