

# An Analytic Approach to Evaluate Flexible Mobile User Interfaces for the Elderly

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**Keywords:** Evaluation, Specialists, Tailorable Interfaces, Flexibility, Cell Phone, Elderly.

**Abstract:** It is necessary to provide interfaces that meet the highest possible number of elderly users, regardless of their sensory, physical, cognitive and emotional abilities. Although the literature reports research related to interaction diversity and tailorable interfaces, there are few studies on methods and techniques to evaluate adjustable interfaces. This paper presents an analytical approach based on the evaluation of flexible mobile user interfaces for the elderly. A case study with evaluation experts applied this approach to an executable prototype, and the impressions of the evaluators about this structure were highlighted.

## 1 INTRODUCTION

The average life expectancy worldwide increased from 48 in the early 1950s to 68 in the first decade of the new millennium (UN, 2010). According to a document issued by the United Nations (UN, 2010), there are currently 893 million people over the age of 60 in the world. This number will nearly triple to 2.4 billion by the middle of this century. According to Nielsen (2011), many elderly people in industrialized countries are active. Although they are usually retired, they lead a dynamic life and often have great interest in modern technologies, as for instance smartphones. This study also shows that 18% of the elderly population use smartphones, and that there was a 6% increase in the purchase of these devices between 2010 and 2011.

Thus, it is necessary to provide interfaces that meet the highest possible number of elderly users, regardless of their sensory, physical, cognitive and emotional abilities. One way is to propose user interfaces that allow changes in their behavior during the interaction, giving each user the possibility to adapt the interface according to their preferences, needs and intended use (Neris and Baranauskas, 2010). Therefore, flexibility refers to changes regarding the presentation of the interface elements, namely changes in color, size and window position, as well as changes in the order of interaction actions. Within this flexibility context, an interface can be seen as adaptable when it performs

adaptations when the user requires them. Therefore, the interface that allows users to define, start, select and produce the adaptation, as well as leaving the system to perform some of these functions, is called an adaptable interface. However, the interfaces which show the aforementioned behavior, but whose initial interacting with the flexible interface is done automatically, that is, initiated by the system, are called adaptive interfaces (Henricksen and Indulska, 2001).

It should be noted that although there are some studies in the literature related to flexible mobile design applications for the elderly user (Gonçalves, Neris and Ueyama, 2011; Olwal, Lachanas and Zacharouli, 2011), little is found on the evaluation of these applications. Thus, this paper presents an analytical approach for evaluating flexible mobile user interfaces for the elderly. The proposed approach was evaluated in a feasibility study in which mobile user interfaces for seniors with low and high education were inspected. The results suggest that the proposed approach enables to identify problems in flexible interfaces, quickly and inexpensively, as another discount inspection method.

## 2 THE PROPOSED APPROACH

Unlike conventional applications, for developing tailorable systems, the designers must predict the

different use possibilities, including the progress of users and using them on different devices and environments. In order to support the evaluation of tailorable interfaces, this research presents an analytical approach that supports the evaluation of flexible interfaces on mobile phones within the context of the elderly.

Considering that this structure involves the "design for change" concept, and is rooted in the Universal Design (Connell, Jones, Mace et al., 1997), it is important to carefully assess systems that allow access to knowledge and information.

Figure 1 shows the ideas, techniques and methods discussed in this proposal which are organized in four steps, leading to the evaluation of tailorable interfaces for the elderly public.

### 2.1 Evaluation Preparation

The goal of the first step is to define how the evaluation will take place, outlining the objectives and the hypothesis of inspecting and selecting the experts that participated in the process. At this point it is also important to structure the specific heuristics for this approach through questions to better illustrate each of these guidelines. And also, define the locations where the individual and group activities will take place. Moreover, apply an adjustable interface pilot test to check for possible technical problems.

Another important topic of this phase regards operational issues. The support material with a list of specific heuristics, the table with the severities and the table to survey the problems must be defined.

Also required is considering the environment for the individual assessments and group discussions, equipment and selection of experts. Finally, a tailorable interface pilot test has to be applied, when the specialist conducts the evaluation in order to verify potential technical problems in the flexible system.

The specific heuristics structuring for this approach enriches the analytical process. Accordingly, questions were elaborated based on the description of each heuristic, as shown in Table 1.

### 2.2 Preparation of Evaluators

The goal of the second step is to present the analytical approach proposed in this paper to the experts, that is, the flexible interfaces that will be evaluated and the diversity of the elderly profiles considered for the evaluation.

In this approach we suggest filling out user profile information forms (Neris and Baranauskas, 2010). These forms enable to define diversity regarding the intended use and also about system domain knowledge (Neris and Baranauskas, 2010).

Furthermore, the material support should be available to the evaluators, for example, a list of specific heuristics for the elderly public that uses cell phones. In this work we used the heuristic design of Hellman (2007), described in section 2, for the evaluation context. Also, submit to the experts the table of severity to be adopted, the instructions and the table where the problems encountered should be described.

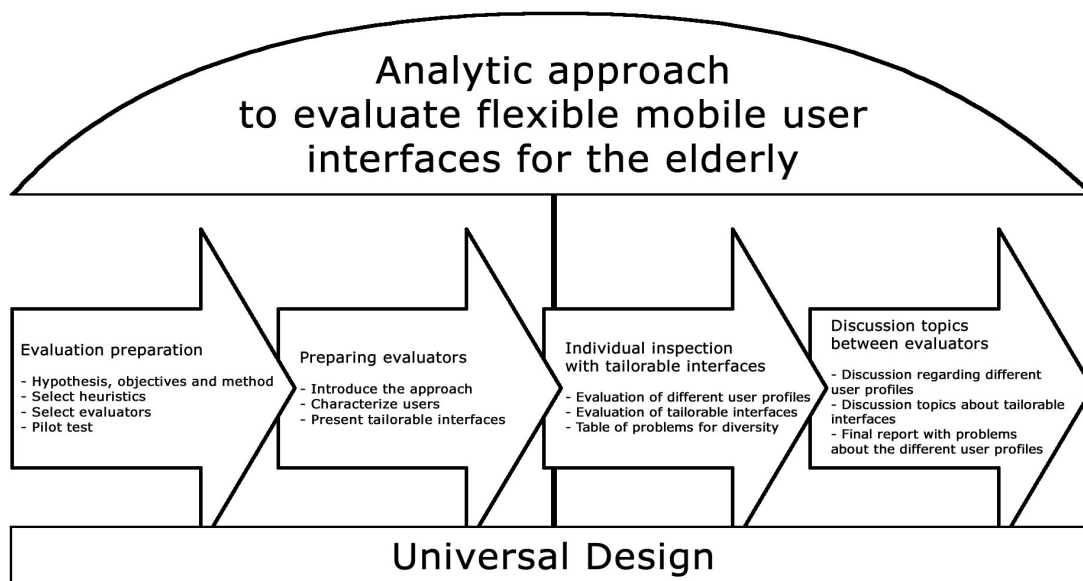


Figure 1: Analytic approach to evaluate flexible mobile user interfaces for the elderly.

### 2.3 Individual Inspection of Flexible Interfaces

In this step the specialist performs the assessment individually, interacting with each of the tailorable interfaces at least twice, making sure the heuristics are in fact specific to the elderly. As support material for evaluation, the experts use a table of problems with the following fields: violated heuristics, severity of the problem, where the problem was found and a description.

Therefore, at this stage the assessor assumes the position of each elderly user profile and carefully inspects the adjustable interfaces. With the outcome of this inspection activity, each evaluator concludes the evaluation with tables of problems for the many profiles.

### 2.4 Discussion between all Evaluators

The last step of this analytical approach is to generate a problem report for each tailorable interface, which results from the discussions topics addressed by the group of evaluators.

At this structure phase, all the evaluators participating in the discussion process address the problems identified during the individual assessments: the main characteristics of each adjustable interface; degree of severity of each of the problems encountered, and finally, based on the evaluators' group discussion, a problem report about

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## 3 FEASIBILITY STUDY

The proposal described in this paper is part of the project of the University of São Paulo, which conducts research related to the design and implementation of flexible mobile user interfaces for the elderly. Therefore, the systems that were tested in the feasibility study use the Lancaster OpenCom (Ueyama, Pinto, Madeira et al., 2009), a middleware approach running in Android mobile phones, which provides the interface changes in interaction time, or running time if a technical perspective that focuses on the system is adopted. For profile diversity, regarding interface change, this flexible system considered the educated and non-educated elderly people. The non-educated profile, for example, was characterized for having little experience with technology.

Table 1: Specific questions for the evaluation.

| Id | Heuristics               | Specific questions for the evaluation   |
|----|--------------------------|---|
| 1  | Navigation and work flow | Is the navigation identical to the other screens? Is there a way to know if the path taken and the applications are activated? Is it possible to close the application and return to the system? Is there too much scrolling? |
| 2  | Error Message            | Are the messages self-explanatory? Are there technical messages to the user? Do the messages appear instantly? For recurring errors, is there additional information?   |
| 3  | Search and Queries       | Are there simple search as default and advanced as options? Is there automatic spell check in the search?   |
| 4  | Enter/Exit               | Can the action be done using the physical and digital keys? Are there interaction alternatives in the menu or in the hierarchical lists?  |
| 5  | Time                     | Is there time flexibility to perform the task? Does the system adapt to the users time? Is there adequate feedback?   |
| 6  | Text and language        | Can the interaction language be defined? Does the system use abbreviations, foreign, professional and long texts? Are there spelling problems? Do titles and labels make interaction easier?                                  |
| 7  | Voice and sound          | Are there voice resources for interaction? Does the voice resource start and stop when solicited?   |
| 8  | Graphics                 | Does the system make use of opposing colors (ex: red and green)? Can the color scheme be defined? Do the icons and symbol follow the norms set up?  |
| 9  | Figures and numbers      | Are there alternative presentation forms for figures and numbers, such as diagrams or verbal descriptions?  |
| 10 | Help and Information     | Does the system offer help? Is help identical in all screens?   |

### 3.1 Evaluation Preparation

For such analytical approach based on the evaluation of flexible mobile user interfaces for the elderly public, which initially defined the objectives, the inspection, hypothesis and methodology to be used were prepared in order to check the hypothesis.

Hypothesis: based on the interaction requirements of the elderly population and the standards set for the design of flexible interfaces (Gonçalves, Neris and Ueyama, 2011), it is believed that the use of tailorable interfaces can be a solution to the preferences, needs and intentions of the elderly user.

Purpose of Evaluation: check accessibility and usability problems in the use of flexible solutions of mobile user interfaces for the elderly.

Methodology Applied: in order to analyze flexible mobile user interface solutions, a group of five evaluation experts were invited to perform an evaluation based on specific heuristics regarding the elderly public in the use of mobile phones. With this evaluation it was possible to check whether the proposed solutions for the diversity context actually made sense to the interaction requirements of the elderly.

For this structure, it was necessary to check operational issues related to evaluation before starting the evaluation.

Equipment/Environment: the equipment of LaSDPC was used for the evaluation. For the evaluation, each expert used a mobile phone (smartphone), and the examiners conducted individual evaluations in LIFeS and group discussions in LInCE.

Support Material: to carry out the evaluation, a table with specific heuristics, a table with the severities and a table to survey the problems were prepared. The table with the specific heuristics for the elderly public regarding the use of cell phones had questions related to each heuristic, to assist the experts in the evaluation. The table with the severities to be considered in the evaluation has a scale from 0 (Unimportant) to 4 (Catastrophic). Finally, the table used to survey the problems was prepared to help the expert describe the problems related to each heuristic, attributing one severity to every problem.

Evaluators: the tests were performed individually by five evaluators, experts in the evaluation of interfaces. The group of experts was composed of masters' and doctoral students of USP and UFSCar, that graduated in Design and Evaluation of User Interfaces and their graduate research work related

to the IHC area, and one of the evaluators is a master's student in nursing.

Pilot Test: in the first phase of the proposed approach in this paper, a pilot test was applied to one of the evaluators in order to check for possible technical problems regarding the flexible system.

After defining the hypothesis, objectives and operational issues of this structure, the evaluation specialists participating in the process were then prepared.

### 3.2 Preparation of Evaluators

At this stage of preparing the evaluators, the analytical approach for evaluating flexible mobile user interfaces for the elderly was clarified. Therefore, the diversity of user profiles to be analyzed, educated and non-educated users, was presented to the evaluators, and the profile considered that non-educated was characterized by low experience in the use of mobile phones. The example shown in Figure 2 consists of elderly users' mobile phone characteristics, considering the features of the cell phone. The aspects listed regard eyesight impairment as a physical characteristic, ease of use as a use purpose and user satisfaction regarding the cell phone. Moreover, the form has a general specification, from the simplest to the most essential characteristics. In the "emotional issues", for example, impatience for the restless users that use the mobile phone, and also the lack of curiosity or interest in manipulating the device for other users, and also some user's fear of breaking something new is highlighted. Thus, the group of evaluators can have a better understanding of the profiles they will consider.

**User Groups: Elderly people**

Knowledge about the Domain: ( ) None (X) Little ( ) Much

|                           |                    |                                |
|---------------------------|--------------------|--------------------------------|
| Physical Characteristics: | Domain Terms:      | Emotional issues:              |
| - Visually impaired       | - Message          | - Impatience                   |
| - Physical Motor impaired | - Small device     | - Fears the device             |
| - Impaired Memory         | - Is calling       | - Lack of curiosity/Interest   |
|                           | - Number of people |                                |
| Devices:                  | Intended use:      | Result of use:                 |
| - Cell phone              | - Independence     | - Satisfaction                 |
| - Land line telephone     | - Convenience      | - Digital and Social Inclusion |
| - TV Remote Control       | - Ease of use      |                                |

Figure 2: Form to characterize the profile of the elderly group.

To perform the evaluation, a support material with a list of 10 specific heuristics in cell phone use for the elderly public was made available to the

evaluators (Hellman, 2007). In addition to the heuristics, the table of severity to be adopted, the instructions for completing the table and the table where the evaluators should describe the problems encountered were submitted to them.

Also at this stage of preparing the evaluator, the manner of presenting the interface to the experts was defined: executable prototype of flexible interfaces (see Figure 3). Next, the evaluator was conducted to LIFeS to perform their individual evaluation, as described in the next step of this approach.

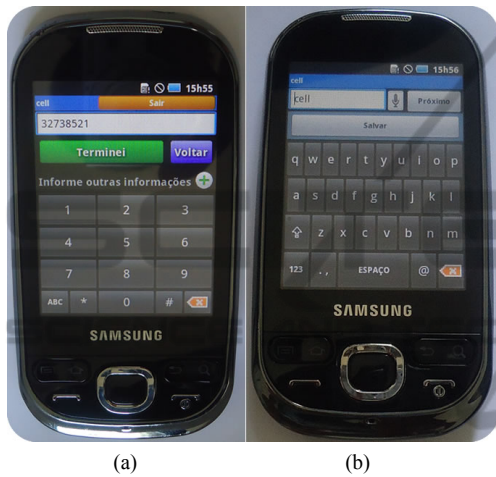


Figure 3: Examples of flexible interfaces evaluated. (a) Non-educated users, (b) educated users.

### 3.3 Individual Inspection of Flexible Interfaces

During the inspection phase, the individual evaluation was performed, when the expert studied each of the adjustable interfaces several times (at least twice) checking whether the heuristics had been violated. The experts had a table to help them with the evaluation, filling out the heuristic violated, the severity of the problem, where the problem was found and a description.

For this analytical approach the evaluator assumed the place of each elderly profile user (educated and not educated) and conducted a careful inspection of the tailorable interfaces. It was by defining the flexible interfaces that meet the requirements of elderly users, that each expert evaluated the interfaces, at first putting himself in the role of a lower-educated elderly user (studied up to 4th grade) evaluating the interface shown in Figure 3a; and next as an educated elderly user (studied beyond the fourth grade), evaluating the interface shown in Figure 3b. It was also considered that the educated elderly user had some experience

with technology. For each user profile there was a different interface behavior, which represented a proof of concept of a set of rules for the adjustable behavior of the interface, defined by Gonçalves, Neris and Ueyama (2011).

### 3.4 Discussion between all Evaluators

The evaluation process is based on the evaluators' review and on their confidence in their experiments (Rocha and Barauska, 2003). The evaluators' analysis consisted primarily of reporting problems, based on the assessment, which were not compatible with the heuristics adopted.

After the individual analysis of the evaluators, based on the aforementioned heuristics, two discussions reports with all the evaluators were generated, and with the first discussion focused on the tailorable interface for the elderly users with low schooling, and the second discussion concerning the tailorable interface focusing on the elderly educated users.

The last step of the analytical approach addressed the main characteristics of each tailorable interface; the problems identified during the evaluation, the degree of severity of each of the problems encountered and, lastly, based on the discussion, a problem report was generated with their respective severities for each tailorable interface, so that changes can be then proposed for the interfaces evaluated.

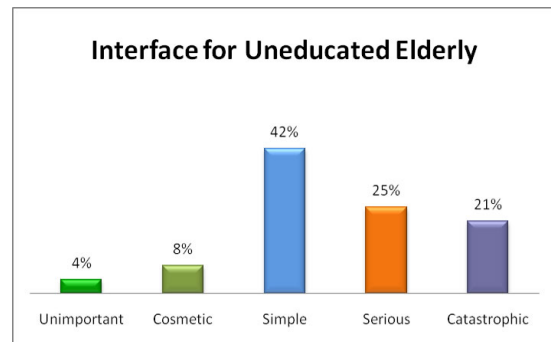


Figure 4: Issues addressed in the evaluation of the low-education profile.

With regard to the severity of the problems raised in the final report, the percentage of occurrence of problems for each level of severity was defined. Therefore, as can be seen in the graph of Figure 4, with the evaluation of flexible interfaces for the low-education users, a list of 30 problems in the interface was obtained, of which 42% were considered simple and 4% regarded as unimportant.

Moreover, the final list for the profile of elderly users showed 33 had problems, of which 50% were considered serious and 0% for problems considered cosmetic and catastrophic, as seen in the graph in Figure 5.

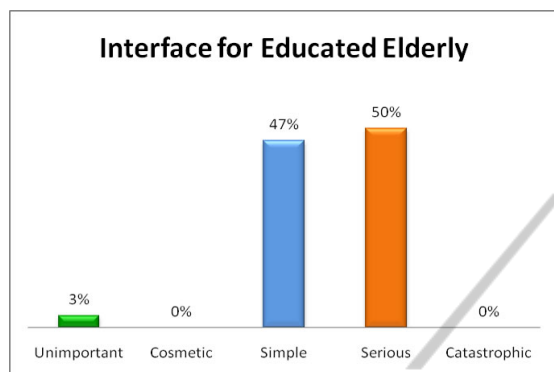


Figure 5: Problems addressed in the evaluation of the educated user profile.

## 5 CONCLUSIONS AND FURTHER WORK

During the feasibility study of the approach described in this study, it was observed that evaluation experts of interfaces felt safer in evaluating flexible interfaces, supported by an approach that considers the interface change in interaction time, as one of the reviewers pointed out: "This is the first time I evaluate flexible interfaces. Indeed, this approach made me think how important it is for the result of an assessment, to have a specific technique for assessing diversity". The analytical approach proposed in this paper, based on the evaluation of flexible mobile user interfaces for the elderly, brings a set of heuristics for mobile phones within the elderly population context. According to one expert: "Specific heuristics made all the difference in my evaluation. If I had used the traditional Nielsen's heuristics during the inspection, I would not have raised all the issues that I enumerated".

In the final phase of the case study, when discussions are held by the evaluators, one of the participants in the process emphasized that: "Having a discussion for each of the types of tailorable interfaces is major differential in this approach. In fact, our final report could conceive specific problems for each of the adjustable interfaces".

Based on the results presented by the experts' evaluation, further works could implement an assessment survey with the elderly users of these

flexible interfaces and perform a comparison with the results raised by the case study described in this study.

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