High Tech for Sports Medicine

Supporting employees improving their health and fitness

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***Abstract*—This work in progress paper describes the development of a eHealth system for sports physicians who support employees in improving their health and fitness. Regular physical activity improves quality of life and has various health benefits. Companies have an interest in the health and fitness of employees. Besides, sporting together can improve interaction between employees of different departments. For employers it is important to encourage this in a safe way. To this end, the sports physicians of Isala Hospital in Zwolle, The Netherlands, offer sports medical examination and guidance programs to companies. The sports physicians want to use smartphone technology to improve and expand their services. To that end, an online data tracking system will be developed that makes it possible to: give employees access to their medical examinations results with personalized standard values; insert goals and training schedules by participant, trainer or sports physician; couple sensors and apps for data entry by participants themselves; compare one's results with those of (company) peers; automatically provide feedback to individual participants; support contact between participants and sports physician or trainer; produce management reports and perform scientific analyses. Since details of the end product are not clear yet, the incremental and iterative development method Scrum will be used to develop the system. We will further 'feed' the project with an elaborated state of the art study, small pilot studies and an expanded evaluation study. A first version of the central database and app has already been developed.**

Keywords-sports medicine; guidance; employees; training; medical examination.

I. INTRODUCTION

This work in progress paper describes the foundation and development of a eHealth system for sports physicians who support employees of companies in improving their health and fitness.

Sports Medicine is the medical specialty that focuses on promoting, safeguarding and restoring the health of people who (want to) sport or exercise. It also aims to promote and restore the health of people with chronic conditions through sports or exercise. For both facets, the balance between specific physical load and capacity are explicitly taken into account [1].

Regular physical activity improves quality of life and has various health benefits [2][3]. However, about 40% of the Dutch population does not meet the Dutch Standard for Healthy Exercise for their age group [4]. This standard focuses on maintaining health in the long term.

Companies have an interest in the health and fitness of employees as this may have an effect on sickness absenteeism and productivity. This is especially relevant nowadays because of the ageing of the working population. Besides, the increase of screen work contributes to non-compliance with the guidelines for sufficient exercise. Employers may want to actively maintain or even improve their employees' health and fitness. A company could present itself as a good employer to offer its employees counseling by sports physicians as part of occupational health care and fringe benefits.

The sports medicine department of Isala in Zwolle, The Netherlands, performs sports medical examinations and guidance for groups of employees of external companies with the aim of encouraging movement and improving the health of the workers. Participants are periodically examined and supervised regarding their training and health during a year. With the aid of the physician, each participant determines his own goal. To this end, employers can choose specific sporting events in which their employees can participate at the end of the year, such as a half marathon or bike ride. Participants receive an individual report with advice and the companies receive a general management report.

Until recently, only data of the sports medical examinations were locally stored in individual files per participant. This had several major drawbacks: a) participants could not see their own data, b) training activities of participants were not included, c) health parameters of the participants could not be followed during the training period, d) it was not clear whether the individual goals were met, and e) it was not possible to analyze data about groups and set up management reports.

The method of data storage of medical examinations and the way of guiding participants needed renewal. The sports physicians wanted to use smartphone technology to improve and expand their services. They wanted more insight in the progress of health and fitness status of the participants, and to provide the participants themselves with meaningful and motivational information. To that end, we looked for an online data tracking system with the following features:

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1. Central, secure and adequate data storage;
2. User-friendly and reliable data entry by the sports medicine staff;
3. Various authorizations for different types of users;
4. Insert goals and training schedules by participant, trainer or sports physician;
5. Coupling of sensors and apps for data entry by participants themselves;
6. Give participants meaningful insight in their own sports medical examination results and progress in training and health parameters, e.g., compared to personalized standard values or goals, and/or results of their (company) peers.
7. Automatic feedback to individual participants via an app to stimulate or warn;
8. Support contact between participants and sports physician or trainer;
9. Automated standard analyzes and reports;
10. Basis for scientific sports medical research.

The sport physicians searched by asking colleagues and on the internet for systems that met these requirements. A system that fully supported the sports physicians' guidance model was not found.

Therefore, the sports physicians contacted the research group ICT-innovations in Health Care of Windesheim University of Applied Sciences, Zwolle, The Netherlands. Together they started a project of which the primary objective was to build a system that met all the requirements of the sports physicians and made use of new technology in the field of monitoring and communication of sports and health parameters, such as web services, database servers, sensors, apps and smartphone technology. The secondary objective was to make students of information sciences acquainted with, and train them for a position in the field of medical informatics. Furthermore, we wanted to encourage knowledge exchange between the hospital and the university of applied sciences and to stimulate the development and use of technology for the benefit of health and healthcare. The project was named Hightech4SportsMedicine.

In Section 2, we will present the approach that we have chosen in order to develop the system. In Section 3, we show the first, preliminary results and in Section 4, we discuss the work that has to be done in the future.

II. APPROACH

A. State of theArt study

We initially performed a short literature study on systems that were available for sports physicians and athletes to share their training progress, training experiences and health parameters to support medical guidance. Later we will conduct a more comprehensive, systematic inventory through literature review and desk research. The findings provide further input for the system to build.

B. Students, integration with education

We deploy ICT students to develop the system. In this way we give the students the opportunity to develop skills in the field of medical informatics. The school of Information Sciences and the research group ICT-Innovations in Health Care have expressed the intention to give three to four students the opportunity to participate in the project in the context of the minor App Development. Different groups of students will be provided this opportunity during four consecutive semesters. The school will provide additional and customized education and guidance, and contribute to the continuity of the project. Three ICT students have, as part of an internship, developed a first basic version of the central database for a data-tracking system. Three other students now further develop the system and work on an app and sensors for the employees. For next semesters we will recruit new students.

C. Agile / Scrum

Many things in this project are still unclear. Research to investigate the needs, desires and possibilities forms a major part of this project. Therefore, an ease of communication and social integration with the stakeholders and end users are heavily desirable. Besides, working iteratively and incrementally makes it possible to quickly obtain the advantage of new insights because the planning and the priorities can be easily adjusted once new information becomes available. Also, good control and coordination mechanisms are important for delivering usable increments. Scrum provides us with the needed instruments to clarify the needs and manage the project [5]. It also provides defined meetings and activities and gives structure and clarity for the team and stakeholders.

The role of the students regarding the important elements of Scrum are:

1) Product backlog

The product backlog is basically a prioritized list of features that the customer wants, described using the customer's terminology. The ICT students of each semester together with the product owner (a sports physician) are responsible for setting up the product backlog document and managing it.

2) Sprint planning

A scrum sprint is a confined to a regular, repeatable work cycle. Sprint planning is a critical meeting. The functionality to be delivered in the sprint is planned at this meeting. The ICT students plan this meeting and invite the product owner to attend the meeting. They discuss the product backlog and decide which functionality is to be delivered in the next sprint, taking the following factors into consideration:

- The sprint length;
- The available capacity and resources;
- The priority and importance of the functionality;
- The scope of the functionality;
- The time estimate for the functionality.

The meeting results in a sprint backlog document. The ICT students ensure that all the privies are provided with a copy of the sprint backlog document.

3) Sprint

The sprint is the heart of Scrum. Within the sprint the needed functionality is implemented, tested, integrated and accepted. To make the feedback cycles short and effective

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enough, the sprint is limited to two weeks. The ICT students start the sprint with making an appropriate design. The design should fit the overall architecture of the software. The ICT students distribute the functionality to be implemented among them. Regardless who is implementing the functionality, all the ICT students are responsible for the performed work. Working in this way should enhance the team spirit and ensure the distribution of knowledge. The sprint is closed with a sprint review. In the sprint review the ICT students demonstrate the work done within the sprint and get the performed work accepted by the stakeholders. The functionality that has not been accepted by the stakeholders or finished by the ICT students will be put back in the product backlog. For a delivered functionality to be accepted, it should satisfy a set of rules that has been defined by the ICT students and the product owner. This set of rules is called a Definition of Done. After the sprint review, the ICT students plan the next sprint planning meeting to start the scrum cycle again.

D. Evaluation study.

If parts of the system have been developed that can be tested on end users, we will set up pilot projects with the aim to evaluate the system. We will first evaluate the performance and usability of the system, and the information value for participants and sports physicians. The aim is primarily to improve the system. After the pilots, we want to evaluate the value of the system in terms of routine use of the system, satisfaction of end users, compliance to training programs and effectiveness of medical support in terms of health, fitness and goal achievement.

Once the database is filled with sufficient data, we hope to scientifically evaluate the effectiveness of several sport medical advices and do subgroup analyses.

III. PRELIMINARY RESULTS

A. Preliminary State of the Art

There are information systems that support sports physicians in recording patient data and are thus in fact electronic patient records (EPRs). However, these EPRs do not usually give patients access to their data. Besides, there are no specific EPRs for sports medicine. Additionally, there are apps that support the physician or athlete in the diagnosis and treatment of a specific sports injury. Examples are the “Medical iRehab AnkleSprain” [6] and the “Medical iRehab Tennis Elbow" [7]. Furthermore, there are countless apps for athletes focusing on the monitoring of training and health parameters, whether or not equipped with training schedules and advice. We found, however, no systems specifically aimed at sports medical examination, advice and guidance where the main objective is to assist employees in safe sports practice and promoting health and fitness. Moreover, the systems found showed no alignment of data collection by the athletes and the information needs of the sports physicians, no fitting with the care processes of the physicians and no provision of an own, secure and insightful database for management reports and scientific analysis.

B. The proposed architecture

The proposed architecture of the system consists of several elements, see Figure 1. These include:

1) Central database

A centralized database where monitoring data and health measurements will be saved. No personal data will be saved that can be directly or indirectly linked to physical persons. The database will also give the possibility for retrieving data for management reports as well as scientific analysis.

2) Web Services

For achieving data quality and data security, secure web services are built. They are a set of functionality, which is used for data entry and data retrieval. It forms the only entry point to the central database.

3) User applications

In this context the term user applications refers to the applications that could be used by the end users for data entry and data retrieval, and for communication between participants and sports physicians. A web site is built for this goal and a native mobile application is being implemented.

4) Sensors

The ICT students will investigate the possibility to integrate sensors. The sensors will also be used for data entry. The sensors will be placed on the body of the employee and send measured data to the mobile application installed on the mobile device of the patient. The way the sensors will be coupled with the mobile application is still unclear. The ICT students are investigating the following options:

- The coupling through ANT+ [8];
- The coupling through Bluetooth Low Energy (Bluetooth LE) [9].

C. Central database, data quality

A first basic version of the central database for a data-tracking system, called the "Isala Sport Monitor", has been developed. The sports physicians currently use this version of the system. At this time, the results of the periodical sport medical examinations can be recorded in a simple manner.

Data quality is achieved by working with value limits for data entry, automatic alerts when capturing improbable values and automatic calculation of values from other values, e.g., BMI from length and weight, and body fat percentage from multiple skinfold measurements.

D. Sports Medicine App with sensor

A first, but not yet complete version of the app has been developed for the iPhone. This version allows participants to see their sports medical test results, like peak expiratory flow, cholesterol level, fat percentage, orthopedic tests, maximum heart rate, ECG, etc. Personified, age and sex dependent standard values, will be added soon. Further, trainings data like type of sports, duration, distance, speed, route, heart rate zones and energy consumption have been implemented. The app works with a heart rate sensor.

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IV. CONCLUSION AND FUTURE WORK

No information system can be found on the market that supports the sports medical guidance model of the sports physicians of Isala in all its facets. Therefore, we started an innovative project in which a system is built using new technologies. The innovation mainly concerns the integration of the use of apps, sensors, web services, smartphone technology and a database server with a feedback function to participants, sports physicians and employers in one sports medical guidance program and not as separate parts. This makes it possible in the future to link advised training programs to actual training and health data in the course of time for large groups of participants who are employees and mostly recreational, non-performance-oriented athletes.

Since details of the end product are not clear yet, the incremental and iterative development method Scrum will be used to develop the system. We will further 'feed' the project with an elaborated state of the art study, small pilot studies and an expanded evaluation study.

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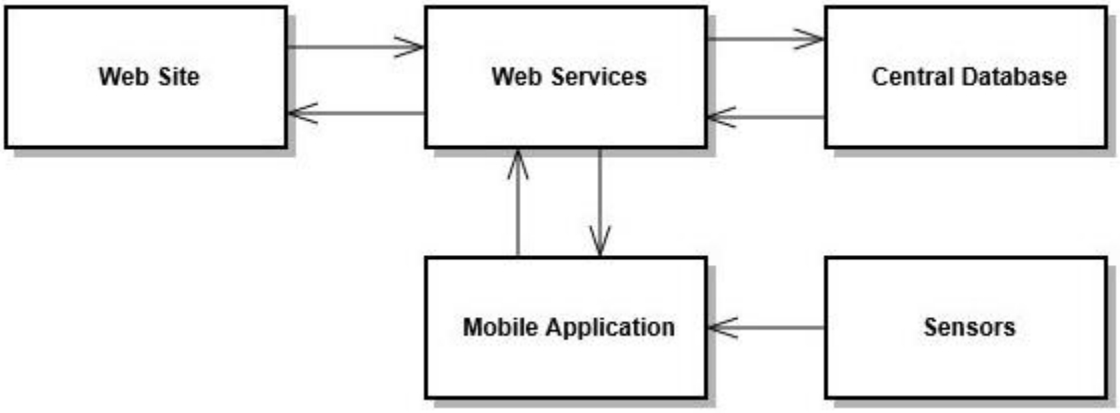

Figure 1. The architecture of the Isala Sport Monitor.

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