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Participatory Heuristic Evaluation of the First Iteration of the eWALL Interface Application

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Abstract—*Worldwide, the number of people having a chronic disease is increasing. Managing chronic diseases is time consuming and expensive. A need for new ways to deliver healthcare to patients with chronic diseases is urgent. Telemedicine and medical devices combined may offer several opportunities as alternative ways for healthcare to be delivered. An example of a device addressed to people with chronic disease is the device from the large-scale project "eWALL for Active Long Living", which has been tested using Participatory Heuristic Evaluation. The main results of the study showed a difference when comparing the most used heuristics given by the usability experts and the work domain professionals. When it comes to the distribution between the use of the severity grades between the usability experts and the work domain professionals, there seems to be an agreement between the two groups. For both groups the higher severity grade number 3 and 4 were more used than the lower severity grade 1 and 2. This Participatory Heuristic Evaluation of the eWALL interface application is the first iteration of the development process towards the final eWALL product. Future work includes the conduction of a second iteration, and perhaps third iteration, of Participatory Heuristic Evaluation on the eWALL interface application in order to optimize the usability of the final system.*

Keywords: telemedicine; eWALL; Participatory Heuristic Evaluation; chronic disease

I. INTRODUCTION

In the future, the correlation between a growing population of elderly people and people having two or three chronic diseases will lead to a massive organizational, economical, and professional challenge for the healthcare sector. Worldwide, the number of people having a chronic disease is increasing. In Denmark the chronic diseases such as: Chronic Obstructive Pulmonary Disease (COPD) and Mild Dementia (MD) affects more than thousands of people on a daily basis [1,2]. COPD is a lung illness characterized by a permanent blockage of airflow from the lungs [2]. The prevalence of COPD among people who have passed 35 year is approximately 14% [3]. MD is the mild form of dementia, which is the fifth frequent cause of death in Denmark [4].

Currently, the treatment of the chronic diseases is time consuming and expensive [5]. A need for new ways to deliver healthcare to patients with chronic diseases is urgent [6].

A new way of delivering healthcare service to patients with chronic diseases is to integrate telemedicine and medical devices into the standard ways that healthcare are currently delivered [6,7]. Medical devices cover a wide range of products, including wheelchairs, glasses, pacemakers, dental crowns and hip implants' [8]. The two terms, "telemedicine" and "medical devices", combined may offer several opportunities as alternative ways for healthcare to be delivered.

An example of a medical device, which is addressed to people with COPD, MD, and age related impairments, is the device from the large-scale project "eWALL for Active Long Living" [9]. The device can be used to monitor health of older adults, giving them easy access to doctors, and sensing daily activities with the aim of informing relatives in case of emergency. For the eWALL device, the overall technical and user requirements are: 1) unobtrusiveness in monitoring functions and 2) seamless interaction with primary and secondary end users (patients, healthcare professionals, and relatives).

Until now, the eWALL device has been tested using several evaluation methods, some of which are designed to provide feedback on the user-friendliness of the technology. The device is currently in the design and development phase, which means that there is still a need of removing usability issues from the system. One of the evaluation methods, which have been performed on the device with the objective to remove usability issues, is the so-called Participatory Heuristic Evaluation. In Participatory Heuristic Evaluation experts in usability perform an inspection as in a traditional heuristic evaluation followed by evaluation by work domain professionals [10]. The purpose of extending heuristic evaluation with work-domain professionals is to supplement the more theoretical knowledge of the traditional inspectors with the very specific knowledge from work-domain professionals. The Participatory Heuristic Evaluation reported in the present paper was performed as a part of the first iteration of the eWALL interface application.

The aim of the present study is to report the results and benefits of conducting a Participatory Heuristic Evaluation on the eWALL device. This paper is further organized as follows: Section II describes the materials and methods employed in eWALL and the overall layout of the interface. Section III presents the results of performing the Participatory Heuristic Evaluation. Section IV and V discuss and concludes the paper.
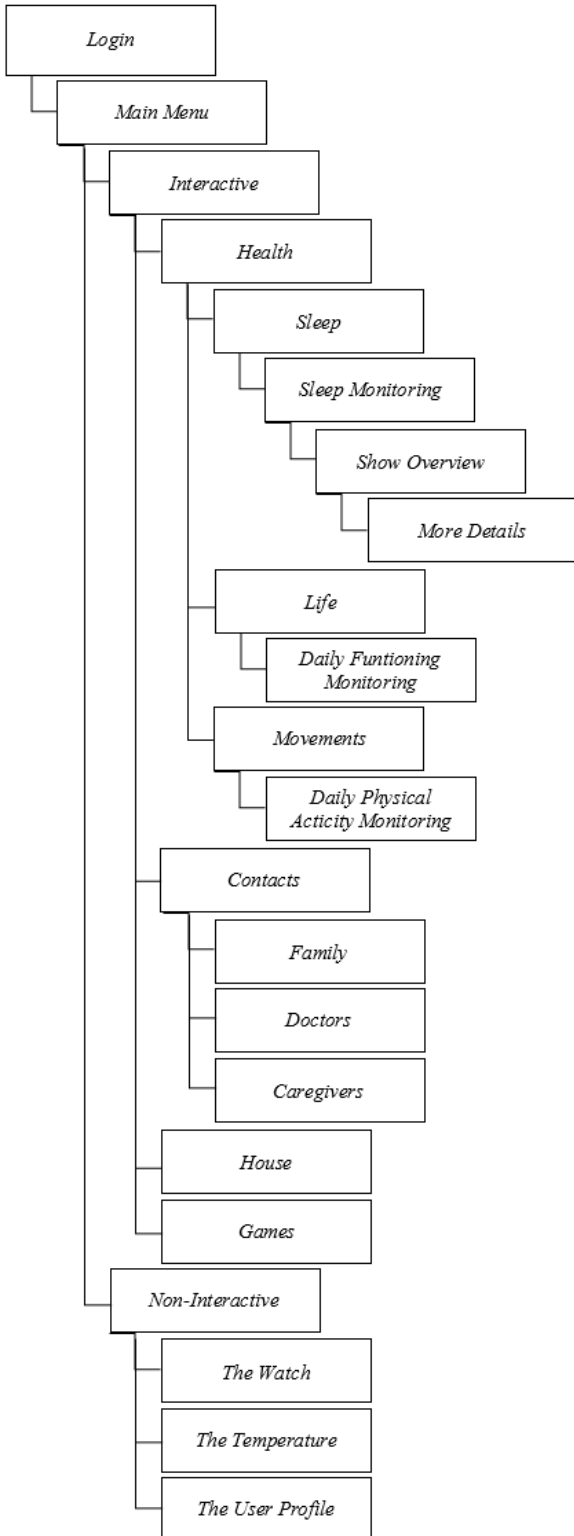
II. MATERIALS AND METHODS

Fig. 1. *Architecture of the functionalities and features in the eWALL device*

A. The eWALL device

The eWALL interface application is an element of the final device, which is a prefabricated wall incorporating various functionalities and features for people with COPD, mild dementia, and age related impairment [9].

Fig. 1 visualizes the architecture of the functionalities and features which are integrated in the eWALL device. The figure shows that after logging in, the users have *interactive* and *non-interactive* services. The interactive services are categorized into the applications: Health, Contacts, House, and Games. Several of the applications have subgroups such as *Health* where it is possible to monitor *Sleep*, *Daily Functioning Monitoring*, and *Daily Physical Activity Monitoring*. The Non-Interactive services are *The Watch*, *The Temperature*, and *The User Profile*.

Overall, the functionalities and features of the eWALL system can be divided in three groups, namely the following: 1) Risk management; 2) eHealth; 3) Lifestyle management.

To get access to the functionalities and features in the eWALL interface application, the users have to enter a username and a password as seen in Fig. 2.

Fig. 2. *A screenshot of the front page where the users enter their username and password*

Next to the line where the users enter their username, there is a dropdown menu making it possible for the user to choose their native language as seen in Fig. 3.

Fig. 3. *A screenshot of the dropdown menu where the users choose their native language*

The non-interactive widgets include a digital watch and a weather application, which informs the users about 1) the

location, 2) the temperature of the day, 3) the cloud situation, 4) the pressure and 5) the wind speed. To make sure that the users understand everything, the information is both written and given by pictographs.

B. Participatory Heuristic Evaluation

As described in Section I, Participatory Heuristic Evaluation is a participatory inspection technique, which serves as an extension to the traditional heuristic evaluation defined by usability-expert Jakob Nielsen [11]. In the Participatory Heuristic Evaluation, five experts in usability were asked to identify and comment usability problems in the eWALL interface application. Furthermore, two work domain professionals were invited to contribute with their perspectives on the interface of the eWALL device.

a) Usability experts

To perform the Participatory Heuristic Evaluations five usability experts were recruited. All the usability experts had a MSc.in Biomedical Engineering. Three of the experts were PhD fellows and two experts were Associated Professors. The usability experts were all working at the Department of Health Science and Technology at Aalborg University. Three of them had prior experience in performing the Participatory Heuristic Evaluations. The remaining two usability experts were novices in performing a Participatory Heuristic Evaluation. All were familiar with traditional Heuristic Evaluation.

b) Work domain professionals

Two nurses were invited to participate as work domain professionals in the Participatory Heuristic Evaluations. Besides their profession as nurses, the work-domain professionals also had a MSc. in Clinical Science and Technology and were PhD fellows. The work-domain professionals were recruited from The Department of Health Science and Technology at Aalborg University. Both of the work domain professionals had experience with conducting Participatory Heuristic Evaluation.

c) Severity rating scale and 15 heuristics

The work-domain professionals and usability experts categorized and reported each usability issue using the 15 heuristics defined by Muller et al. [10]. In the following enumeration, the 15 heuristics are listed: 1) *System Status*, 2) *Task Sequencing*, 3) *Emergency Exits* 4) *Flexibility and Efficiency of Use*, 5) *Match Between Systems and the Real World,* 6) *Consistency and Standards,* 7) *Recognition rather than Recall,* 8) *Aesthetic and Minimalist Design,* 9) *Help and Documentation,* 10) *Help Users Recognize, Diagnose, and Recover from Errors,* 11) *Error Prevention,* 12) *Skills,* 13) *Pleasurable and Respectful Interaction with the User,* 14) *Quality Work,* 15) *Privacy.*

Every time a usability issue was identified, the usability experts and work domain professionals were requested to grade the usability problem using the following four level severity rating scale: 1) *Cosmetic problem only*, 2) *minor usability problem*, 3) *major usability problem*, and 4) *usability*

catastrophe. By grading the usability problems, it was possible to collect information about how severe the usability problems of the eWALL interface device were.

The usability problems identified and the related severity grade were entered and categorized into columns in a Microsoft Excel worksheet. Subsequently, descriptive statistical visualizations were generated.

III. RESULTS

Fig. 4 shows the number of times each heuristic is used in total for the five experts, in total for the two work domain professionals, and in total for the usability experts and work domain professionals altogether. Heuristic no. 8, *Aesthetic and Minimalist Design* is the most used heuristic among the usability experts. The second most used heuristic is no. 6, *Consistency and Standards*, and the third most used heuristic is no. 5, *Match between the System and the Real World*. In comparison, the work-domain professionals use heuristic no. 6, *Consistency and Standards*, the most, heuristic no. 5, *Match Between the System and the Real World*, the second most and heuristic no. 13, *Pleasure and Respectful Interaction with the User*, the third most.

Fig. 4. *Number of times each heuristic is used in total for the five experts, in total for the two work-domain professionals, and in total for the usability experts combined and work-domain professionals altogether*

The diagram in Fig. 5 visualizes the total number of times each usability expert and work-domain professional has referred to a heuristic. Among the usability experts, the lowest total number of times a usability expert has referred to is 35 and the highest is 55. The difference between the lowest and the highest is 20 references. The work-domain professional no. 1 had the highest total use of heuristics, 91, and usability expert no. 2 had the lowest total use of heuristics, 52. The difference between the lowest and the highest is 39.
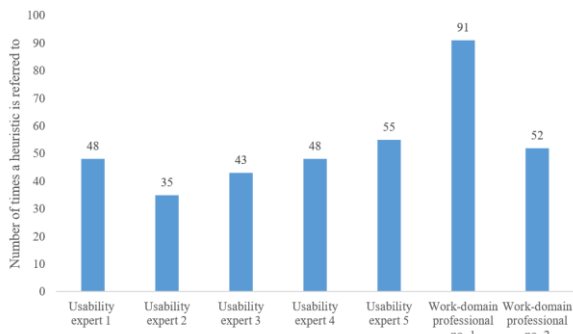
Fig. 5. *Number of times each usability expert and work-domain professional has referred to a heuristic*

Fig. 6 shows the total use of heuristics for each usability expert visualized in percent. Expert no. 2 represents the lowest, 15% of the total, and expert no. 5 represents the highest, 24% of the total.
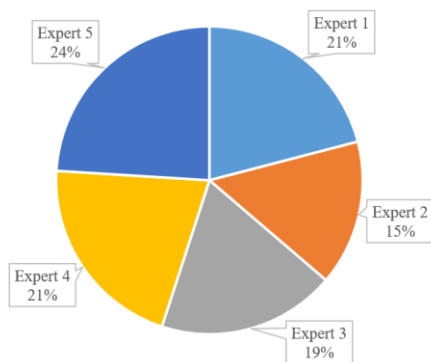

Fig. 6. *Total use of heuristics for each usability expert visualized in percent*

Figure 7 visualizes each work-domain professionals' total use of heuristics during the Participatory Heuristic Evaluation. The work-doman professional no. 1 represents 64% of the total use of heuristics. In comparison, work-domain professional no. 2 represents 36% of the total.
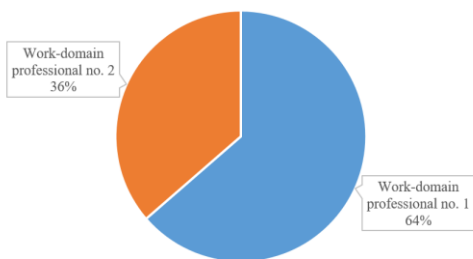

Fig. 7. *Total use of heuristics for each work-domain professional visualized in percent*

Fig. 7 shows the number of times each severity grade was used by the usability experts and by the work domain professionals.

For both groups, severity grade no. 3, *major usability problem*, was the most used and severity grade 4, *usability catastrophe*, was the second most used.

Fig. 8. *Number of times each severity grade was used by the usability experts and by the work domain professionals*

DISCUSSION

The aim of the present study was to report the results and benefits of conducting a Participatory Heuristic Evaluation on the eWALL interface application. In the Participatory Heuristic Evaluation, five usability experts and two work domain professionals were invited to participate. The five usability experts had theoretical knowledge in the field of usability and interface applications and the two work domain professionals had more practical knowledge in the domain area. The two groups of experts represented quite different perspectives when doing the Participatory Heuristic Evaluation.

The main results of the study showed a difference when comparing the most used heuristic given by the usability experts and the work-domain professionals. This might be seen as an illustration of how the work-domain professionals probably have a very strong focus on a respectful interaction with the user, where the usability experts are having a more theoretical approach, which is focused more on aesthetics and a minimalistic design.

When it comes to the distribution between the use of the severity grades between the usability experts and the work domain professionals, there seems to be an agreement between the two groups that the eWALL interface applications contains severe usability problems. 66 times did the usability experts refer to the severity grade 3 *major usability problem* and 68 times did the work-domain professionals refer to the same grade (see Fig. 8). For both groups the severity grade number 3 and 4 were more used than the lower severity grade 1 and 2.

Developing a system requires several phases of testing and rounds of iterations [12,13]. This study is the first iteration in the development phase of the eWALL interface application. The results from the study indicate that there is a need for more iterations. According to the usability expert Jakob Nielsen it is mandatory to evaluate a system during the development phase because potential usability irritations can be more easily removed and thereby help to keep the users interested in using the system [14].

In the present study, the Participatory Heuristic Evaluation was performed on the eWALL interface application. The

strength of using the extended technique is that the system will be evaluated from more perspectives – both more theoretical and more practical perspectives. Another strength of the study is that by using heuristics, it is possible to collect quantified data, because the usability experts categorize each problem into a heuristic and a severity rate. Finally, it is a strength that it is relatively straightforward to perform a Participatory Heuristic Evaluation session – it is the usability experts and work domain professionals who articulate the problems. A potential weakness of the Participatory Heuristic Evaluation is that for sure not all usability issues will be identified. A weakness of the paper is that only two work domain professionals participated. It had been more likely if five work domain professionals had participated in order to have an equal number of usability experts and work domain professionals.

IV. CONCLUSION

Performing a Participatory Heuristic Evaluation on the eWALL interface application has given very usable and relevant results. The usability experts have provided a more theoretical perspective on the eWALL interface application, and the work domain professionals have provided a more practical perspective on what is necessary to improve in the eWALL interface application.

Conducting this Participatory Heuristic Evaluation on the eWALL interface application is the first iteration of the development process towards the final eWALL product. The results indicate a second iteration of the eWALL system.

Future work includes the conduction of a second iteration, and perhaps a third iteration of Participatory Heuristic Evaluation on the eWALL interface application in order to optimize the usability of the final system.

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