

User Centered Design Methods and Their Application in Older Adult Community

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Abstract. Older adults have unique perspectives on technology use that may involve having acquired disabilities, be more likely to be novice users and have more life experiences/biases that can influence user testing results. This literature review is aimed at assessing the application of basic User Centered Design (UCD) Instruments with Older Adults. 41 research articles published between 1988 and 2015 were gathered from different databases. Papers were included if the target audience was older adults and were analyzed only if the primary data collection instrument was any of the following: Questionnaire, Focus Groups, Cultural Probe, Diary Study, Think Aloud protocol, Interviews, Paper prototyping. The major findings from the resources reviewed showed that the application of UCD methods in older adults were commonly used to measure illness and understand their daily lives, experiences and living conditions. Only a few instruments such as Cultural Probe, Think Aloud Protocol and Paper Prototyping were used in the development of technology or devices. Many UCD methods may exist, but none appears to be a superior way to gather requirements. All methods have limitations when applied in an older adult context. A new design method approach should be developed to accommodate older adults in technology development process.

Keywords: User Centered Design methods · Older adults

1 Introduction

Measuring and fulfilling requirements of older adults in the development of assistive devices can result in successful products, reduce product recalls and avoid frequent design modifications [1]. Despite an increasing older adult population, organizations and researchers tend to concentrate on producing technologies aimed at younger audiences. This is because companies want products that suit the masses so that profits are maximized or it is too difficult to engage older adults [2]. As a result older adults have been left out of the development process, particularly of assistive technologies, or are being consulted at the end of the design process (Peterson 2013). Additionally, although some scientists and engineers adopt the practice of involving end users in the early stage of the product development process, different factors impact the quality of data collected

such as the use of proxies instead of real end users [1]. As a result there is an increasing recognition that poor usability increases risk for the user [1].

Capturing needs and desires as well as system requirements from older adults is part of a human-centered approach to design and development. According to ISO standard 13407 “The human centered design (HCD) process is intended to help those responsible for managing hardware and software design, and processes to identify and plan effective and timely human centered activities” (1999, p. 21). Along the continuum of HCD is inclusive design, which refers to designing for everyone by considering diverse abilities [3]. Applying the principles of inclusive design can aid designers in serving those needs and can enhance safety and agency for the individual [4]. Devices developed by designers without understanding specific needs dissatisfy the users therefore resulting in product failure.

Existing needs analysis techniques used UCD provide some methods that may be used in the design process to capture the needs and priorities of older adults. In this paper, UCD methods will be presented and discussed with respect to their applicability, use and usefulness in the context of designing assistive technologies for older adults. Although there are many tools available, very little information has been generated on the extent to which they have been used in designing for older adults. The goal of this study was to search literature involving older adults as target group and assess the use of basic UCD instruments among them.

2 Methods

Literature searches were conducted in the following electronic databases: Proquest, Science Direct, Google Scholar, SAGE research methods and Springer. The time range was from 1988 to 2015.

The following search terms related to UCD methods were used Questionnaires, Diary Study, Cultural Probe, Focus Groups, Interview Study, Paper Prototyping, Think Aloud Protocol and Questionnaire which were identified from Interaction Design by Preece et al. [5]. The terms were combined with terms related to the target population: Older adults and Assistive Technology.

Articles were selected through a scanning process: abstracts and conclusions were scanned. About 35 potential references were identified which included reports, internet sources and books. The inclusion criterion is that the target group of the research study must be older adults. The documents were analyzed only if the above mentioned UCD instruments were used as a primary method for data collection or design evaluation with older adults. This helped narrow down articles to proceed with the assessment of UCD instruments in an older adult context.

3 User Centered Design Methods

3.1 Questionnaire

Questionnaires are often used in psychological and social science studies, although the instrument specific to HCI or user need analysis context is comparatively lower [6]. Here

we summarize the feasibility and ways in which questionnaires have been used with older adult populations.

According to a study conducted by Troyer and Rich [7] questionnaires have been used as a meta-memory self-reporting tool, which allows the researcher to measure the everyday memory issues happening among the targeted older adult population. Twenty-one items that addressed various emotions and perceptions of concern to the participants' current memory ability were used in the questionnaire. A mood and feeling questionnaire was included as a measure of the subjective memory ability of the participants and was found to be in larger correlation with Meta memory tool ability.

Another study conducted with older adults having subjective memory complaints aimed to develop a questionnaire to measure the perceptions of older adults' help seeking behavior [8]. The illness perception scale consisted of two different scales: the identity scale and causal scale. Additional measures were taken using the Geriatric Depression Scale (GDS) and Memory Functioning Scale (MFQ) to capture depression level due to memory impairment and to assess their memory complaints. Although these questionnaires were being used to understand the older adult's perception, designers can use the Illness Perception Questionnaire (IPQ) as an additional construct to the needs analysis questionnaire to analyze the user experiences rather than asking what they need.

Results from a study conducted by Muntinga et al. [9] shows the designed questionnaire to measure the client centeredness of a home care service resulted in a cognitive burden imposed on the older participants due to various characteristics such as length and comprehensibility. The authors suggest that this may be the result of questions composed with the unavailability of standards or hypotheses derived from the small population.

Based on the findings from the articles, most of the scenarios where questionnaires were used with older adults tended to gather information on their social life, illness, psychological ability and opinion. No papers were found where questionnaires were used as a primary tool to gather user needs.

3.2 Focus Groups

The focus group method is a very important qualitative tool for exploring a particular topic which is exploratory [10]. Six papers were identified where focus groups have been used as a primary method of data collection. Researchers from the World Health Organization Quality of Life (WHOQOL) field centres conducted a focus group that aimed at eliciting key concepts of life among older adults in a multi-cultural scenario [10]. Since the sessions were conducted at multiple locations a new set of guidelines for conducting the sessions was established which included a timeframe for conducting the group, number of groups, preparation for conducting the groups, procedure and structure of the focus groups discussion [11]. The guidelines were designed for adults over 80 years of age and four to six members in each group. The focus group discussions were well structured but most of the centres were only able to partially complete their discussion due to the many strict guidelines set by WHO.

The benefit of the focus group method is that it creates an interaction between the moderator and the participants: it allows the moderator to get a full explorative view of

the participants without decontextualization [12]. Claes insists if a discussion is being conducted among a diverse population with age as the only criterion, it would narrow the focus, which involves the risk of fixating on a solution and leaving other relevant solutions unexplored. Hence, the diversity of the sample population needs to be taken into account. Moderators conduct the focus group session by jumping into the discussion topic which might leave the participants unaware that the topic is in a biased situation.

To address this issue, researchers from the University of Salford implemented a round table concept where participants are brought together and thoroughly briefed about the topic for which the discussion is being held [13]. An increase in the confidence level of the participants about the topic to be discussed was observed.

Findings from the papers reviewed shows that although there are multiple ways of conducting a focus group, there are many key issues that need to be mentioned. As indicated by Mehta when selecting a user sample for the focus group session, steps must be taken to ensure cultural equivalence, language equivalence, age consideration, and cognitive-ability [14]. The topic of the focus group should also address a specific issue that the sample population has been facing every day, because they will have better insight of problems known and that they regularly experience.

The above studies were concentrated on gathering information to assess the mental ability, behaviour and identifying the problem faced in conducting focus groups with older adults. Although older adults often mention the problems they encounter in their daily activities, the data must be carefully reviewed by experts to identify their needs. There were three major criteria that must be followed while conducting a focus to design efficient products for older adults [15]. The first was focus groups should collect data to understand and investigate how older adults managed their activities. The second was understanding how older adults are currently coping with or have coped with the problem. Finally, findings from this data must be applied in the design and development process so that designers can create or modify existing system or tools.

Results from the papers reviewed show that the focus group method can be an effective way to identify user needs even if it is time consuming and resource intensive. However, it has been accepted by older community, because it helps them put forward their opinion in a supportive environment [16].

3.3 Cultural Probe

When the designer does not know the group of participants for whom the products are being developed, it is difficult to understand the culture, attitude, behaviour and preferences. According to [17], cultural probes are a way to identify user needs. This method involves using digital cameras, diaries, paper prototyping and other materials. The major criterion in conducting a culture probe activity is that the design kit should contain materials that will support the goal of the researcher. Also, the researcher should not make any addition or modification of the kit halfway through the process to justify the results [18].

For this study there were eight papers were identified where cultural probe was used as a primary method of data collection. Concerns have been raised about cultural probes being rationalized by the user's intent of analyzing the data [18]. Hence, they suggest

that the cultural probe technique should be used to encourage subjective engagement. Based on the articles analyzed most studies conducted with the cultural probe as a methodology focused on understanding user needs rather than assessing the individual's ability. From research conducted by [18–20, 44] on using cultural probe as a technique for requirements gathering for developing assistive technology it can be established that cameras and diaries are the most common probe material to capture rich data. However, a diary study is considered as a separate UCD method that has been widely used to understand the illness behaviour of the older adults which will be discussed later in this article. Also findings from the above sources show that the relation between cultural probe and design was not the primary way to apply design to the new technologies but it can point the designer in a direction where there was a need for assistive technology.

The cultural probe method is an efficient way to capture user experiences and data but another qualitative UCD method is required to elicit further information relevant to the design [19]. The cultural probe alone cannot provide the data we need unless another method is adopted to discuss about the findings because analyzing the used probe will provide data on how the probe has been used, whereas a questionnaire or interview session is required to gather their views and experiences on using the probe. There are limitations with certain items used in the cultural probe, such as photo – map documentation, journey map and postcards. These probes require more effort in their preparing and evaluation than other probes, but they provide a higher degree of insight. However, because they require higher effort from participants, they are valuable as tools to capture data from older adults [21].

3.4 Diary Study

Diary study has been used widely among medical researchers where patients are requested to keep a track of their treatment or diagnosis in the form of a diary. Five papers were identified where diary study have been used as a primary data collection method. A diary provides rich data of an individual's daily experience [23] and provides researchers with progressive and rich information. However, analyzing enormous amount of qualitative data is the most tedious part of the diary study where the process lasts between few days to several months based on the volume of data collected [25].

The methodology is commonly used common among medical and psychological researchers. The way older adults tackle their problems is not straightforward and diary study helps researchers understand the depth of the individual needs, as it varies across symptoms and each individual might be dealing with different problems ranging from acute to chronic conditions [24]. A study conducted by [25] where the researchers used diary study and quantitative method to identify the effects of meditations on chronic pain, and sleep. Results from twenty seven participant's diaries provided depth in the experience of older adults, which a quantitative method could not provide. This is because the participants were able explain their feedback and record them every day, rather than answer survey questions at the end of the treatment. Also, studies conducted by [23, 45, 46] used diary study as a primary method to collect data from older adults concerning their illness behaviour and their interpretations of symptoms of illness.

Results from the articles reviewed shows that diary studies have been used widely in medical research to understand an older adult's illness and the effect of treatment on them, but has not been used as an instrument to identify design requirements for assistive technology or devices. Although the diary study can be an effective way of collecting rich data and are found to be less expensive than focus groups or interview methods, the cumbersome process of analyzing the data collected makes it less desirable [23].

3.5 Think Aloud Protocol

The think aloud protocol requires people to say out loud everything that they are thinking and trying to do [16]. The think aloud protocol has been commonly used in usability studies. It is useful in studies highlighting problems faced by a participant while carrying out a task or process [15]. The HCI protocol involves participants being asked to verbalize what they are doing as they navigate through screen, pages and menus in a test interface [27]. Five published articles were reviewed where think aloud protocol is used as a primary User Design method.

In the case of older adults it must be confirmed that the individual knows about product or activity [15]. To tackle this issue, [15] implemented a task-based approach where users are asked to complete certain tasks in a multimedia interface rather than exploring the system. This helps the users to understand the flow of the system, rather than being frustrated and withdrawing while the study is in progress. Think aloud protocol is an effective method of understanding the user's view on a product [15]. The same approach is adopted by [28] where the author used scenario based think aloud protocol to evaluate an online diagnosis tool with the help of older adults [28]. The most common issues faced are deviation from task protocols [27], familiarity with the product or tool [15, 28], and balancing user frustration with another task. For older adults, cognitive ability may also add complications to verbal protocol analysis.

Moderators need to understand that for certain older adults the process of thinking aloud and navigating will be a dual task and sometimes users perform these simultaneous tasks poorly due to their possibly limited cognitive and motor ability. To address this problem, users can be asked to complete the task first without verbalizing and later perform the task again by thinking aloud [15]. Although this method seems to be promising, there are chances to include bias or performance variations as the users becomes familiar with the system while performing the task second time. This methodology can be very challenging while conducting study with people who are Deaf. To address this issue, a gestural think aloud protocol can be used where the Deaf participants use American Sign Language that is interpreted in real-time (for hearing researchers) to describe as they perform the task [29]. Based on the findings from the articles collected, it is evident that the think aloud protocol is often used as a user evaluation tool in the HCI studies with older adult participants.

3.6 Interviews

There are three major types of interviews; open ended, structured and semi structured [30]. Unlike the focus group and think aloud protocol the interviewer imposes control on the

conversation. Structured interviews have been used in scenarios where the designers need feedback on a product or design [16]. For this study seven papers were reviewed where interview technique was used as a primary data collection instrument from older people.

Research conducted by [31, 32, 48] used an unstructured method and semi structured method to examine the challenges faced by older adults having schizophrenia, analyze the ways in which older adults with psychiatric disability experience pain and social relations, and to developed a patient diagnoses system [31]. Findings from above scenarios showed the author's aim was focused on understanding the older adult's perception and experiences [32]. Hence, the concept of unstructured general interview technique was adopted as it provided the richest source of data compared to the other interview techniques [30]. The absence of the structured framework can allow the participant's view on the issue to be the focus [33]. The use of semi structured interviews has enabled the collection of rich data on individual experiences and also the interviewer acquires the intended information [34].

The interview technique helps the researcher capture the intended information in a qualitative form, but it has not been used in studies involving more than 15 to 20 older adults since each session takes place between 60 to 90 min, and the health and mental condition of each individual makes the process more complicated. Results from the studies reveal that structured interview technique is often used to gather feedback and ratings from older participants on the assistive products or treatment received, and the unstructured interview technique is used to gather information on older adult's perceptions of illness or the experiences in the daily life. Based on the findings from the articles referred, interview technique was never used to gather user requirements from older adults.

3.7 Paper Prototyping

“A paper prototype is a visual representation of what the System will look like. It can be hand drawn or created by using a graphics program. Usually paper prototype is used as part of the usability testing, where the user gets a feel of the User Interface” [35, p. 11]. The low fidelity paper prototyping requires more cognitive load as the participant has to put together the designer's explanation of the concept and can become frustrating when performing the process for multiple scenarios. Hence, it is not efficient among older participants. Another reason that the paper prototyping will be harder for the older adults is that most individuals lack design vocabulary [36]. But, studies suggest that older people worked well when designers were instructed by participants on features and design needed in the device interface or product, which results in high fidelity prototyping which were more accurate than the prototypes created by the older participants. To address this issue narrative scenario based prototyping has been designed which includes storyboards and videos. This may be an apt solution, because it is valuable for portraying context dependent nature [37]. This methodology of prototyping slows down the designer as it requires much coding to write. It also involves more modifications than the low fidelity designs. Although this method requires users to expend a significant amount of cognitive effort, results based on the studies conducted in articles [35–37, 49–52]; show that the paper prototyping has been widely and

successfully used in HCI studies among older adults to design computer application interfaces and interactive products.

4 Conclusions

Based on the articles reviewed, more importance has been given to collecting qualitative data from the end-user likely because this type of data provides rich details about user experiences. In general, paper prototyping and cultural probes have been used to identify typical user needs, and the diary study method has been used to understand the behaviour of individuals.

Although the above reviewed methods can be efficient tools for collecting data from older adult users, they require participation and user involvement throughout the design and development process either in home or in a laboratory environment. Since these processes require the user's participation over a period of time, they can impose a burden among the participants to varying degrees. This is particularly true for people with dementia or partial memory deficiency, which may make many of these tools unsuitable for these user groups.

Older adults with cognitive disabilities were identified as a key group for whom specially adapted tools were needed. Even though researchers have been adopting the interview and observational methods for individuals with dementia, several issues persist. Use of the interview technique tends to result in less valuable data and fewer responses in terms of user needs. Use of the observational method can help designers understand problems and concerns, but generate less information about the user experience. Culture probes and diary studies can be used by designers to more efficiently design assistive technologies or products for older adults with intermittent memory loss or dementia,

In conclusion, a new design approach is needed that builds upon, but still uses, the core conventional methods. This would address the need to design a new user needs method by enhancing the existing methods and giving a voice to people with cognitive issues. For older adults in this category, involvement should not just be as participants in the study or test, but also they should be given the opportunity convey their issues, how it affects their daily life and express the need to address the problem by means of inclusive design and assistive technology development. As part of the future work, new tools or method should be created to help designers to identify user requirements of the older adults.

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