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Involving Older Adults in the Technology Design Process: A Case Study on Mobility and Wellbeing in the Built Environment

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Abstract. Older adults benefit from unstructured, lifestyle-based activity that can be carried out in people's houses, neighbourhoods, and the built environment. Technological solutions may support physical activity and encourage wellbeing. To ensure such technology is suitable for, and usable by, older adults, it is crucial they are involved in all stages of design. Participatory design methodologies facilitate collaboration and engagement with potential users. We examine the suitability of participatory design for collaborating and engaging with older adults. Participatory design workshops were conducted with 33 older adults in the UK with the aim of designing mobile applications to support and promote physical activity and wellbeing in the built environment. As well as summarising the outcome of these workshops, the paper outlines several methodological issues relating to the suitability of participatory design for involving older adults in the technology design process.

Keywords. Participatory design, User study, Older adults, Mobility, Wellbeing, Built Environment

1. Introduction

There are well-established advantages of remaining mobile and physically active in old age. A substantial number of studies have highlighted both physical and psychological benefits of physical activity for older adults (for reviews, see [1, 2]). This abundance of evidence has led the World Health Organisation (WHO) to recommend that older adults do at least 150 minutes of moderate physical activity each week or at least be as physically active as their abilities and medical conditions allow [3].

Physical activity is not only sporting activities or planned exercise. According to the WHO, physical activity for older adults may include

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occupational activities, leisure time activities (e.g. dancing, swimming or gardening), household chores, and getting from one place to another (e.g. by walking or cycling) [3]. Such unstructured, lifestyle-based activity may be just as beneficial as more formal physical activity [4, 5] and can generally be carried out in people's houses, neighbourhoods, and the "built environment".

The built environment refers to all our artificial or human-made surroundings [6]. It includes the physical infrastructure of roads, pavements, cycle paths, railways, and bridges; public transportation systems; buildings, green spaces and urban areas [7]. Though the built environment may present many opportunities for physical activity for older adults (e.g. the availability of cycle paths, footpaths, local parks, and shops) it can also pose significant challenges (e.g. the presence of unsafe pavements, steep hills, busy roads, and badly lit areas) (for reviews of environmental factors that encourage or discourage physical activity in older adults, see [8, 9]).

Technology may be used to support the mobility of older adults in the built environment. For example, people with walking impairments often rely upon walking aids, such as canes, crutches and walkers. People with visual impairments commonly use a long cane as a mobility aid. People with more severe physical impairments may use a wheelchair or mobility scooter to support their mobility. Such examples represent effective low-technology mechanical solutions to facilitate older adults' mobility in the built environment. Opportunities exist however, for high-technology interactive solutions to both support and promote physical activity in older adults.

To ensure technology is suitable for, and usable by, its intended users, it is recommended that users be involved in all stages of design [10]. This is particularly important for older adult users, who may be reluctant to adopt new technology due to negative perceptions of usefulness and ease of use [11]. Building on a previous study [12] that involved older adults in the requirements elicitation process, the current study explores the effectiveness of involving older adults in the development of mobile application design concepts to support their mobility and wellbeing in the built environment.

2. Related Literature

Researchers have drawn upon a variety of user-centred and participatory design methodologies to facilitate collaboration and

engagement with older adults. These include creative activities, such as sketching [14], paper prototyping [15], and model and mock-up making [16]; exploratory activities, such as card sorting [17], storyboarding [18] and diary keeping [19]; and playful activities, such as design gaming [20], scenario-based role-playing [21], and future thinking and envisioning [22].

Participatory design methods with older adults have been employed in the design of a disparate array of technologies, including games [20], banking technologies [14], health monitoring devices [18], mobile phones [15], and mobile healthcare applications [13]. No studies could be found however, that involve older adults in the design of mobile applications to support their mobility and wellbeing in the built environment.

Participatory design studies tend to differ according to the degree of creativity and ideation expected of older adult participants. Some researchers (e.g. [14, 15]) advocate the critiquing of existing designs before, or instead of, design ideation. They claim older adults find it easier to envisage existing prototypes than generate new designs. Other researchers (e.g. [13, 20]) argue older adults' potential technical naiveté does not impact upon their creativity and that exposing them to existing designs may actually limit the novelty of their contributions. A secondary aim of this study is to explore the degree of design fidelity necessary to encourage and inspire ideation in older adults without inhibiting or suppressing their creativity.

3. Method

3.1. Design

Older adults participants were invited to attend one of a series of participatory design workshops held in their local area. The workshops engaged participants in a series of fun and interesting activities with the aim of designing mobile applications for supporting and promoting physical activity and wellbeing in the built environment.

Participants were recruited from two locations in the UK: Leeds, a large city in West Yorkshire (population: 757,700); and York, a small city in North Yorkshire (population: 153,717). The two locations were chosen as diverse examples of built environments, whose design, topography and infrastructure present a range of mobility challenges and opportunities.

3.2. Participants

Thirty-three participants, took part in the study. There were 16 men and 17 women, aged ranged from 55 to 85 year. Participants were recruited on the basis that they were willing to discuss mobility problems and explore how technology, such as mobile phones and tablet devices, may be used to support people to get out and about in their local area. It was stressed that no previous experience with mobile phones or tablet devices was necessary. Participants each received a £25 gift voucher in compensation for their time and effort.

3.3. Procedure

Participants attended one of X participatory design workshops. Both venues were easy to find, fully accessible and close to public transport links. Participants were invited to bring a family member or friend to the workshops, if desired.

Each workshop involved 4-12 participants. They began with a brief presentation by a member of the research team on the outcomes of a previous study [12] conducted as part of the Co-Motion project. That study adopted a photo diary method to explore the experiences of older adults in the built environment and elicit requirements for new technologies. The presentation helped to introduce participants to the overall objectives of the Co-Motion project and to orient them to the purpose of the participatory design workshops.

Participants were then given the opportunity to provide feedback and share their own experiences by contributing to a series of affinity diagrams [ref] located around the room. The affinity diagrams related to several distinct issues concerning mobility of the built environment that emerged from the previous study [12]. Participants were encouraged to think in particular about how technology might address these issues.

While participants took refreshments, the research team collated and summarised the participants' responses to the affinity diagramming exercise. Once the participants reconvened, the research team presented the results highlighting any new issues that had emerged. Participants were then given the opportunity to discuss how technology, specifically mobile phone and tablet applications, might address these issues. Participants were not expected to propose specific technological

solutions at this stage but instead to consider broad "black box"[2] conceptual design solutions.

After another refreshment break, the research team summarised the outcome of the previous activity before presenting a series of conceptual design solutions for mobile phone and tablet applications. Participants then discussed these designs. Participants were also asked to rate how useful they would find each of the design solutions on a series of seven-point Likert items (1 = not at all useful; 7 = very useful).

The workshop concluded with a general discussion in which the research team summarised the overall findings and gave participants the opportunity to provide any additional feedback about the problems and solutions, as well as their experience of taking part in the participatory design workshop.

With the participants' permission, audio of workshop discussion was recorded for later analysis. The workshops each lasted approximately 2.5 hours.

3.4. Equipment and Materials

Prior to taking part in the workshops, participants were provided with a detailed information sheet about the study. At the start of each workshop, participants were asked to complete an informed consent form and a demographics questionnaire.

During the workshops, participants provided feedback on a series of conceptual design solutions. These were developed by the research team based on the outcomes of the previous study with older adults [12] and broadly related to journey planning, navigation, and social interaction within the built environment.

The concepts were illustrated by infographics depicting how mobile phone and tablet devices might support and promote mobility and wellbeing in older adults. Figures 1 and 2 illustrate of two of the conceptual design solutions presented to participants. The fidelity of the design solutions was intended to be sufficient to inspire participants' creativity and ideation without discouraging them from critiquing or elaborating upon the proposed ideas.

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[2] https://en.wikipedia.org/wiki/Black_box

Figure 1. Conceptual design solution 'Urban Walking for Wellbeing'. The text reads: *"Walking can be a pleasant experience or a hardship, depending on the route that you choose. Finding the best route for you is important, and tailoring a journey to suit your individual needs can make a huge difference."*

Figure 2. Conceptual design solution 'Does anyone else need…?', that were presented to participants. The text reads: *"If you think of a way to improve the city, find out whether anyone else agrees with you. If you think that a particular street needs a pelican crossing, see whether other people agree. If enough people agree, the idea will be sent to the appropriate authority for consideration."*

4. Results

4.1. Supporting the Mobility of Older Adults with Technology

Older adult participants, on the whole, recognised the value of technology for supporting mobility in the built environment. Ratings of

the potential usefulness of the conceptual design solution varied. Four of the solutions received average ratings of 5 or above (from a scale of 1 to 7; 1 = not at all useful; 7 = very useful), suggesting participants considered them potentially useful. The other four solutions received average ratings of 4 or below, suggesting participants considered them less useful.

The potential usefulness of each conceptual design solution appeared to depend not on its particular purpose or function but on its apparent complexity. Participants tended to favour design solutions that had a relatively simple concept (such as identifying the location of nearby features and services, which was rated most useful and ranked most important) over design solutions that had a more sophisticated concept (such as monitoring pavement clutter to reward businesses that provide clear access to their premises, which was rated least useful, and ranked least important). The intention of both concepts is to facilitate navigation of the built environment, yet they provoked very different reactions from participants.

Participants considered mobile phone and tablet applications particularly effective in ensuring they feel confident, safe and secure when out and about - one of the key themes to emerge from the previous study [12]. For technology to provide such reassurance however, participants emphasised that the information they provide (be it bus timetables, walking routes, or the location of the nearest public toilet) must be trustworthy, reliable and safe. One of the least popular design concepts provided a means of arranging shopping, social activities, services or work within people's local area. Participants met this with caution, citing concerns it could share people's private information and whereabouts with potential strangers.

Participants were particularly interested in technology that provides the opportunity to contribute to society by producing as well as consuming information. One of the more popular design solutions (see Figure 2) draws upon existing e-participation practices, such as online voting and petitions, to provide a means of highlighting aspects of the built environment requiring attention from local authorities. Several other design concepts rely on up-to-date information about the built environment, such as the availability of features and services or the location of mobility barriers and facilitators. Many participants recognised the role of users in providing this information and were keen to contribute in this way.

4.2. Fidelity of Conceptual Design Solutions

A secondary aim of this study was to explore the degree of design fidelity necessary to encourage and inspire ideation in older adults without inhibiting or suppressing their creativity.

Exposing participants to our design concept solutions did not appear to inhibit or suppress their creativity. Many participants felt free to elaborate on the concepts and make suggestions as to how they could be developed. For example, participants related one of the least popular concepts - a means of arranging shopping, social activities, services or work within people's local area - to the timebanking movement[3]. They felt this would provide a safer, more structured framework to coordinate such activities.

Though the conceptual design solutions appeared to successfully encourage and inspire ideation, some participants became preoccupied with the technical feasibility of each solution. In addition to enquiring how the design solutions might operate, where their data might come from, or how users might interact with them - questions for which the research team did not necessarily have answers at that stage – participants also raised concerns over the potential costs of mobile devices, applications and the data they might consume. While these are all valid concerns, they occasionally distracted from the actual purpose of the participatory design workshops, which was to focus on high-level design concepts as opposed to technical implementation details.

The tendency highlighted in [13] for older adult participants to "fixate on the familiar" also arose in the current study. Several participants observed that some of our conceptual design solutions (such as locating the whereabouts of the next bus, or identifying aspects of the built environment that require upkeep and maintenance) were similar to existing mobile applications. Participants also rated the usefulness of these familiar conceptual design solutions more highly than the arguably more novel design solutions.

4.3. Methodological Reflections on Participatory Design Workshops

In addition to ideating design concepts to support the mobility and wellbeing of older adults in the built environment, we also reflected on different methodological aspects of participatory design workshops.

[3] http://www.timebanking.org/

The choice of venue was carefully considered when arranging participatory design sessions. Venues that were easy to find, fully accessible, and close to public transport links were preferable. The venues were dressed to minimise distraction and the possibility of external interruptions, but were in no way clinical or formal in appearance.

The use of clear language, good communication, and consistent planning were important when recruiting older adult participants, particularly as some participants found scheduling difficult because of their busy personal lives. In relation to remuneration, many participants were pleasantly surprised to be offered a gift voucher in addition to their expenses. Some commented that they would have been content to take part in the process regardless of any financial incentive.

In order for any participatory design workshop to be effective, participants must feel able to communicate their ideas and questions without obstruction. It has been noted that a high proportion of older adults have one or more sensory deficits [23] and so extra consideration and support is needed to overcome the barriers potentially faced by older adults. For example, a participant may be eager to voice an opinion or take part in an activity, but is prevented from doing so by sensory, cognitive or motor disabilities. In these cases, it is the responsibility of the research team to ensure that these individuals have ample opportunity to contribute. Techniques for facilitating inclusion may involve providing assistive aids (such as large print materials), asking the opinion of an individual at appropriate points in a discussion, or offering assistance during a physical task. For example, in one of the workshops, a number of participants had mobility and visual disabilities. So instead of asking them to move around the room and add comments to the affinity diagrams, one of the researchers acted as a scribe and created comments on post-it notes for these participants and another researcher then added them to the affinity diagrams.

Participants have a wide range of motivations to take part in research activities. While these motivations are overwhelmingly positive, there are some cases where motivations may have an effect on the contribution of a participant. In some cases, the motivation for participation in a session may be grounded in the desire for inclusion and respect, and there is a possibility that in this case a participant may offer responses tailored to elicit the most favourable response from the group, to avoid disharmony. One solution to this problem is to facilitate individual feedback outside the participatory framework. A simple paper-based questionnaire can be disseminated at key stages of the process, providing

participants with a pathway for honest communication without raising public objections or risking antagonism within the group. This paper-based approach has the added benefit that it can be tailored to yield quantitative data on key topics, and this quantitative data can typically be assessed much more quickly than audio or video recordings.

Overall, we felt that the design process benefited greatly from the involvement of older adults, and was a suitable method for engagement. We also felt the inclusion of paper-based questionnaires worked particularly well, and prevented some of the problems associated with collaborative working. The workshops proved particularly inspiring to one participant, who later contacted the research team to inform us of a funding application they had made to the local council for the provision of benches in their local community garden (this was an issue which had been discussed in their workshop. The participant made the point that benches are a simple (but often overlooked) addition to the built environment and an important step in encouraging people to get out and about.

5. Discussion

The results indicate that participatory design workshops are a suitable and effective methodology for involving older adults in the technology design process. It provides a reliable basis for ideating mobile application design concepts to support the mobility and wellbeing of older adults in the built environment.

The study has illustrated the value and importance of involving older adults in the technology design process. Participants provided quantitative and qualitative feedback on the potential usefulness of a number of conceptual design solutions. Though these solutions had been developed by the research team in response to the to outcomes of a previous study involving older adults [12], the workshops provided an opportunity to further validate and refine the solutions with older adults.

As well as confirming some of the outcomes of the previous study, such as the importance that older adults place upon safety and security in the built environment, this study highlighted new issues and concerns. Though many participants were enthusiastic about the opportunities that technology offers for contributing to the upkeep of the built environment, several feared how others might perceive this enthusiasm. Similarly, some participants felt that using a mobile phone to navigate the built environment might make them a target for thieves or a hazard for other

road users. These concerns demonstrate a degree of self-awareness that was not observed in the previous study.

This study has also provided further insight into the degree of design fidelity necessary to encourage and inspire ideation in older adults without inhibiting or suppressing their creativity. We asked participants to critique a series of feasible but undeveloped conceptual design solutions that emphasised high-level concepts over implementation details. This approach was effective in stimulating participants' creativity, reaffirming the conclusions of [14] and [15] regarding the critiquing of existing designs with older adults. Further exploration is needed on participants' attitudes towards the design concepts were influenced by the actual complexity of each concept or the clarity of their presentation.

Though exposure to existing designs did not appear to inhibit or suppress participants' creativity, it may have limited the novelty of their contributions. The tendency highlighted in [13] for older adult participants to "fixate on the familiar" was observed in the current study, as participants tended to favour more familiar design concepts. Taking inspiration from [14], future participatory design workshops should include design solutions based on outré, silly or playful concepts to provoke and inspire participants as well as nudge them away from the familiar.

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