User Interface Evaluation of a Ski Injuries Management System

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Abstract. Although many technological devices and solutions to enhance the skiing experience are now available for skiers, skiing sometimes could turn to be potentially dangerous. The speed of movement, environment unpredictability, and variable weather conditions, among others, can contribute to some of the most common skiing injuries that skiers incur. In this paper, we conduct an interface prototype evaluation of a ski injury registration system architecture that is already developed. This system will improve the communication from the ski resort to the medical center, in case an injury has occurred. The results of the interface evaluation indicate that the ski patrollers showed very positive attitude and experience with this prototype. Furthermore, the post-task and SUS (System Usability Scale) question results showed very high score for all participants, indicating that locating the body parts and the right injury was very easy using the interface.

Keywords: ski patroller, user interface, usability analysis, mobile app.

1 Introduction

Skiing is very popular recreational activity that brings people together to enjoy and carry out physical exercises. This popularity is also related to injuries, which sometimes may be even fatal for skiers. Skiers experience variable terrain and weather conditions, high speeds, and obstacles including other people and structures (e.g., trees, fences, poles), all increasing the chance of a severe injury [1].

Today, the use of mobile devices and applications (*mHealth*) in healthcare have become a global reality. *mHealth* and cloud computing can offer the potential to extend the scope of health services, efficiently deliver and access the care and make the healthcare better and cheaper. Inspired by the need of integrating *mHealth* apps in managing skiing injuries to provide higher healthcare service quality and faster availability

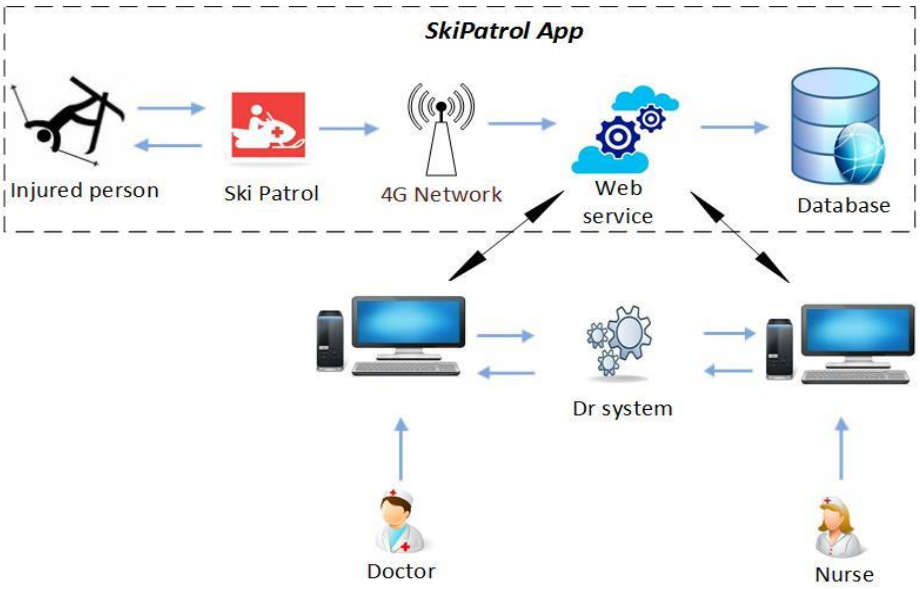

Fig. 1. Workflow scenario of the ski injury registration system.

of data, we have developed and presented a system architecture for ski injury registration [2]. The workflow scenario of the system is presented in Figure 1.

As shown in figure 1, using the SkiPatrol App the ski patroller is able to provide patient information to doctors at health centers in a timely manner. Consequently, the system greatly simplifies the workflow between ski patrollers and medical staff as well as it helps improve the delivery of healthcare services. An example for such improvement is whether the injured person can be treated at a local center or should be directly transferred to a fully equipped hospital. Another benefit would be the proper scheduling of medical personnel in expectation of a certain number of injuries due to certain indicators e.g. month of season, precipitation level, temperature.

The described system has only been tested preliminarily, and the main goal of this paper is to conduct an interface evaluation analysis of the ski injury registration system for further development. We present the screenshots of the app developed and describe the specifications for the ski patrol interface. The ski patrol app requirements were generated by observing the working conditions of ski patrols in the mountains of Trysil, Norway. Our aim is to find out whether the existing app interface is satisfactory for the users and whether there is need for any improvements.

The rest of the paper is structured as follow: in section 2, we present the related work in the field. Section 3 provides a description of the interface design, whereas section 4 presents the experimental setting. In section 5, we present the findings and discussions. Lastly, section 6 concludes this paper.

2 Related Work

In recent years the research community has presented many alternatives to support various aspects of developing mobile healthcare system [3],[4],[5],[6],[7],[8],[9]. Pflegning and Schmidt in a seminal paper describe the ways of enhancing the ski experience by applying ubiquitous connectivity [10].

Fedosov et al. [11] discuss empirical findings related to challenges and opportunities to using personal and situated devices on ski lifts. Authors also propose possible applications that could support user needs and enhance the overall skiing experience. Fedosov and Langheinrich [12] provide some design ideas for mobile and wearable devices to enhance group-sharing behavior in a skiing community. This work reports result of an exploratory research study conducted with seven experienced skiers and discovered that sharing information is a fundamental pillar that contributes to a positive skiing experience. Another research work, proposed by [13] is performed in ski injury analysis and a decision guidance support system is under development for early warning for ski injuries. Depending on the movement of skiers, the system is able to calculate average speed of skier, average weight of slopes, etc.

As far as the technological devices are considered, devices as Penetrometer [14] warns the participants for an avalanche or accident, and RECCO system [15] can also help enhance skiing safety. The RECCO detector, which is a small reflector included in ski clothes, such as coats, echoes the signal of radar carried by ski patrol or other rescue teams when an avalanche has buried someone.

Nevertheless, very scarce is the research addressing the challenges and benefits of existing systems for digital management of ski injuries using mobile apps [16], [17]. In his study, Jeppesen in [17] identified a need for better management of ski injury related data when doing research on ski injuries at the local ski resort. The result of that research showed an under reporting of potential severe injuries by approximately 50%, due to the limitations of using a paper based system.

The main challenge of such a system lies in delivering of treatment with reasonable response time, free of errors, and with proper use of human resources. In order to achieve such goal, we have designed, developed and introduced a complete system architecture that addresses these challenges [2]. The advantage of such a system would be availability of data concerning each injury, such as injured person related information and suspected injury type to medical personnel in advance. The system also addresses the instant transfer of person to a convenient health institution immediately when the incident occurs. In addition to addressing the stated challenges, the system also provides statistical data (e.g. the number of injured people per month of a season), which could be useful in predicting skiing injuries [18], [19], or in the planning of health and emergency services locally or nationally.

3 User Interface Design and Interactions

The user interface design and interactions were conceptualized for increased usability, while maintaining its simplistic appeal. The interactions implemented in the interface

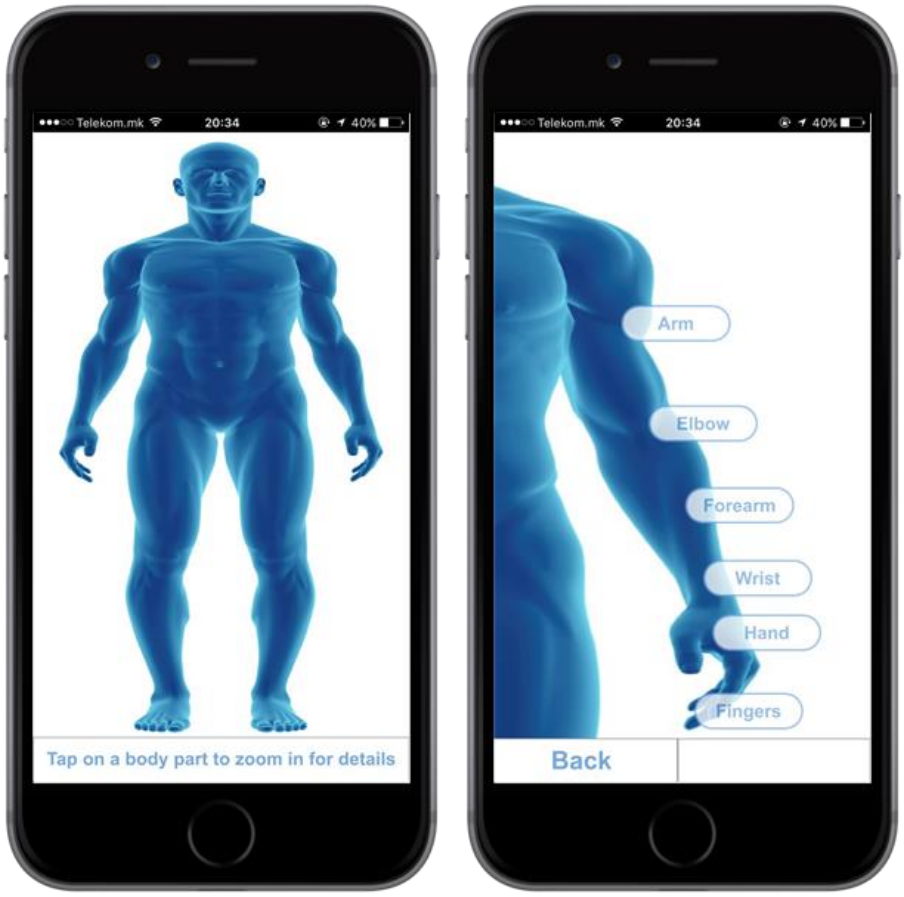

Fig. 2. User interface: a) full body image b) left arm image

involve only tapping on objects visible on the screen. Other interactions, such as, swipe, pinch or other complicated actions involving two or more fingers, purposefully have not been considered in our design to eliminate difficulties likely to occur when interacting in cold weather conditions, e.g., while wearing gloves.

After the initial login page requiring user's credentials, the interface displays a full body image as shown in Figure 2a. To access details of a particular body part, the user is required to tap on a specific part (head, neck, shoulder, chest, stomach and extremities). For instance, when a user single taps on the left arm of Figure 2a, the zoomed-in image of left arm with details is shown as in Figure 2b. Alternatively, tapping on the left leg, shows more details such as knee, heel, etc., as depicted in Figure 3a. The user then could tap on the labels (e.g., knee, heel, etc.) in the zoomed-in image of the left leg to indicate an injury of that body part. Once the appropriate label is tapped upon, the user is automatically forwarded to the next screen where she/he could record person's injury information, as shown in Figure 3b. Here, the user selects the type of injury,

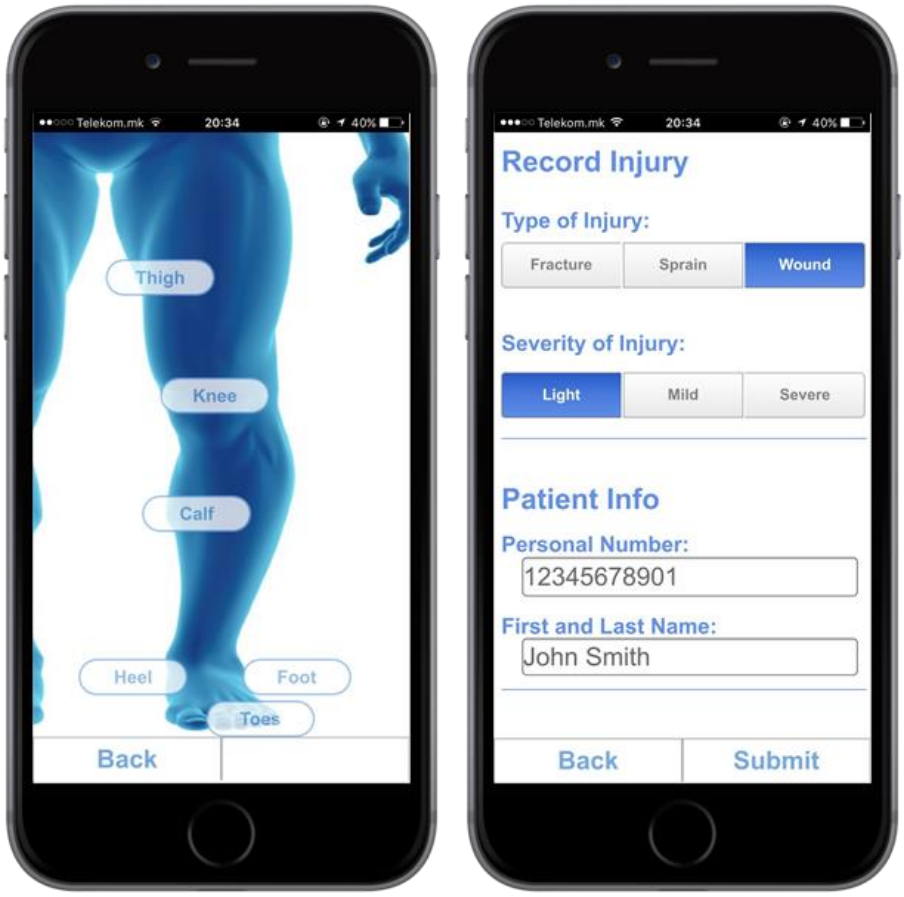

Fig. 3. User interface: a) left leg image b) information on injured person

its severity, and confirm personal information for the injured person, which is already provided by the interface prototype. The same process is followed for the other body parts as well. This step completes the data gathering and the user has the option to submit the data or to return to the latest screen to make a change.

In this version of the prototype, we did not explore the part when the user enters patient's personal information, thus data input is simulated by the prototype. Considering that typing is difficult in cold weather conditions, other modalities should be explored. We discuss this further in section 5.

4 Experimental Design

4.1 Overview

In order to evaluate the initial proposed design of the interface prototype, we conducted a preliminary evaluation with people who do ski patrolling and are familiar with the context in which this app will be typically used. The experimental design required participants to complete two tasks, three questions after each task, and 10 standardized questions from the system usability scale (SUS) questionnaire. Participants were also encouraged to provide comments. We used an iPhone 6+ as a device to test the prototype.

4.2 Participants

Three professional ski-patrolling participants used our prototype in two different ski resorts in Macedonia. Two participants were between 30 and 40 years old, while one of them was in his late twenties. Two participants had two-to-four years of experience in ski patrolling, while one had five-to-ten years. They all had five-to-ten years of experience of using smartphones.

4.3 Procedure and data collection

The evaluation of the prototype was conducted in two steps. First, participants were asked to perform two tasks and answer three questions after each task. We judged that providing two tasks was optimal due to the simplicity of the interface. The following were the tasks:

Task 1: While ski patrolling, you have just found an injured person, who has injured his left elbow. More specifically, he has suffered a mild fracture. Report this using the app.

Task 2: After reporting the first injury, you actually see that the person has also a light wound on his right knee. Please, report it using the app.

After the participants completed each of the task, we asked them three questions to judge the immediate user experience with the tasks. On a 5-point Likert scale ranging from Strongly Disagree to Strongly Agree, participants were asked the following questions:

Q1: Was it easy to locate the body part, in this case, left elbow?

[right knee, task 2]

Q2: Was it easy to locate the right injury, in this case, mild fracture?

[light wound, task 2]

Q3: Overall, was it easy to complete this task?

After the completion of the tasks and related post-task questions, as a following step, we administered a SUS questionnaire in order to assess the user experience with the current version of the prototype's interface. The goal was to capture participants' overall experience concerning their interaction with the interface for the ski patrol app. The standard version of the SUS questionnaire was used as shown in Table 1.

5 Findings and Discussion

The results of the preliminary user evaluation of our ski injury management prototype interface indicate very positive attitude and experience from our participants. The post-task question results showed very high score for all participants, indicating that locating the body parts and the right injury was very easy using the interface.

The SUS questionnaire results were analyzed using the methodology described in [20]. The results show very high percentiles (over 90) for all three participants as shown in Figure 4. This is an indication that users highly rated the interface and are likely to recommend it to others. Further details for each question and participant are shown in Table 1.

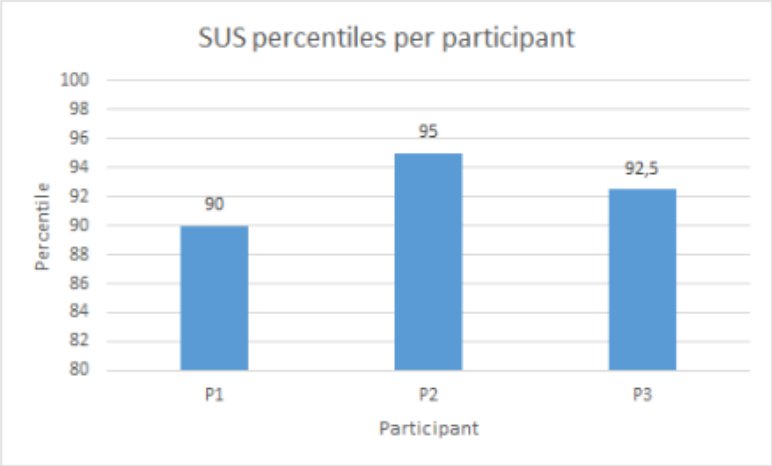

Fig. 4. SUS percentiles per participant

The participant with lowest score (P1: 90) provided comments explaining in his view the weakest points of the prototype. A very accurate observation from him was that the prototype in its current version provides only frontal body parts and extremities, but not the back. The participant commented that the interface should be more comprehensive and provide a way to report injuries of the back, such as, the spinal cord and lower back parts, including hips and buttocks. Additionally, this participant explained that the internet access is limited in some parts of the ski trails, thus the application should consider this and provide offline mode of operation. Other participants gave generally positive comments with one participant expressing that the image of the body shown on the prototype should show more natural skin colors.

Table 1. SUS questions and scores for each participant.

SUS Questions	P1	P2	P3	AVG
1. I think that I would like to use this app frequently	4	5	5	4,67
2. I found the app unnecessarily complex	1	2	2	1,67
3. I thought the app was easy to use	5	5	5	5,00
4. I think that I would need the support of a technical person to be able to use this app	1	1	1	1,00
5. I found the various functions in this app were well integrated	3	4	4	3,67
6. I thought there was too much inconsistency in this app	1	1	1	1,00
7. I would imagine that most people would learn to use this app very quickly	5	5	5	5,00
8. I found the app very cumbersome to use	1	1	1	1,00
9. I felt very confident using the app	4	5	5	4,67
10. I needed to learn a lot of things before I could get going with this app	1	1	2	1,33
Percentile SUS Score	**90**	**95**	**92,5**	

One important aspect that we did not explore using this version of the interface prototype is inputting patient's personal data. Given the device's small screen and the harsh weather conditions this app is typically used, which imposes use of gloves, the traditional data input using keyboard and letter typing is not ideal. For this reason, the prototype excludes inputting textual information using keyboard and letter typing. At this stage, our goal was to only evaluate other aspects of the interface. We consider that other non-traditional data input modalities, such as speech interaction, could be more appropriate for an app of this kind, however, that remains to be explored and tested in our future versions.

6 Conclusion and Future Work

Despite the fact that this evaluation only included three participants, the positive findings indicate that the prototype has a very good potential and its interface provides the desired interactions potentially required in a skiing environment by ski patrollers for reporting an injury. In addition, this preliminary evaluation provided us valuable information about the future steps needed to be taken in order to improve this application, and whether the app requires in advance learning of knowledge.

Our evaluation of the prototype consisted of two stages: providing the patrollers with two tasks to achieve, and asking each patroller three questions to answer right after each task. Afterwards, in order to assess the user experience of the current version of the prototype, we provided a SUS questionnaire to the patrollers consisting of questions related to the ease of use, convenience and confidence in using the app and the interface.

The SUS score obtained for each participant was equal to or above 90, which indicates ease of use, no need of technical support, convenience and confidence in use, well integration of functionalities and no need for any type of knowledge learning in advance to use.

In the future, we plan to investigate non-traditional modalities when providing data input using the SkiPatrol app, considering the context of use in cold weather conditions. Based on comments received during this evaluation, the interface will also include back body parts. Additionally, the app should be made to run in offline mode to consider places when cellular network is lacking.

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