Combining user-centered design with the persuasive systems design model

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Combining User-Centered Design with the Persuasive Systems Design Model;

The Development Process of a Web-Based Registration and Monitoring System for Healthcare-Associated Infections in Nursing Homes

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***Abstract* — To improve the usefulness and user-friendliness of eHealth interventions, a framework for the development of eHealth technology has been developed. It combines User-Centered Design with the Persuasive System Design model. The current paper is aimed at offering a (practical) method for the integration of these two design approaches. Via a case study, the paper demonstrates how User-Centered Design and the Persuasive Systems Design model can complement and mutually enrich each other.**

Keywords - User-centered design; Persuasive design; Web-based; eHealth technology

I. INTRODUCTION

In this paper, we present an extended version of work presented at the Sixth International Conference on eHealth, Telemedicine and Social Medicine (eTELEMED 2014) in Barcelona, Spain [1].

In healthcare, and specifically in infection prevention and –control, many apps have been developed. They are intended to improve quality of care and patient safety, but are definitely not always successful. They often don't fit with the way the intended end-users work or think, or they fulfil a non-existent need.

Therefore, the Center for eHealth Research and Disease Management, has developed a framework to develop apps that are successful in daily clinical practice: the CeHRes Roadmap [2]. This framework makes use of User-Centered-Design (UCD) and the Persuasive Systems Design (PSD) model.

Within UCD, during the entire development and design processes of a technology, close cooperation is sought with end-users and other stakeholders. This is done to achieve an optimal fit between the newly developed technology, the context in which it is used and the way the intended end-users work or think [3]. User problems can thus be recognized and prevented. For the prevention of such issues, and to motivate and support the end-users, the PSD model is used [4]. According to this model, technology can be developed with the aim of changing the users' behavior, without using coercion or deception [5][6]. Thus, the technology itself can make a substantial contribution to its own success. We, the Center for eHealth Research and Disease Management, are convinced that the combination of these two models can be of great added value for the development of successful eHealth technology.

This paper describes such a development and design process, with the aim of offering a tool for the development of persuasive and user-friendly eHealth technology. To do so, the different stages of the iterative development process (following the CeHRes Roadmap, see Fig. 1) of a single app is described.

Whereas most development processes start with the design of a technology, we consciously take a step back. The first stage of the CeHRes Roadmap is the *Contextual Inquiry*. In this stage, the developer seeks cooperation with known stakeholders of the technology to explore the context in which the technology must be used, and which preconditions it should meet [2].

Based on the outcomes of this inquiry, and again in cooperation with known stakeholders, it is then studied whether there are any potentially relevant stakeholders missing, and what values and needs they have. This is all done during the stage of *Value Specification* [2].

Then, in the *Design* stage, attention is given to the question of how solutions to the found problems and preconditions can be incorporated within the technology. A prototype of the technology is developed and evaluated by intended end-users [2].

As mentioned before, within this paper, the development process of a single app will be described, i.e., the Prevalence App. Aim of this app is to support Elderly Care Physicians in nursing homes during the registration of their clients during prevalence measurements of Healthcare Associated Infections (HAIs).

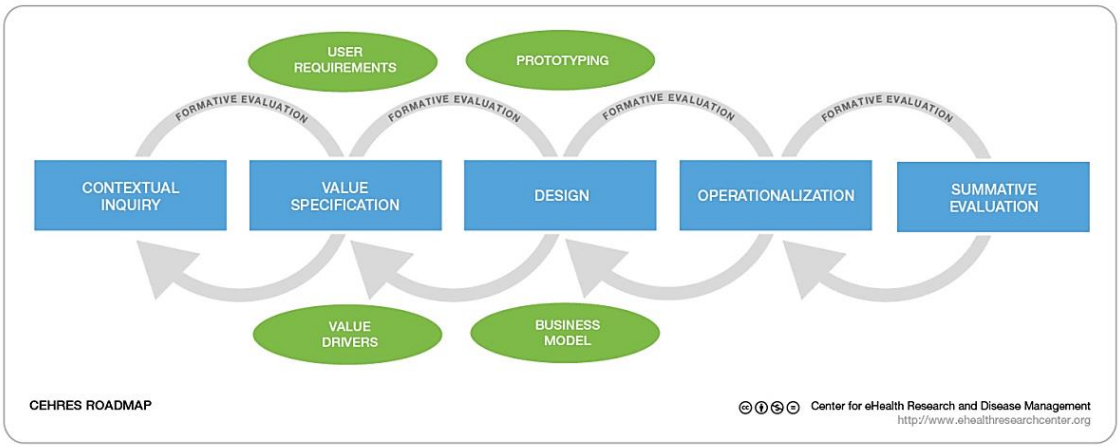

Figure 1. The CeHRes Roadmap [2].

HAIs form an increasingly pressing threat to patient safety [7]. To be able to adequately protect patients against this threat, one of the first steps is to gather knowledge on its occurrence [7]. For hospitals, already a vast amount of surveillance data is available [7][8][9][10][11][12][13]. For other healthcare institutions (such as nursing homes), prevalence studies have more recently begun to take place. The results of the first prevalence study of HAIs in Dutch nursing homes were published in 2011 [14].

To enable prevalence research in nursing homes, data must be collected on all clients that are present in the nursing homes at one point in time. The success of such data collection is entirely dependent on the willingness and capability of the elderly care physicians to register their clients in a correct and timely manner. Preferably, the registered data should be collected in a standardized way to fit other (e.g., nation-wide) surveillance programs [7][8]. The prior registration system consisted of many (often irrelevant) long and very complicated questions, that are prone to interpretation errors. Physicians sometimes doubted the exact meaning of the questions, which could harm the reliability of the data. Registration via this system also took its users quite some time.

The eventual aim of the new registration system is to use user-centered and persuasive design to optimally support nursing home physicians during the registration of their clients in HAI prevalence measurements. However, for the current paper, that is not the main purpose or focus. Here, we describe the process towards achieving such aim. To reach the end goal, our approach is applied. In this paper, we describe how UCD and PSD can together contribute to the development of a successful registration system for HAIs in nursing homes.

The rest of this paper is structured as follows. In Section II, the methods that are used in this study are described: an expert-discussion to gain insight into the current situation (Section II-A); a questionnaire study to analyze the users' needs (Section II-B); in-depth interviews and scenario-based user-tests to analyze the system's user-friendliness and persuasiveness (Section II-C). Then, in Section III, the results of the different parts of the study are described: Section III-A is about the current situation, Section III-B concerns the users' needs and values, and Section III-C goes into the development and evaluation of the prototype. Finally, the study is discussed (Section IV) and conclusions are drawn, about the added value of combining UCD and PSD (Section V).

II. METHODS

Here, the different steps, that are taken to follow the CeHRes Roadmap towards the development of a user friendly and persuasive eHealth technology are described.

A. Contextual Inquiry – An Expert Discussion

This project started with a request from iPrevent [15] to aid in the development of a new 'mobile' registration system. iPrevent is a regional infection control network within which healthcare institutions, elderly care physicians, medical microbiologists and Infection Control Professionals (ICPs) work together to structurally offer high quality care in the field of infection prevention [15].

Instead of immediately initiating the development and design of a technology, the CeHRes approach required us to take a step back, to perform a Contextual Inquiry [2]. Therefore, to gain insight into what iPrevent specifically wants or needs from this project, and into the prerequisites for the registration system, an expert discussion was held.

1) Participants

Participants in the expert discussion were invited to the meeting via e-mail. Two of them are project leaders (a medical microbiologist and an ICP) of the iPrevent network, they are also the initiators of the development of a Prevalence App. One of the project leaders is also the data analyst, who is responsible for collecting, analyzing and reporting the registration data (both for publication purposes and as feedback towards the participating nursing homes). Also, two behavioral researchers, specializing in UCD for persuasive technology, participated in the expert discussion.

2) Procedure

The expert discussion included relatively few people. Therefore, it was decided to keep the setting and discussion informal. The expert discussion thus took the shape of a conversation, during which the behavioral scientists did ask additional questions to acquire all the information that was necessary for the development of a new registration system, e.g., who have an interest in the performance or results of the prevalence measurements, and why.

3) Data-analysis

Notes were made by one of the behavioral researchers, during the entire discussion. These were used to form a 'working document' that would be used as a communication tool (between behavioral researcher and project leaders) during the entire development process. In the document, the outcomes of the discussion were complemented with literature about the registered HAIs and national surveillance programs. This was done to make sure the registration system would fit the context as described by the experts.

B. Value Specification – A Questionnaire

Then, following the CeHRes Roadmap, the Value Specification stage was initiated, to gain insight in what values end-users had (concerning a registration system) and whether the project aims match these values [2]. For this purpose an online questionnaire was developed, based on the results of the Contextual Inquiry.

1) Participants

Elderly care physicians were invited to participate, by one of the project leaders, via e-mail. They were informed about the Prevalence App that was being developed, and that their input was needed to make sure that it would fit their needs and work processes. A total of 24 elderly care physicians, who worked at different nursing homes within the iPrevent network, were willing to participate in the study. Their ages ranged from 30 to 61 (mean age 47 years). Most participants were female (19 female vs. 5 male).

2) Procedure

The invitation e-mail included a direct link to the questionnaire. The questionnaire consisted of some basic questions about the demographics of the respondent, his / her technology use and how the registration is currently being performed. Then, questions were asked about how relevant the physician feels the prevalence measures are, and how, when and via what kind of device the physician prefers to register clients. Additionally, questions were included about what information or feedback the physician expects to get from the registration system and what would motivate them to adopt a new system.

3) Data-analysis

Questionnaire results are analyzed to obtain descriptive statistics. Further statistical analyses were deemed redundant, given the developmental purpose of the study. Answers that are given to open-ended questions, were summarized if they overlapped and then their frequencies were analyzed as an indication of how many respondents share a specific opinion.

C. Design – In-Depth Interviews and Scenario-Based Tests

Next step in combining user-centered and persuasive design, is to start the Design stage of the CeHRes Roadmap [2]. Thus, to validate the questionnaire data and to optimize the user-friendliness and persuasiveness of the prototype, scenario-based user-tests and in-depth interviews with end-users are performed.

1) Participants

Participants were invited to the study by one of the project leaders. If they agreed, they were contacted by the researcher to schedule a meeting at a location that was convenient for the participant. Four female elderly care physicians who worked in different nursing homes within the iPrevent network participated. Their ages varied from 33 to 59 (mean age 45 years). One of the nursing homes they worked at, already used Electronic Client Files (ECFs), the others expected they would start to do so in the near future.

2) Procedure

First of all, a prototype of the Prevalence app was developed, in close cooperation with an ICP, using Balsamiq software [16]. It was based on the outcomes of the expert discussion, about the context of requirements of the registration. The prototype incorporated elements of the PSD model [4]. Not all elements of the PSD model were deemed relevant, only elements that are relevant in this specific context and for this specific app have been applied.

Then, two scenarios were developed to be used in the user-tests. They were developed in close cooperation with an ICP and made use of literature on the HAI definitions. The scenarios addressed critical issues for registration e.g., a client with multiple infections or a lab test that has been performed without the results being known yet.

The physician was instructed to talk out loud during the entire user-test, not only mentioning what she thought, but also what she saw or sought, did or wanted to do during the registration of the fictional client. The entire conversation was audio recorded, with permission of the participant.

3) Data-analysis

The conversations, including both interview and user tests, took about 45-60 minutes each. Audio recordings of the conversations were transcribed verbatim and analysed using a code book, which aided in the structuring of data. Some examples of the codes are given in Table 1. All codes were combined and the frequencies with which they were mentioned were analysed.

TABLE I. EXAMPLES OF CODES USED FOR ANALYSIS OF USER-TESTS

Examples of codes used for data-analysis		
Category	***Code***	***Description***
Contextual Inquiry	C1	Subject describes a problem that is experienced in the current work process
Value Specification	V1	Subject thinks working with the new system might be faster
Design	D1	Subject thinks the order of the items in the mock up is wrong
Operationalization	O1	Subjects talks about a possible barrier for using the new system

III. RESULTS

Aim of the current paper is to describe how UCD and the PSD model can simultaneously and complementarily be applied, to develop successful eHealth technology. For that purpose, the development process of the Prevalence app is used. In this section, we will describe the results that were rendered during the different stages of the CeHRes Roadmap.

A. Contextual Inquiry – Description of the current situation

First of all, the Contextual Inquiry generated more in-depth insight into the current situation (the situation prior to the development of a new registration system).

iPrevent has, over the last years, worked together with the approximately 30 nursing homes within their network, to perform annual prevalence measurements for HAIs in nursing homes. This implies that the elderly care physicians are required to once a year register all relevant data about the residents that live in their nursing homes. This not only entails information about the presence of HAIs, but also about the presence of risk factors for the occurrence or spread of infections. Risk factors are e.g., the use of antibiotics or catheters, or staying in a room with multiple other clients. Inherent to the fact that it is a prevalence measurement, all clients must be registered within a short timeframe around a reference date.

The content of the registered data is largely determined by the given definitions of HAIs. These definitions were developed by the regional network in cooperation with the national surveillance system (PREZIES) [17]. In the hospital setting, surveillance is performed by trained infection control nurses. The use of the definitions in the nursing home setting, where registration is performed by physicians with little or no experience with surveillance, registration is far more complicated. The prior registration system directly used the definitions of HAI as questions. It did not, however, offer additional explanation or clarification about their meaning, or any other kind of support with answering the questions. Physicians had indicated that they sometimes debated with their colleagues about how to interpret and answer a certain question (see Quote 1). This, of course, caused some issues with standardization and analysis of data.

> (Quote 1 – Originally in Dutch) "[…]The way the questions are asked. They are not always clear, and that's important. Now, I sometimes have to go to one of my colleagues to ask them, like: hey, how do you answer this? And it is important, that everyone registers in the same way."

The prior registration system consisted of an online questionnaire, developed by experts in the field of Infection Prevention and Control. The questionnaire consisted of a long list of complicated questions (see for example the screenshot of the prior registration system in Fig. 2). Many of them are irrelevant for most residents. For example, if a client does not use an antibiotic, the question about what an antibiotic is used for, is rather redundant. Also, most questions were presented on a single page. Physicians thus had to scroll down for quite some time. They had to read all questions, including irrelevant ones, to check whether they applied to the client.

Figure 2. Screenshot of the prior registration system

Furthermore, an increasing amount of nursing homes (>30) participate in the prevalence measurements that iPrevent performs. Thus, increasingly large datasets are collected. Data processing, data analysis and presentation of feedback of the results to the nursing homes were all performed by a single data-analyst. This will soon no longer be feasible. Therefore, project leaders (and the data-analyst) would like the system to perform these tasks automatically.

Finally, project leaders requested that the new system would be 'mobile' (to be used on a smartphone) to enable bedside registration of clients by elderly care physicians.

B. Value Specification – Users' Needs and Values

For the second stage of the CeHRes Roadmap, the questionnaire that was used resulted in insight in the users' values and needs.

First of all, most (83,3% out of 24) participants indicated that they did consider prevalence measurements of HAIs in the nursing home setting to be relevant. They found it important since it contributes to gaining insight into the current status of HAIs in nursing homes, and enables organizational policies to be adapted to the findings. One of

the participants also considered it to be of great importance for the quality of care (see Quote 2).

> (Quote 2 – Originally in Dutch) "Thus far, too little research has been performed, among the nursing home population, to be able to act in a meaningful and evidence based way."

When asked what kind of device they would like to use for the registration, most subjects indicated they preferred a PC (50,0%) or laptop (20,8%). The other subjects preferred to use a smartphone (12,5%), tablet (8,3%), or paper (8,3%).

Most important reasons for users to be willing to use the new registration system were: (1) if they can interrupt registration without losing data; (2) if the new system is more user friendly; (3) if it can be opened simultaneously with ECFs; (4) if clear insight is given in the results; and (5) if registration can be performed faster.

One of the prerequisites that were found during the expert discussion said that it would be desirable if registration could be performed at the residents' bedside. This would enable the physicians to directly see how the resident is doing. However, the questionnaire showed that none of the physicians considered this to be desirable. Most of them (54,2%) did indicate that it would be of added value for them to be more flexible in the location in which they register their clients, but didn't want to do so at bedside. Also, 41,7% said that it would not be of added value at all since they just liked to register their residents in their offices. One physician (4,2%) wanted to register her clients in the department's office, with the client files at hand.

The in-depth interviews gave even more insight into the situation. The clients that are to be registered with the prevalence app are mainly elderly people, who have health issues. Unfortunately, these elderly clients are quite often also somewhat lonely. So, upon doing their rounds or checking up on their clients, the elderly care physicians had experienced that clients were in need of attention and wanted to interact with them. The physicians felt it would be poor bedside manners to be standing next to a client, while being entirely focused on the registration. At the same time, if they were to pay more attention to the client, they feared that the registration would take up to much time, or would be prone to errors due to a lack of concentration. They are therefore opposed to bedside registration of clients.

At the same time, physicians did indicate that being 'mobile' during registration would have advantages. They explained that their nursing homes were (going to be) using ECFs. This is software that contains highly personal and private information about the residents. Therefore, many safety measures have been taken to protect this information. Because of one of these safety measures it is impossible to simultaneously open the ECF and the World Wide Web. In practice, this meant that elderly care physicians had to open the ECF, and write down all the information about all of their clients that they needed to register in the prevalence measurements. Then they had to close the ECF, open the registration system and enter the information they had written down. Not to mention that if they had forgotten any information, the entire procedure had to be repeated. Therefore, some subjects did want registration to be possible on a mobile device, but for reasons that differed from what was expected, i.e., so they could simultaneously open the ECF on their pc and the registration system on the other device.

C. Design – Developing and evaluating a prototype

The results that were generated in the Design stage are twofold: (1) we can now describe how we applied certain elements of the PSD model to the prototype of the prevalence; and (2) we can make a brief analysis of the user-friendliness and perceived persuasiveness of the prototype of the app.

1) The use of the PSD model in the Prototype

Here, a description is given of how elements of the PSD model were incorporated in the prototype. This is intended to benefit other eHealth technology developers, who might use it as an example for how the theoretical constructs of the PSD model can be applied in practice.

a) Primary Task Support

One of the main concerns with working with the prior registration system was that working with it required the physician to read through many irrelevant questions for every client. One of the most important elements of PSD that were to be used in the new system was therefore *tunneling* [4]. Tunneling is defined by Oinas-Kukkonen and Harjumaa as 'Using the system to guide users through a process or experience' [4]. The prototype system was designed to guide the user through the process of registration: questions to be answered are dependent on the answers given to prior questions. Thus, the entire system is one big decision tree, to make sure every client is registered via the shortest (fastest) possible route.

Another concern with the prior registration system was the complexity of the used questions, a single question could actually consist of multiple individual questions (see for example Quote 3). To reduce the complexity, and thus the risk of interpretation errors, *reduction* was used. The aim of reduction is 'to reduce complex behavior into simple tasks, to help users perform the target behavior' [4]. This was done by translating complex and long questions into multiple shorter and easier questions with a routing structure between them. For example, the originally used question for Gastro-Enteritis, was rather lengthy and complicated (see Quote 3).

Does the resident have Gastro-Enteritis? The diagnosis Gastro-Enteritis is given if one of the following symptoms occurs in the client:

- Three times or more diarrhea (different from normal for this client, frequency is not applicable when using incontinence materials)
- Diarrhea and two of the following symptoms: fever, vomiting, nausea, stomach ache, stomach cramps, blood or mucus in feces.
- Vomiting three times within 24 hours, without any additional symptoms (if vomiting is not associated with medicine use)
- Vomiting and two of the following symptoms: fever, nausea, stomach ache, stomach cramps, blood or mucus in feces.

Quote 3. Question about Gastro-Enteritis in the prior registration system (Originally in Dutch)

The different elements of this one question were split up into multiple questions. These were one-by-one presented to the users. A build-in logic system directed the users to the appropriate follow-up questions on different screens. Some of these screens are shown in Fig. 3.

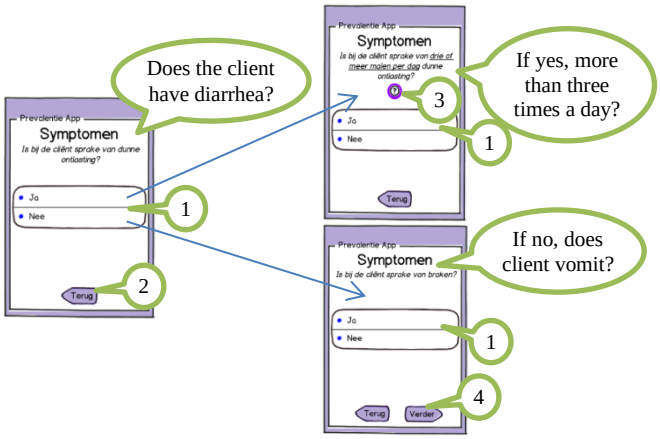

Figure 3. Part of the screens of the prototype used for Gastro-Enteritis; Example of Reduction: *(1) Answer options: Yes / No; (2) Button to return to previous screen; (3) Help-button for additional information; (4) Button to continue to next screen.*

As mentioned before, it was of great importance that registration would be faster and could be paused without losing data. To enable this, elements of *tailoring* are applied to the prototype. Tailoring, according to Oinas-Kukkonen and Harjumaa, stands for 'the adaptation of the offered information to the potential needs, interests, personality, usage context, or other factors relevant to a user group' [4]. In this case, the system tailored the information to the usage context factors. Every nursing home was given a unique log-in code and password. A physician had to log-in once, and was then able to continue registering their clients one after another. Moreover, when starting the system, physicians are given two options: to register a new client or to edit data of an existing client (see Fig. 4). For the latter, an overview was generated of all clients that had previously been registered by that specific nursing home. Clients of other nursing homes are not shown. By selecting a client, their data are shown and can be adjusted.

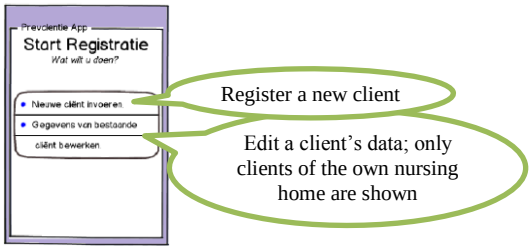

Figure 4. Example of a screen that leads to Tailored information

b) Dialogue Support

Dialogue support stands for the feedback that a system gives to its users, to help them keep moving towards their goal (completing the registration) [4]. In this case, the prototype registration system requires physicians to indicate which pathogens caused an infection. However, during the user tests it became clear that within nursing homes, little funding is available to perform the laboratory tests to acquire this knowledge. Furthermore, if a laboratory test was performed at the moment of registration, its results were not always known yet. Therefore, in the final registration system, questions are added to ask whether a laboratory test was performed. If yes, the system inquires whether its results are already known. If the latter question was answered with 'no' a pop-up screen appeared. This screen *reminder* was shown, which means that the system reminds its users of their target behaviour [4]. In this case, the reminder made the physician aware that lab results should be added later.

Also, *suggestion* [4] is added to the final registration system. According to Oinas-Kukkonen and Harjumaa 'systems offering fitting suggestions will have greater persuasive powers' [4]. Within the prevalence app, this is done by letting the system offer fitting suggestions for reaching the goal of registering clients. A suggestion might concern a suggested behaviour, but in the case of the prevalence app, it consisted of suggestions in the sense of finishing the words that the user started to type. For example, physicians have to register all antibiotics that are used by their clients. However, the variety of antibiotics that exist is enormous and their names are complex. Initially, the intention was to let physicians scroll through an alphabetical list of generic names of all available antibiotics (see Fig. 5).

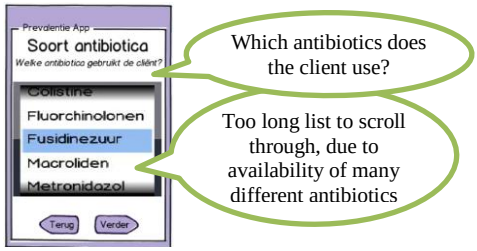

Figure 5. Example of the screen that subscribes the need for Suggestion

However, due to the large number of antibiotics that are available, this was still too time consuming. Therefore, in the final registration system, a search system in which the physician enters the first three letters of the antibiotic is added. The system then automatically generates only antibiotics that start with these letters. The same search system was then used for selecting the pathogens that have caused the infection.

c) System Credibility Support

Finally, in healthcare in general and for the registration of HAIs in nursing homes specifically, it is of great importance that the system is credible according to its users. Therefore, a website was created about the services provided by the registration system [18]. The Infection Manager website was developed within the (INTERREG IVa) EurSafety Health-net project [19]. This is a large and successful European cross-border project, involving many hospitals, microbiology laboratories and other healthcare institutions. It aims to increase patient safety by preventing (the spread of) HAIs. The part of the Infection Manager website about the registration system consists of e.g., background information about the project and the parties that were involved in the development process. This was intended to give more clarity about the *trustworthiness* and *expertise* of the project and its project members [4].

Lastly, in the final registration system, it was decided to add the EurSafety Health-net logo, to give the system more *surface credibility* [4]. This entails the initial assessment that users make about the credibility of the system, based on first hand inspection [4].

2) Analysis of the User-Friendliness of the Prototype

User-testing the developed prototype, is aimed at evaluating whether the elements of PSD have indeed contributed to the development of a user-friendly and persuasive eHealth technology.

Based on the performed user-centered scenario-tests, we found that issues with the prior registration system had indeed been resolved, or had at least been improved. For example, to implement the concept of tailoring, elderly care physicians now had to log-in to be able to register their clients. Besides allowing us to tailor the presented information, it also had other (unintended) benefits: some questions had become redundant, which could possibly speed-up the registration process (see Quote 4).

(Quote 4 – Originally in Dutch) "Cause now, I have to indicate every time: Nursing home X, Department so-and-so. But we fill in the registration for one entire department. So it saves time if we would only have to fill it in once."

According to the physicians, an additional advantage of the log-in system, is that registration can be paused without losing the data (see Quote 5).

(Quote 5 – Originally in Dutch) "Well, the advantage is that one can keep adding (new) clients. You could for example continue at a later moment. Such as when you only have time to complete the registration of 10 clients, then register 10 now, and just continue two hours later."

Still, major and minor adjustments had to be made in the mock ups. These concerned the clarity of wording, sequence of questions, completeness, user-friendliness, design and location of the buttons. For example, initially, there were two screens in our prototype for 'Aids', which asks whether the client uses any aids such as a catheter or tracheotomy; and 'Incontinence', which asks whether the client is incontinent. During the user-tests, the subjects had several comments about these screens. First of all, whereas we interpreted the term 'aid' as being a catheter of some kind, the subjects indicated that the term 'aid' to them meant 'walker' (see Quote 6). So, they suggested using a different term.

(Quote 6 – Originally in Dutch) "Yes, we use the word 'Aid' for something completely different. We use this word for walkers. So I would try to come up with a different word here."

Furthermore, they found the screen about incontinence unclear. In one of the scenarios, a client was described who had a catheter. The participants indicated that, although incontinence is a possible reason for clients to get a catheter, they did not consider this client as being incontinent anymore (see Quote 7). Therefore, they said the option of having a catheter or stoma should be added to this screen.

(Quote 7 – Originally in Dutch) "You see, this client is not incontinent, but has a urethra catheter… So this is strange. You should add catheter here I guess. Because with a catheter you are not really incontinent anymore."

As a result, the two screens where replaced by a new screen. This screen asks whether a client is incontinent. However, an additional answer option has been added, to indicate that a client has a catheter or stoma.

After the fourth user-test, no major issues where found anymore. Therefore, meetings with Information and Communication Technology (ICT) developers were held to

further discuss how to incorporate the requirements into the registration system and to finally develop it.

IV. DISCUSSION

As far as the authors know, this study was the first to demonstrate how User-Centered Design (UCD) and the Persuasive Systems Design (PSD) model can be combined, and can even complement each other, in the development of easy to use eHealth technology. It was intended to provide insight into the steps that might be taken for applying elements of the PSD model during the developmental stages of an eHealth technology. It did so, by describing the development process of a single app: the Prevalence App.

First of all, the use of UCD has proven its benefits: the constant and structural cooperation with end-users during the development process, gave us the opportunity to make it an iterative and reflexive process. This means that it was possible to evaluate the eHealth technology with end-users, in every stage of its development, and to (at any time) adjust the direction that it was going in. This aids in the dynamic development of an eHealth technology that fits its users' needs and context, and could potentially prevent high costs of re-design if major necessary adjustments are only found after final release of the technology.

Second, this paper has shown that the PSD model is indeed useful and applicable for the design of any kind of eHealth technology. However, and more importantly, we believe that it is the combination of the two theoretical frameworks above, within the CeHRes Roadmap, that has proven to be of the greatest added value. We feel that by 'simply' applying the PSD model to an eHealth technology, one would not be using it to its full potential. Merely incorporating elements of the PSD model in eHealth technology, does not necessarily mean that the end-users of the technology also have a need for these elements. If there is no such need, developers are at risk of using sledgehammers to crack nuts, to be greatly overreaching themselves. This paper has demonstrated that the success of a technology is not dependent on the quantity of persuasive elements that are used. Rather, the key to success is to use elements of the PSD model in a focused and user-centered manner. This is why the combination with UCD is so beneficial. Using UCD, for instance in the form of scenario-based user-tests, developers can expose which elements of the PSD model should be used, to cope with any kind of usability issues and to create an optimal fit with the end-users.

In their paper, Oinas Kukkonen and Harjumaa present the PSD model as being part of development process [4]. They indicate that before the actual design of the technology, the first step in that development should be to understand 'fundamental issues behind the persuasive systems' [4]. Then, 'the context for persuasive systems needs to be analyzed, recognizing the intent, event, and strategies for the use of a persuasive system' [4]. The integration of the PSD model within the Contextual Inquiry, Value Specification and Design stages of the CeHRes Roadmap offers a structure for the application of these steps in the development of a successful eHealth technology. It offers a practical framework by which elements of the PSD model can be used in practice.

We believe that the holistic approach using the CeHRes roadmap, has provided the opportunity to further ground the PSD model. It has proven to be a very suitable tool to integrate UCD and the PSD model in a way that developers not only profit of their individual strengths, but were they also complement and further strengthen each other. Via UCD, for which we used e.g., scenario-based tests, we found essential issues during the use of the prototype. Via the PSD model, we were able to address these issues, and to eliminate or at least decrease their presence.

Thanks to the CeHRes Roadmap, we developed a registration system to optimally support elderly care physicians in the correct and timely registration of their clients, taking into account the national prevalence studies [7][8] with which collected data should be compatible. Certainly, we still want to evaluate the speed, user-friendliness, fit with work processes, ease of use, clarity and persuasiveness of the final registration system. Thus, a summative evaluation is currently being planned. This evaluation will combine both qualitative and quantitative methods and will e.g., focus on user friendliness, speed of registration (both were found important by the end-users) and amount of errors that are made (important for the quality of the data). But for now, it can be said that the new system has already been used in two rounds of prevalence measurements, successfully registering over 3000 nursing home residents. It is web-based, so it can be used on any device capable of connecting to the world wide web. An example of a screen of the eventual registration system is given in Fig. 6.

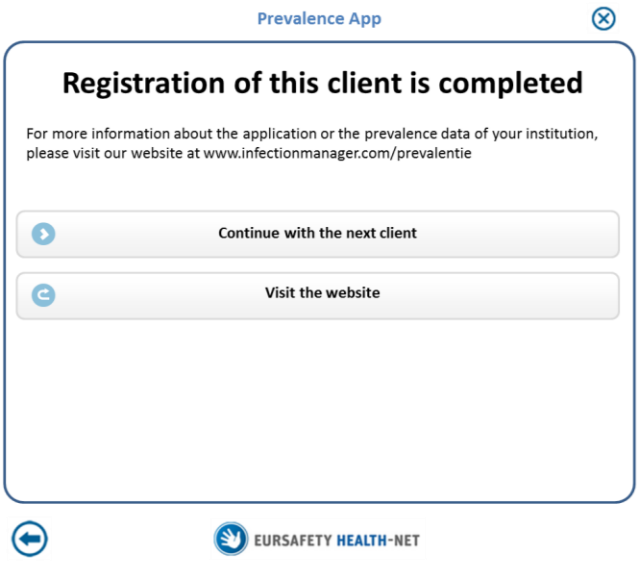

Figure 6. Example of the look and feel of the eventual registration system (Originally in Dutch)

A. Limitations

A limitation of this study is that it suffered from very strict and ambitious deadlines. This limited us in the amount of effort that we could put into the implementation stage of the development. Although this is thought to be a very relevant stage according to the CeHRes Roadmap, in this project its influence might be limited. The elderly care physicians who are the end-users of the registration system in this study, are obligated to use it if their nursing home participates in the prevalence measurements.

Another possible limitation might be that our study had a relatively low number of participants. However, aim of this study was solely the serve as an example of a development process of an eHealth technology, not to perform an evaluation of its effects.

Also, the prevalence measurements have to be suited to be used in national surveillance (by PREZIES). Therefore, the new registration system has to meet certain requirements (e.g., data that must be collected, or in what form). Thus, in this case, and in most cases where a new eHealth technology is being developed, legislation was part of our Contextual Inquiry and also may have had an influence on the design of the technology.

Finally, the given setting for this project (nursing homes) presented us with its very own challenges. The opportunities for using technology were limited, because of the technological infrastructure of Dutch nursing homes (wherein often outdated PCs are used), and the degree to which people are used to working with technology (e.g., only 47,1% of the physicians used a smartphone). However, this gave us an interesting opportunity to put ourselves and the possibilities of the CeHRes Roadmap to the test, to see how it and how we would cope with such limitations.

V. CONCLUSION

This article goes beyond the mere development of eHealth technologies. It has subscribed our strong believe that combining UCD and the PSD model is of paramount importance for the creation of successful and persuasive eHealth technologies, because (1) UCD gives insight in the needs and wishes of the end-users, that have to be met by the eHealth technology; (2) the PSD model offers opportunities to deal with the issues and needs that are found using UCD; and (3) although they might have used their own words to express themselves, end-users appeared to have very clear ideas about the their needs regarding Persuasive Systems Design.

Also, our approach, using the CeHRes Roadmap has allowed for the development to be an iterative process, which may prevent costly redesign to be necessary.

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