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## Cognitive Walkthrough: An Element in System Development and Evaluation – Experiences From The eWALL Telehealth System

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### Abstract

Epidemiological changes in the population lead to an increasing number of elderly people with a chronic disease. Telehealth is proposed as one of the solutions for the growing challenges of the health care system caused by these changes. The telehealth system eWALL seeks to promote the independent living of people with chronic obstructive pulmonary disease, mild cognitive impairment or age related impairments. The eWALL system is in a developmental stage in which partners from 14 different European countries are included. A three phase cognitive walkthrough-approach was performed on the eWALL system in order to evaluate the usability of the system. First the cognitive walkthrough performed by experts, second, rating of the identified usability problems identified by other medical partners, and third, discussion on a plenary telecommunication call among medical partners and technical partners. (n=119) usability problems were identified distributed among the 14 functionalities of the telehealth system. The majority of the usability problems were discovered in the functionalities: 'TV' (n=21), 'Calendar' (n=20), and 'Environmental box' (n=18). The least usability problems were identified in the functionalities: 'My sleep' (n=1), 'Photo frame' (n=2), and 'My Everyday Life' (n=3). The results of the cognitive walkthrough served as a concrete, structured and constructive collaborative tool between the medical partners and the technical partners involved in the eWALL project.

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## 1. Introduction

The increasing number of elderly people suffering from a chronic disease has expanded over recent years and affected the healthcare sector<sup>1</sup>. The epidemiological changes induce extended hospitalization time, extra treatment costs, more healthcare personnel, overtime work among the healthcare professionals, etc.<sup>2</sup>. The healthcare sector has started to test and implement telehealth systems as an attempt to overcome these challenges<sup>3-5</sup>.

An example of a telehealth system is the European funded large scale project, eWALL for Active Long Living. The goal of the project is to develop an intelligent interactive wall, named eWALL, for people suffering from chronic diseases, including chronic obstructive pulmonary disease (COPD), mild cognitive impairment (MCI), and age related impairment (ARI)<sup>6</sup>.

To design, develop, and produce the intelligent interactive wall, a consortium consisting of 14 partners from various European countries are collaborating over a period of 36 months. Four of the 14 partners, Roessingh Research and Development (RRD), IRCCS San Raffaele S.p.A. (IRCCS), Center for Usability Research and Engineering (ATE), and Aalborg University (AAU), represent the medical partners and the rest (n=10) of the 14 partners represent the technical aspects of the project, including Hewlett Packard Italiana SRL, Ericsson Nikola Tesla D.D., AIT Research and Education Laboratory in Information Technologies, Universitatea Politehnica din Bucuresti, UKIM Ss. Cyril and Methodius University in Skopje, UOM Javna Ustanova Univerzitet of Zagreb, Stelar Security Technology Law Research UG, and Austrian Institute of Technology. RRD is represented as both a medical partner and a technical partner<sup>6</sup>.

The idea of dividing the tasks and responsibilities of the project into 10 technical partners and four medical partners is to achieve synergy. The mix of different competences and knowledge that both groups bring into the project may strengthen the collaboration and project outcome.

The eWALL system has gone through different usability evaluation methods. These evaluations have led to improvements of the eWALL system including a more user-friendly layout and a reduced number of functionalities. The current list of functionalities has an increased focus on the end users' needs compared to earlier versions of the system. However, the system is not yet ready to be delivered to real end-users. The four medical partners have tested the eWALL system separately and delivered the results and findings of the tests to the technical partners without further description. After delivering the results to the technical partners, there has not been any further organized actions in order to follow up and correct the usability problems identified in the tests. This lack of organized follow up has led to problems in the communication between the medical partners and the technical partners and has been a weakness in the collaboration.

The latest evaluation performed on the eWALL system is a cognitive walkthrough. A cognitive walkthrough is an evaluation technique that seeks to evaluate the design of a user interface<sup>7</sup>. The cognitive walkthrough was performed in order to evaluate the eWALL system by identifying usability problems. A side benefit of performing the cognitive walkthrough was that the technique served as a structured tool for the collaboration between the medical partners and the technical partners in the eWALL consortium.

The aim of the current study is firstly to describe the results of the cognitive walkthrough of the eWALL telehealth system, and secondly to demonstrate the beneficial side effects of performing a cognitive walkthrough in a collaboration project with 10 technical partners and 4 medical partners.

This paper is organized as follows: In section 2, the three steps in the applied cognitive walkthrough method is expanded in details. Furthermore, a visual presentation of the telehealth system is shown by a mock up of the system main screen and by showing the architecture of the system. In section 3, the two types of results after performing the cognitive walkthrough method are presented: quantitative results and qualitative findings, respectively. Finally, in section four and five a discussion and a conclusion is given to the reader.

## 2. Methods and Materials

The applied method was structured as a three phases-approach. First, the eWALL system was evaluated by two experts using the cognitive walkthrough technique<sup>7</sup>. Second, the other medical partners were asked to rate the identified usability problems and, in addition to that, add further usability problems if relevant. Third, the results of the cognitive walkthrough were discussed on a plenary telecommunication call among the medical partners and the

technical partners. The aim of the plenary telecommunication call was to discuss the identified usability problems through and obtain a mutual understanding of the problem and their implications for the system design. Furthermore, the plenary telecommunication call was used as a platform for clarifying misunderstandings between the collaborating partners.

### 2.1. The first session: Cognitive Walkthrough with experts

Two experts participated in the cognitive walkthrough session. The first expert was educated as occupational therapist and the other experts was educated as nurse. Both experts had a Master's degree in Clinical Science and Technology from Aalborg University. Furthermore, both experts had extensive experience in the field of usability testing and had knowledge of the eWALL system and the system functionalities.

The experts were placed in front of the eWALL system to have the best possible access to all the functionalities of the system (Figure 1, Figure 2).



Fig. 1. When a user stands in front of the eWALL system, he can enter a username and a password on a login page. Hereafter, the user enters the 'Living Room' from where all the functionalities of the system are available.

Before starting the cognitive walkthrough session, the experts received an overview of the functionalities in the system and repeated that the goal of the cognitive walkthrough session was to evaluate each functionality by assessing whether or not the functionality had a usability problem. In total, 14 functionalities are integrated into the eWALL telehealth system and the available functionalities of the eWALL telehealth system is seen from the architecture shown in Figure 2.

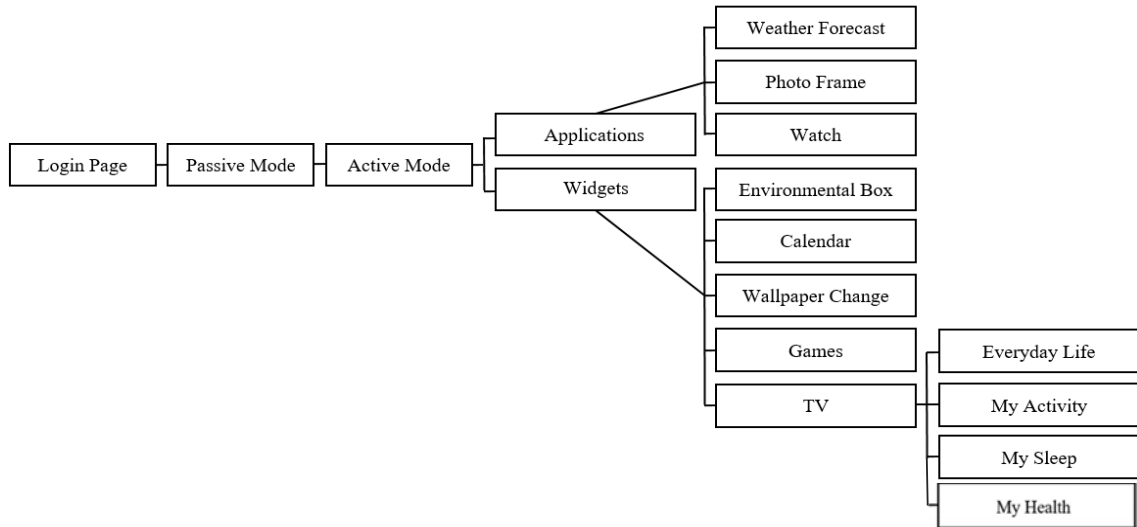


Fig. 2. The architecture of the eWALL system.

When a usability problem was identified, the experts followed the same procedure:

1. The usability problem was described
2. The location of the usability problem was described (in which functionality)
3. The usability problem was rated using a four level scale (1-4): 1) *a cosmetic problem*; 2) *a minor problem*; 3) *a major problem*, and 4) *a catastrophe problem*
4. A recommendation for how to improve the usability problem was suggested

The cognitive walkthrough lasted approximately six hours.

### 2.2. The second session: Including the other medical partners

The cognitive walkthrough resulted in a list of usability problems addressing all the functionalities of the eWALL system. The list was uploaded to a joint internet folder which all of the partners of the eWALL consortium had access to. The other three medical partners then gave their opinion of the severity of each identified usability problem, and, in addition to that, if any of the medical partners had identified further usability problems, they were invited to add those to the list. Even though the medical partners were asked to use the same four-level scale as the two experts from AAU had used, another level was added to the scale. The three remaining medical partners added the level 0 which indicated that the partners either did not acknowledge the problem or was indifferent to the problem.

### 2.3. The third session: Discussion in a plenary telecommunication call

When all the medical partners had given each usability problem a severity rate, a date for a plenary telecommunication call was arranged. Four medical partners and two technical partners participated in the plenary telecommunication call. The agenda for the telecommunication was as follows:

- One by one, the identified usability problems were read aloud by a medical partner from AAU. This was done to avoid any misunderstandings or confusion among the technical partners and the other three medical partners.
- The different severity rates that had been given were then gone through. If the problem had received the severity rate no. 1 or severity rate no. 2, it received the label 'Low Priority'. If the severity rate no. 3 or severity rate no. 4 had been given, the problem received the label 'High Priority'. The two categories 'Low Priority'

and ‘High Priority’ were an indication to the technical partner regarding how to prioritize their resources when correcting the usability problems.

- The two experts from the cognitive walkthrough had, as already mentioned, given a recommendation for how to correct and improve each usability problem. Some of the technical partners had problems understanding the meaning of some recommendations, so the plenary telecommunication call was also used to give a more precise and full description of the recommendations.
- After the partners had gone through all the usability problems, classified them into ‘High Priority’ or ‘Low Priority’, and clarified any misunderstandings, the meeting was closed and the technical partners could start implementing the suggestions in order of priority.

The plenary telecommunication call, lasted approximately five hours and was distributed over two meeting days.

### 3. Results

The result section is divided into quantitative results and qualitative findings. The quantitative result section presents the total number of problems identified during the cognitive walkthrough, and the distribution of the severity rates done by the four medical partners. The quantitative finding section describes how the cognitive walkthrough worked as a tool to communicate results and discuss further actions between partners in the eWALL project.

#### 3.1. Quantitative results

The two experts from AAU evaluated 14 functionalities of the eWALL system (Figure 2).

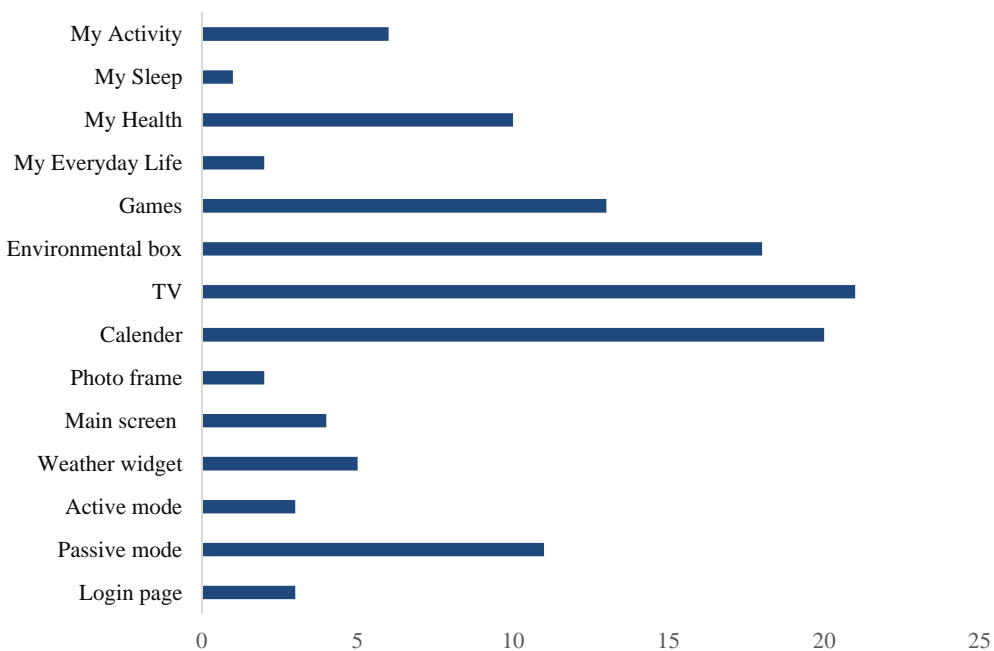


Fig. 3. The distribution of usability problems among the 14 partners.

The experts identified usability problems in all of the 14 functionalities (Figure 3). In total, 119 usability problems were identified by the experts. Figure 3 visualizes the distribution of the problems across the different functionalities. The experts identified the most usability problems in the functionalities: ‘TV’(n=21), ‘Calendar’ (n=20), and ‘Environmental box’ (n=18). The least usability problems were identified in the functionalities: ‘My sleep’ (n=1), ‘Photo frame’ (n=2), and ‘My Everyday Life’ (n=3).

Figure 4 illustrates the distribution of the severity rates given by the four medical partners. As described AAU did the first round of rating using a four level scale (1-4). The remaining partners used a five-level scale (0-4).

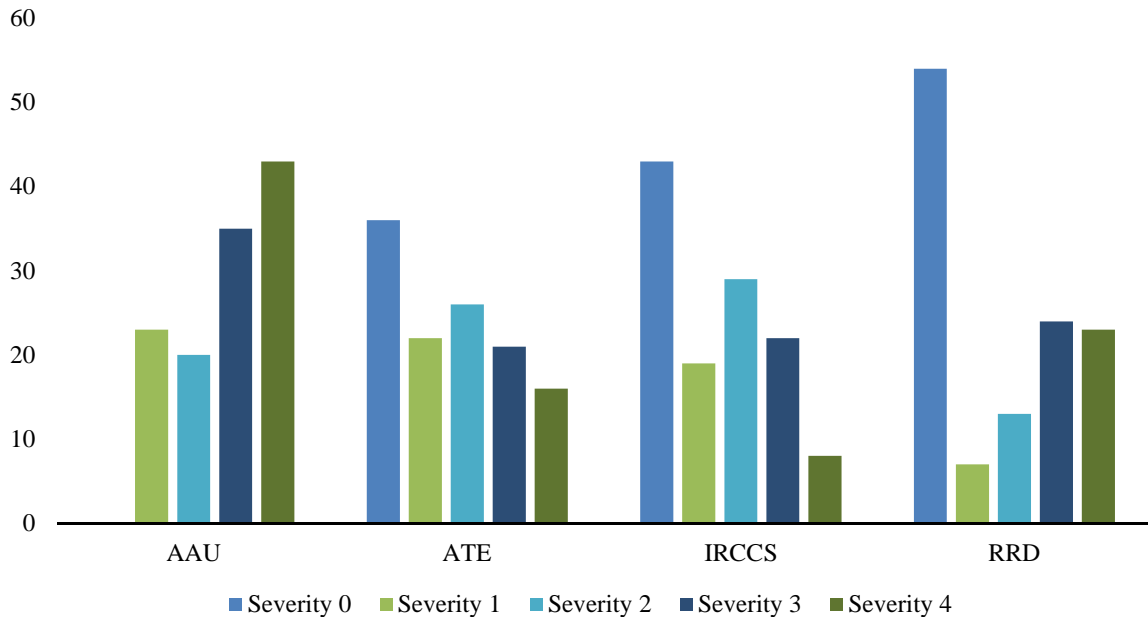


Fig. 4. The distribution of the severity rates used by the four medical partners.

AAU used severity rate 4 the most and severity rate 2 the least (please note that AAU did not include level 0 in their evaluation). ATE used severity rate 0 the most and severity rate 4 the least. IRCCS used severity rate 0 the most and severity rate 1 the least.

### 3.2. Qualitative findings

The layout and the functionalities of the eWALL telehealth system were developed by the technical partners in the eWALL consortium. The cognitive walkthrough was performed by medical partners in the eWALL consortium. The cognitive walkthrough provided a list of 119 usability problems including recommendations for improvement of the system. This structured list combined with the fact that all medical partners gave their input to the severity and the relevancy of each usability problem, provided a tool in a collaboration taking place across 14 different countries. Thereby, the cognitive walkthrough involved all medical partners in the eWALL project and provided a platform for collaboration between medical partners and technical partners.

As an example, some of the usability problems and/or recommendations for improvement of the eWALL system were difficult for the technical partners to understand. The plenary telecommunication call was used to enhance the understanding of the usability problems and recommendations for improvement identified by the medical partners.

#### 4. Discussion

The aim of the present study was firstly to describe the results of a cognitive walkthrough of the eWALL telehealth system. Secondly, to demonstrate the beneficial side effects of performing a cognitive walkthrough in a collaboration project across 14 countries where 10 of the partners were technical partners and 4 of the partners were medical partners.

The study ended up with quantitative results and qualitative findings. The distribution of the identified usability problems among the 14 functionalities of the eWALL system was presented. Furthermore, the distribution of severity rates used by the four medical partners was presented. The qualitative findings of the study included a description of how the cognitive walkthrough and the follow up section was used as a collaborative tool.

A large amount of usability problems was identified in the cognitive walkthrough ( $n=119$ ), and usability problems were identified in all of the functionalities of the eWALL telehealth system. Previously, the eWALL system has gone through several rounds of usability testing including user tests and heuristic evaluations<sup>8</sup>. Thus, 119 usability problems must be considered a large number to identify in such a late stage of the system development. These findings indicate that the results of the previous rounds of usability testing have not been communicated and managed optimally. This highlights the need for delivering the results of a user test to the developers in a constructive and structured manner.

AAU identified the 119 usability problems. The other three medical partners were encouraged to add further usability problems to the list. However, only two other usability problems were added. On the contrary, all three medical partners rated the severity of all usability problems. Thereby, the method used in this present study allowed all the medical partners to be included in the process. However, the findings indicate that it may only be realistic to expect other partners to rate the severity of the usability problems, and it may not be realistic to expect other partners to add further usability problems.

The use of severity rates varied among the medical partners. Obviously, AAU did not use severity rate 0 at all, since they followed the originally intended four-level scale. The three remaining medical partners used rate 0 the most. Rate 0 was used both when a partner did not acknowledge the problem and when a partner was indifferent to the problem. Therefore, it is unclear whether the high use of severity rate 0 indicates that the three remaining medical partners disagreed with AAU or if there was a high level of indifference among the partners. The disagreement or indifference may be caused by cultural differences or lack of knowledge about usability and/or the user groups among the partners.

The cognitive walkthrough was used as a collaborative tool. The fact that the cognitive walkthrough consisted of three phases, strengthened the study as both medical partners and technical partners were included in the testing process at different times. The first phase of the method, the actual cognitive walkthrough, provided a thorough walkthrough of the system. No technical partners who had been involved in the development process were included in this part of the process. This allowed the experts to perform an objective walkthrough of the system and to provide a list of results unbiased by feeling senses of ownership of the eWALL system. The second phase of the method included the other medical partners allowing their voice to be heard. The third phase of the method included the technical partners in the form of a plenary telecommunication call. The plenary telecommunication call provided a platform for discussing misunderstandings and disagreements. Moreover, the plenary telecommunication call allowed the technical partners' voice to be heard as well. Using a plenary telecommunication call as a platform for communication is not ideal compared to a physical meeting. A limitation of a plenary telecommunication call is that the non-verbal communication is invisible which can trigger objection and cause uncompromising collaboration<sup>9</sup>.

Before the cognitive walkthrough, several rounds of other usability testing methods had been used to evaluate the eWALL system<sup>8</sup>. The results from these tests had been closely written in deliverables to the European Commission and had had some attention from the technical partners in the eWALL project. However, none of the other usability methods led to the same attention from the technical partners as the cognitive walkthrough. All the identified usability problems were corrected after the plenary telecommunication call. Thus, the cognitive walkthrough was a usable tool in the eWALL development process. The cognitive walkthrough led to a more user-friendly interface with less usability problems. Moreover, the cognitive walkthrough worked as a collaborative tool providing a structured, concrete, and constructive tool for working together between 14 different countries.

The cognitive walkthrough was easy to perform as it only required the involvement of two experts. The costs related to performing a cognitive walkthrough are low, so are the required time resources. However, the method also has some limitations. One limitation is that the experts who did the cognitive walkthrough already knew the eWALL



system. Thus, the experts could have been blind to some of the usability problems and have overseen them. This emphasizes the need for several rounds of testing in a system development process.

Retrospectively, it would have been beneficial to do a cognitive walkthrough as the first round of usability testing of the eWALL system in order to do a primary evaluation of the system<sup>10</sup>. The next rounds of user tests should then include heuristic evaluations and user tests. The authors consider that the eWALL system is not yet ready to be delivered to end-users until further user tests with end-users have been performed.

## 5. Conclusion

The cognitive walkthrough identified a great number of usability problems in the eWALL telehealth system. The results of the cognitive walkthrough contributed to a more user-friendly interface with less usability problems. Furthermore, the results from the cognitive walkthrough served as a structured, concrete and constructive collaborative tool. Thus, the cognitive walkthrough served as a usable tool in the development process of the eWALL telehealth system. The results indicate that other projects may benefit from including cognitive walkthrough as an element in their system development process.

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