# Interactive and Inclusive Design for Older People and Carers

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***Abstract*—The inclusive design process following the 'interaction design' model was used throughout the requirements gathering, design, development and evaluation of a domestic well-being indicator system (DWIS). Various stakeholders: Cared for, informal and professional carers and technologists were included to collect the requirements through various elicitation techniques such as workshops, brainstorming and focus groups. Scenarios and paper-based prototypes were used to design a DWIS system with a small group of participants who attended a workshop. An interactive version was built to provide an early model for the design team and to provide a system which could then be refined. A final version of the system was tested with 10 older people and ten carers. Qualitative and quantitative analysis methods were used to analyse the results. The results showed that the DWIS system is helpful to enhance the dialogue of care between older people and carers.**

***Index Terms*—Inclusive and interaction design, older people, dialogue of care.**

## I. Introduction

Researchers involved in the human aspects have proposed methods, methodologies, guidelines and recommendations to design and develop technology that involves older people. The UTOPIA project [1] proposed a methodology to design and develop technology that fits older people's needs using different techniques to involve the older people in the elicitation process such as questionnaires, interviews, focus groups and workshops.

A successful example that followed this methodology was the Cybrarian project [2] whose purpose was to build and evaluate an email system and a search and navigation system for older people. The system was built in collaboration between a group of researchers with good knowledge in designing for older people and a group of software developers with knowledge in human- computer interaction (HCI). Older people were trained before testing the system.

Researchers at the University of Toronto designed a mobile phone using participatory activities such as meetings between older people and designers, and paper-based prototypes [3]. Various mobile phone models were evaluated by older people. The participants then suggested software and hardware features that they would like to have in their own mobile phone. At the end, a real mobile device was tested by the same group of people involved in the design team. Design and user engagement recommendations were the output from the testing and the participatory activities.

The ENABLE project [4] involved formal and informal carers and older people with dementia to test two assistive technology devices. They also included the participants to develop and test a remote day planner prototype. They used different techniques to elicit the user requirements such as mock-ups, early prototypes and focus groups. A trial was run with people with dementia and their family carers to validate the appropriateness and usefulness of the products.

Taking into consideration the results and recommendations from the projects mentioned before (in order to design accessible and useful interfaces for older people and carers), it was necessary to understand the features of the target population, its needs, and constraints.

## II. Inclusive Design Process

In order to design and build the DWIS system, an inclusive design process following the interactive design model steps [5] was used throughout the requirement process: Gathering, design, development, and evaluation. In addition, some methodologies and recommendations proposed by many authors, and guidelines to design for older people [6, 7] were reviewed and consulted.

All previous studies helped the researcher to use the techniques described to conduct the design and to build processes following the steps illustrated in fig. 1 and table I.

### *A. Identifying Preliminary Needs and User Requirements*

The first step of the inclusive design process was to identify the preliminary needs and user requirements for all the stakeholders. This step aimed to establish the stakeholder perspectives, identify the initial needs and establish the scope of DWIS.

In order to encourage a collaborative, team-oriented approach to requirements gathering, a team of stakeholders and researchers worked together to identify the problems, propose elements of the solution, negotiate different approaches, and specify a preliminary set of design requirements.

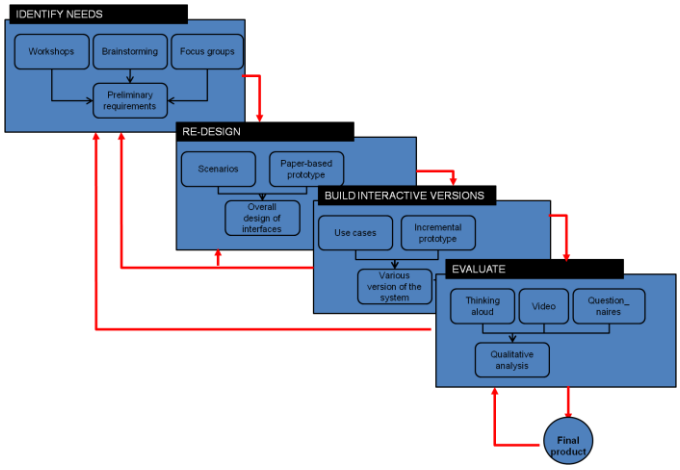


Fig. 1: Inclusive design process used in this study

TABLEI: TECHNIQUES USED DURING THE INTERACTION DESIGN PROCESS

| Step | Stakeholder | Result |
|---|---|---|
| Identifying needs | Large mixed stakeholder (cared for, informal carers, professional carers, technologists and one policy maker) | Some high-level requirements |
| | Design team. Small mixed stakeholder (cared for, informal carers, professional carers and technologists and researcher) | Preliminary functional, non-functional and design requirements |
| Re-designing a DWIS system | Design team. | Further functional, non-functional and design requirements |
| | Design team and invited designer | Overall design of interfaces. |
| Building interactive versions | Researcher | Use-cases |
| | Design team | Coded version of DWIS system |
| Evaluation | Small mixed stakeholder (group of two or three participants and individual performance) | Observation notes |
| | | Notes from video |
| | | Qualitative and quantitative analysis |

*Elicitation techniques*

During the identification of user needs, different elicitation methods were used to collect the requirements directly from the end users [1] such as workshops, brainstorming, and focus groups.

--Workshop: Twenty six participants attended the workshop. Eleven older people (nine cared for and two informal carers), six occupational therapists, two physiotherapists, three researchers, three technologists, and one policy maker attended a one-day workshop. The purpose of the event was to establish different stakeholder perspectives about home-care, expectation and the individual role.

--Brainstorming: During the workshop, the participants were divided into five groups: Two groups of elderly people and three mixed groups (physiotherapists, researchers and technologists). During four brainstorming sessions, people were asked to give their opinion on the following aspects:

What kind of information about older people well-being would be useful to older people and formal and informal carers?

What are the preferences in data presentation of each stakeholder?

Where would end-users prefer to have this information (computer, telephone, mobile phone, television)?

As a summary, table II presents the concerns, requirements and user needs collected using workshops, brainstorming and focus group sessions.

TABLEII: CONCERNS, REQUIREMENTS AND INFORMATION NEEDS

| Concerns, requirements and information needs | Stakeholder | | |
|---|---|---|---|
| | Cared for | Informal carers | Professional carers |
| Reminder for medication, appointments and tasks | ✔ | ✔ | |
| Environmental conditions (temperature and safety) | ✔ | ✔ | |
| State of the occupant (mobility, personal hygiene, eating and drinking habits, sleeping patterns, health conditions, social interaction and psychological behaviour) | ✔ | ✔ | ✔ |
| Data presentation preferences | Text | Text | Graphs, trends, text and icons |
| Appropriate devices to display information | Television, mobile phone, computer | Mobile (cell) phone, computer | Laptop, computer (using the Internet) |

--Focus groups: After the workshop, the researcher contacted a small group of participants who expressed their interest in continuing to work as part of the design team. Two older people, one informal carer, one physiotherapist and two technologists attended a meeting to discuss the results found from the workshop. The purpose of this focus group was to refine the initial set of requirements and to establish the scope of DWIS.

*Preliminary Requirements*

From the discussion, the following main functions were derived:

--Registering stakeholders: This function let the professional carer enter the personal details of occupants, informal carers and professional carers.

--Checking changes of well-being areas: Allows the stakeholders (older person, informal carers and professional carers) to visualise areas of well-being (mobility, eating and drinking, personal hygiene, sleeping and health conditions) through graphs, trends and textual data at various levels of granularity (days, weeks, months).

-Checking the professional carer's workload: This function allows the professional carers to check their workload and prioritise their work.

--Registering actions: It is used to register actions taken by informal and professional carers, who look after the older person.

Other non-functional requirements were discussed during the meeting as follows:

--The privacy of contextual, health and lifestyle data collected from sensors installed at home.

--Appropriate access control to the system. One participant suggested restricting access to sensitive data to specific users. For example, an informal carer might have access to data related to the person he or she looks after.

In addition, specific design issues were discussed with the group, including:

--Allowing users to reconfigure their display preferences: Colour, font, size of the text.

--Presenting data in visual and textual form.

The following section describes how to design intuitive and self-explanatory interfaces for older people and carers based on the preliminary requirements.

### B. *Re-Designing a System Involving all Stakeholders*

As requirements were gathered, an overall vision of system functions and features began to materialise. The researcher (developer) needed to understand how these functions and features would be used by different stakeholders. To accomplish this, the group of participants and the researcher created a set of scenarios that identified a thread of usage for the system to be constructed [8]. The team worked with a paper-based prototype to design the user interfaces.

#### *Scenarios*

The purpose of this technique was to illustrate some situations with which a potential user of the DWIS system would be faced. For this exercise, the group of participants consisted of two technologists, three older people (one cared for and two informal carers), and one professional carer working together.

Under the assumption that all the technology was in place, the older person agreed to be monitored and the end-users (the cared for, the informal and professional carer) had access to the system.

#### *Paper-based prototype*

Following the scenario discussion, the design team had another meeting which aimed to design a paper-based prototype. On that occasion, two older people (one cared for and one informal carer), one professional carer, one technologist, one invited designer and the researcher attended the meeting. The participants were given a list of scenarios, an interface template and a set of pieces to start considering the best position of each element: buttons, labels, graphs and text boxes.

The group of participants came out with an overall design for the following interfaces: logging into the system; registering stakeholders; checking the occupant's areas of well-being; checking the occupant's mobility; checking the occupant's personal hygiene; checking the occupant's blood sugars, and checking the professional carer workload.

### C. *Building an Interactive Version of the System*

The third step in the interactive design process was to build an interactive version that aimed to provide an early model of the DWIS system so that the design could be evaluated and refined in consultation with the group of participants. This step implied the elaboration of some use-cases that described the interaction between the user and the system and the construction of an interactive version of the system.

Based on the requirements gathering, the paper-based prototype and the use-cases, the development of the DWIS system commenced. The DWIS system was developed using Visual Studio .NET, Dundas, and SQL Server 2005. Firstly, the user interfaces were coded and a very preliminary version was informally reviewed by two older people. They agreed with the design features of that version which did not have any functional requirements implemented.

Secondly, the "registering stakeholders" and "checking changes of well-being" functions were developed. The researcher had a meeting with three of the participants (two older people and one occupational therapist) on which a second version of the DWIS system was informally evaluated (see fig. 2 and 3).

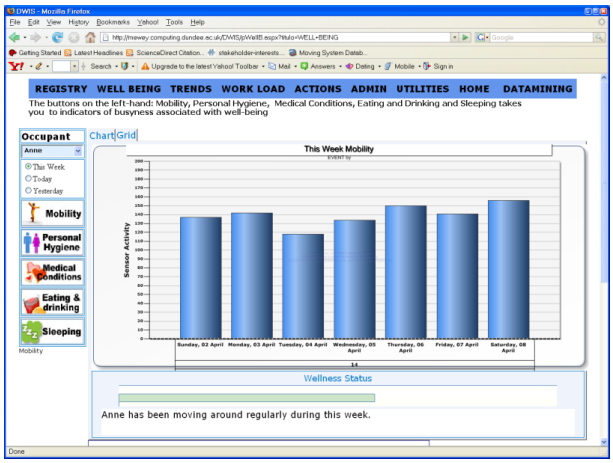


Fig. 2: User interface for older adults

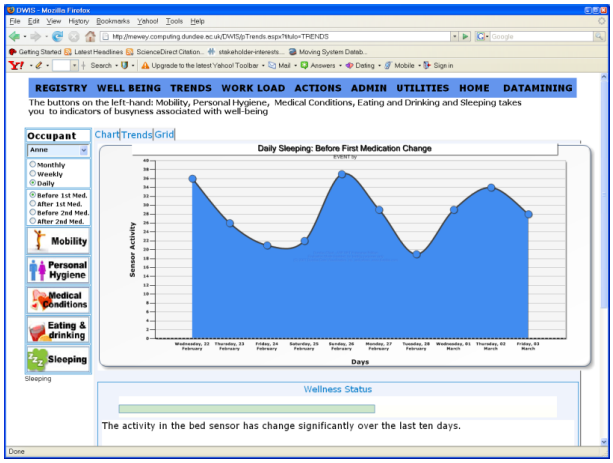


Fig. 3: User interface for carers

### D. *Evaluation of the System*

Once an operational DWIS system was created, it was

evaluated to determine whether it met the needs of the users. The purpose of the evaluation of the DWIS system was to measure the usability, functionality, usefulness, and acceptability. Questionnaires were distributed to users to collect quantitative data of DWIS.

*Participant's profiles*

Twenty people were recruited in person, by phone and by post. There were ten independent and autonomous older people aged between 60 and 80 years, 5 females and 5 males (eight of them lived independently at their home and two lived at sheltered accommodation). Some of the participants attended IT classes at the user centre at the School of Computing in the University of Dundee. Ten female carers (three physiotherapists, two occupational therapists, two scheme managers, two wardens and one social worker). The participants had different levels of computer skills: Basic, intermediate and advanced. Some of them were familiar with reading graphs. Some participants were confident using technology.

*Measures*

While users were performing their tasks, an observer was taking notes. After each individual and pair task, the participants were requested to fill in a questionnaire. Furthermore, each session was video recorded as an extra source for the qualitative analysis of the data. After the pairs exercise, the facilitator conducted a semi-structured interview.

The evaluation of the prototype aimed to evaluate the usability criteria, the user experience and the usefulness of the prototype in terms of the measures shown in table III

TABLE III: MEASURES COLLECTED

| Measures | Type of measure | Part of the exercise |
|---|---|---|
| Effectiveness | Usability | Interview |
| Learnability | Usability | Interview |
| Appropriateness | Usefulness | Interview |
| Intuitive and self-explanative | Usability | Interview |
| Memorability | Usability | Interview |
| User satisfaction | User experience | Individual |
| Reliability | Usability | Individual |
| System performance | Usability | Individual |
| Usefulness | Usefulness | Pairs exercise |

### E. Data Analysis

Qualitative analysis methods [1] [9] [10] were employed to identify emerging categories from the evaluation data of the DWIS system collected from videos, questionnaires and interviews. Moreover, quantitative analysis was used to determine the mean score and deviation from the mean of each measure [11].

*Qualitative Analysis*

The information collected from videos, questionnaires and observations in the individual, pairs exercise and semi-structured interview were transcribed and imported into NVivo 8 [12] to start the data analysis.

To find the meaning of the data, line by line coding was used at the beginning. Then, some preliminary categories were defined such as fear of technology, familiarity, data presentation, and training.

The initial categories were refined by making comparison among people based on the following factors: The user's computing skills (basic, intermediate or advanced), the ability to read graphs, the stakeholder group (older adults and carers), the familiarity with reading graphs, the modality of the exercise (individual and in pairs) and the type of user interface (older adults, carers and none). Data was also compared at different points of time by observing the same participant: During the individual and pairs exercise; by comparing changes in the process such as becoming familiar with the DWIS system and becoming more relaxed.

*Quantitative Analysis*

Descriptive statistics such as mean score, and standard deviation were used to analyse the data collected from questionnaires and semi-structured interviews. The mean gives a measure of how the average participant performs and evaluates the usability, user satisfaction and usefulness of the DWIS system.

The following section provides the results of the data analysis using the qualitative and quantitative methods described in this section.

## III. RESULTS

The first part of this section described the categories that emerged from the qualitative analysis and provided some samples of the participants' opinion. Then, the remaining section presented the measures collected from the evaluation study.

### A. Categories

The following categories emerged from the data analysis as shown in table 4.

TABLE IV: EMERGED CATEGORIES

| Category | Properties | Related with |
|---|---|---|
| Dialogue of care | Discuss evidence, focused conversation and share perceptions between stakeholders | Integrated data, user interface |
| Integrated data | Accessing data and purposes of data.<br>Data presentation: graphs, text and images with text.<br>Quality of data: accuracy and reliability, refinement and normalisation | Ethical and safety, user interface |
| Ethical and safety | Privacy and security, confidentiality, informed consent | Integrated data, user interaction. |

| Category | Properties | Related with |
|---|---|---|
| User interface | Navigation, visibility, personalisation and standardisation | User interaction, utility and benefits |
| User interaction | Struggle or cope with technology, achievement, familiarity and learning | Integrated data, user interface, utility and benefits and user experience |
| User experience | Attitudes and feelings (anxiety, nervousness, confidence), user engagement and enjoyment (motivation, involvement and satisfaction) | Integrated data, user interaction |
| Utility and benefits | Utilities: build a picture – make sense, monitor older adults, and raise questions. Benefits: better feedback and service, assertive decisions, on-line data, quick overview and better use of time | Dialogue of care, Integrated data and user interaction |
| Acceptability | Friendly, interesting, impressive, clear and visual | User interaction and user interface |

### *B. Measures*

Quantitative analysis was used to analyse the data collected from questionnaires. In addition, comments and feedback were collected to improve the DWIS system. The questionnaire produced the following results as shown in fig. 4.

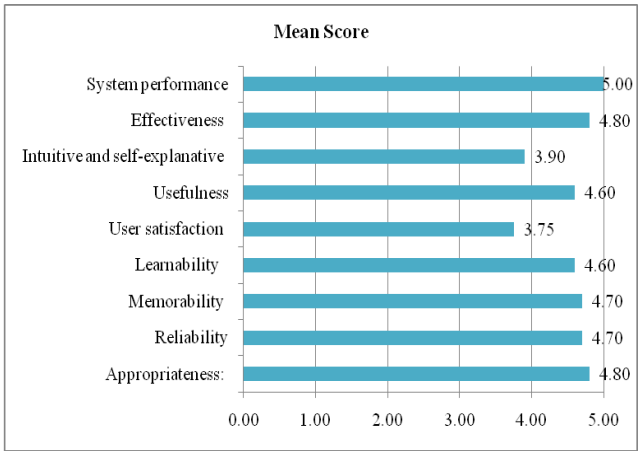


Fig. 4: Quantitative evaluation

## IV. CONCLUSIONS

This study was undertaken to evaluate the usefulness of a domestic well-being indicator system to enhance the dialogue of care between the older adult and the carer. In addition, the usability and acceptability of two user interfaces that were designed with a group of participants (described in chapter five) was evaluated. The DWIS system was evaluated individually and in pairs. The results were collected using qualitative and quantitative methods. The methods included video, notes taken by two researchers, two post-task questionnaires and a semi-structured interview with each pair of participants.

It was found that lifestyle, health and contextual data could communicate changes related to the quality of life and well-being of an older person and could enhance the dialogue of care between the older person and their carers. The data needed to be presented in a clear visual way so all the stakeholders could recognise changes easily, interpret the data and make a decision towards enhancing the life of the older person.

The output from the individual exercise was the interaction between the participant and the DWIS system. There were some participants who found the DWIS system easy to understand and learn. However, there were some participants who had trouble understanding the graphs at the beginning of the first part because they were not used to reading graphs. When the participants became familiar with the DWIS system, all of them managed to complete their tasks successfully.

The main output from the paired exercise was the dialogue of care between the older person and the carer while they were looking at the user interface. It was observed that all the participants had a good discussion working together; they learned from each other and they enjoyed the exercise. However, this dialogue of care might be different when the DWIS system is tested within a real-home environment.

Testing the DWIS system with older adults and carers had three important aspects to take into account: The user interface, the reliability and the user interaction. The user interface needs to be easy to navigate, clear and visual, to have standard templates and to be flexible as far as possible. The data presented to all the stakeholders involved in the care of the older adult needed to be reliable. The user interaction could vary according to previous experience of using computers, the ability to read graphs, , the stakeholder group and the modality of the exercise (individual or in pairs).

The results of this study not only provided evidence of how a domestic well-being indicator system could enhance the dialogue of care between the older person and the carer, but also provided feedback to improve the DWIS system. All participants felt the interface did enhance the dialogue of care between the older adult and the carer, because better data promoted greater understanding and gave greater confidence in the quality and relevance of the care being given. The customisation needs and the usability problems mentioned earlier revealed that users want to see data in different ways, to control the level of monitoring and to have clear and intuitive data. A demonstrator has limitations because it is run using a controlled environment. However, the methodology employed in this experiment and the output from the evaluation could be the basis for a real field trial.

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