Towards an Architecture for a Game Achievement Based System to Analyze Human Health Comparative Behavior

Analysis of People's Behavior Regarding Sharing Their Health Data and Proposing a Health Achievement Service Known From Computer Games

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Abstract—**Nowadays a few concepts of games and game design are used in different non-entertainment domains (this is also called gamification). Part of this gamification is also emerging in the health sector. This work-in-progress paper tries to define a methodology and an architecture how an achievement based service in healthcare can be designed, analyzed and implemented. This service uses patient data from different sources (e.g., from a patient's personal health record) to share anonymized health related information/achievements with other people. Thus, it might build up a comparative behavior between patients and motivate them to increase the usage of a personal health record.**

Keywords - electronic health record; patient empowerment; achievements; medical informatics.

I. INTRODUCTION

Noncommunicable diseases, e.g., cardiovascular diseases, cancer, chronic respiratory diseases, diabetes, are leading causes of death and found to be rooted in unhealthy behavior [16]. People are facing day-to-day negative stress and put themselves at risk largely due to tobacco use, alcohol consumption, physical inactivity as well as unhealthy diets resulting in overweight and obesity [16]. A change of behavior, however necessary, is relatively unlikely to occur. While short-term behavioral changes may be accomplished rather easily, it is the long-term change that is of interest to affect one's health and well-being. Hence, motivational factors are paramount to be proposed and further focused on. One way to tackle this problem might be gamification of which several definitions are available. Deterding et al. [17] declared it as "the use of game design elements in non-game contexts." Gamification concepts are on the rise, invading not only the health sector, but a magnitude of disciplines and markets [18].

While electronic health records (EHR), respectively personal health records (PHR), are a much debated issue [9][15], their implementation and adoption leverages tracking and analysis of continuous patient data, thus, treatment progress.

Nonetheless, as of today, "gamifying" PHRs, in contrast to the adoption of rewarding concepts in online social networks [6][8][19] or wikis [7], has not been the center of attention.

This work-in-progress paper aims at identifying and evaluating reasonable motivational factors to be incorporated into EHRs/PHRs, respectively, health related information sharing platforms, in general, and proposes a methodology as well as an architecture in an effort to introduce change in behavior and mind upon encouraging a healthier lifestyle among people by means of an achievement based service.

The basic idea of this is to analyze, design and develop a prototype application which allows to gather information from different sources (e.g., a PHR) and to change the entered values into an achievement which can be displayed in a desired social network. An achievement system is a reward system, where players can complete goals and earn achievements for it, which are visible to others [6]. In case of this work those achievements do not contain any personal health data, but just display the activity itself. E.g., if someone enters the blood pressure, an achievement will be generated and displayed which shows that the user entered the blood pressure, but does not reveal the specific values. This system should then be evaluated to determine if such health achievements could be used to increase the usage of PHRs and to motivate other people to use it by communicating health activities.

The remainder of this work-in-progress paper is structured as follows. Section II gives an overview on current and related research subject to gamification and the health sector. Section III outlines methodology to gather information for developing an achievement based service. Section IV describes the basic architecture of such a system and Section V covers the conclusion and future work.

II. RELATED WORK

There are a few studies on EHR/PHR, in particular aspects like security, privacy and acceptance (like in

[9][15]). The association thereof, with concepts traditionally known from the gaming industry and psychological discipline, i.e. social rewards/achievement systems, is scarce, if at all present in research. Here, we give an overview on what has been the recent center of attention. Utilizing EHRs, or at least parts thereof, is subject to a certain extent of skepticism. Upon editing or entering data into EHRs results to be found were of neither positive nor negative connotation [1][15].

From a psychological point of view several theories for changing human behavior are existent. The Transtheoretical Model (TTM), Health Belief Model (HBM), Social Cognitive Theory (SCT), and the Theory of Reasoned Action/Planned Behavior are among the most common ones [23]. TTM delineates six stages [24], namely, precontemplation, contemplation, preparation, action, maintenance and termination, whereas adherence does not occur in a linear fashion [23]. SCT [21], on the other hand, relies on a construct called "triadic reciprocity" [23]. The individual, one's environment and one's behavior are all influencing, thus, affecting each other either way. Moreover, key concepts associated with this triadic cycle involve – to name just a few - behavioral capacity, expectations and reinforcement. The latter centers on achieving higher motivation to perform or change certain behavior by means of rewards and incentives [23]. Adding up further to that line, a sole intention is likely not enough to induce behavior change [22]. Hence, research on bridging mechanisms like certain motivators is yielded necessary. This is where the proposed achievement architecture in here comes into play.

Assuming that people are lacking some sort of motivation to update their health status, certain incentives as in gamification aspects could play a key role in raising people's interest and awareness. This becomes especially important since we put ourselves at risk to various diseases by engaging in unhealthy lifestyles. Several frameworks have already been established in an effort to empower individuals upon recording health activities as well as deliver them with an overview on their general lifestyle. There are a lot of applications allowing earning some sort of reward for reaching a goal, but those applications are not connected to each other and the earned goals are not always displayed in a social community. Apart from utilizing specific software to recover one's own data [3], approaches range from implementing wellness journals promoting mobile interaction [4], to the development of hardware devices, e.g., heart rate belts, body area networks (BAN), aiming at leveraging measurement and sharing of data with social networks [12].

Initial approaches have been undertaken to become familiar with people's reasoning as to why information and communication technologies and designated eHealth platforms are used in order to introduce behavioral change [5]. The underlying model could serve as a basis on designing the proposed survey in this paper.

A community dealing with amyotrophic lateral sclerosis (ALS) indicated that patients suffering from this neurodegenerative disease are more likely to communicate and share their own experience and health related information via support of peers [14]. Here, the underlying idea was not to hide or disguise one's health data, but rather, be open about it in an effort to share experience and help others coping [14]. A study [13] even points out that linking PHRs with social networks is increasingly becoming more important for patients. Hence, the proposed idea is likely to be of benefit to users struggling with one's health and well-being.

Achievements in video games are seen rather critically when it comes to user benefits [10]. Needless to say, that research solely carried out in theory provides only a limited indication for the success of this approach. Therefore, putting gamification to practice is favored. By means of utilizing WiFi or GPS signals, a client/server software architecture succeeded in transforming gamified aspects into real-life achievements, such as 'user has been to Paris once' [2].

Comparing the effects of using a photo-sharing environment that is associated with an incentive based service was the primary intention in [6]. Subject to this study, users did not report designated interest regardless of whether the achievement service had been provided to them or not [6]. A service for a wiki system to reward users with a ranking based on wiki-activity proposed several methods of bringing achievements to the people [7]. However their work was reported to be at an initial stage, still, which is why additional research to succeed in raising motivation was proposed.

In a study [20] a mobile application was developed to define and enter goals. When those goals are reached users are rewarded with trophies and ribbons, which can be displayed on facebook. After a test just three people (out of 23) did find the trophies and ribbons motivating.

In [8], a movie-rating community gives movie recommendations to members based on numerical ratings and reviews. Authors designated higher participation within the community upon assigning specific goals, whereas unspecific goals reflected quite the contrary. Interestingly, establishing group goals has shown to be of higher efficacy regarding individual movie ratings than no goal assignment at all [8].

Bearing in mind aforementioned research about social rewarding, achievement systems and services are suggested to succeed in raising awareness as well as motivating people towards higher contribution and sharing of health related data.

III. METHODS

The proposed methodology for an achievement based service can be found in Figure 1 (the numbers represent the order of the methodology, while the arrows indicate the dependency) and consists of the following steps. First, a literature research is conducted to get an overview of the
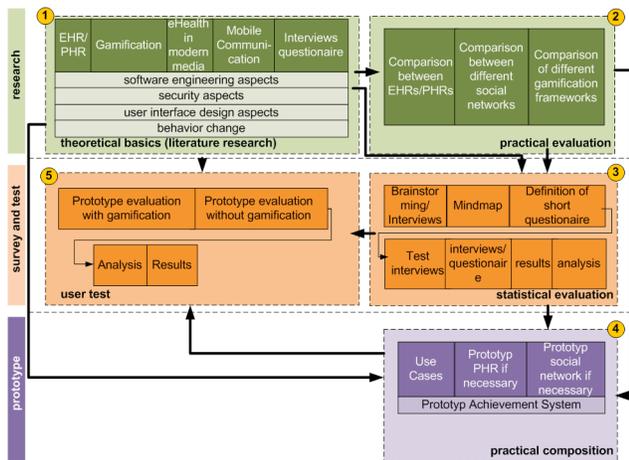
Figure 1. Methodology

current state of the art regarding needed topics. Topics besides general aspects (user interface design, security, software engineering and psychological aspects for behavior change) are gamification, eHealth in modern media, mobile communication, EHRs, PHRs and theoretical basics about interviews and questionnaires. Subsequently, a practical evaluation is carried out to compare different gamification frameworks which might be used to set up the prototype as well as a comparison between different PHRs and social networks to include in the prototype setting. This step is done to find out if there are services or applications that might be usable in the prototype setting. If no satisfactory result is found, the needed components will be newly implemented.

To explore people's visions and desires for such a system a few initial interviews will be conducted. In combination with brainstorming a mindmap will be drawn. Based on this a short questionnaire will be constructed to get sociodemographic data and to assign the interview partners to gaming categories (e.g., if someone plays games and is open to achievements). This should include the reference to the Bartle Type of Gamers [11]. Afterwards the interviews and the short questionnaire will be conducted and the results will be analyzed. As a consequence use cases will be drawn which will end up in designing and implementing an achievement system prototype (as well as a PHR and social network prototype if needed). After the implementation of the prototype, a few users (20 to 40 people) should test the system with the gamification service over a given period of time (about 2 months). The users should all have a positive attitude towards rewarding systems and achievements (which will be determined with the interviews and questionnaires) and should be between the age of 18 and 40. The users should be split up into two groups – for one group achievements will be generated and displayed but not for the other group. The reason for doing so is to uncover if there is a difference in the usage of such a system when a gamification service is present or not (which will be concluded in the results and analysis).
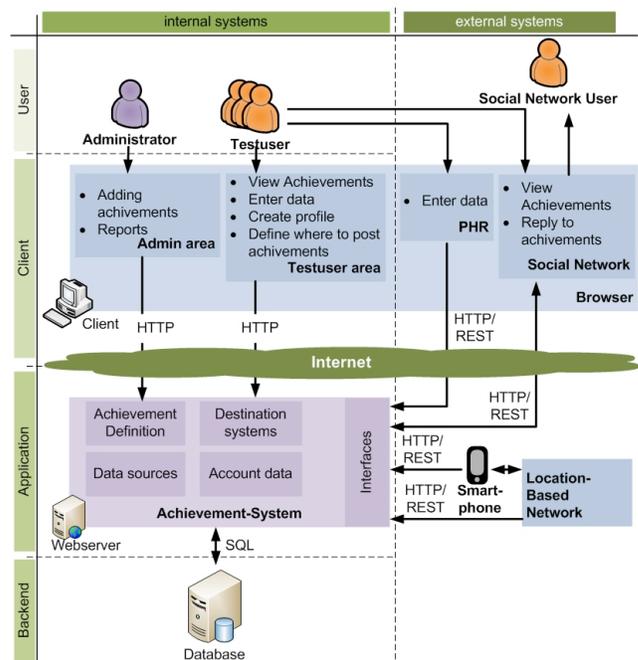

Figure 2. Architecture

IV. RESULTS

Based on the results from the interviews a final architecture will be postulated. However, a few basic requirements will be defined before. The architecture should be able to handle the definition, display and altering of achievements. It should be possible to have different views for different user groups (e.g., the administrator has the possibility to define new achievements), so each user can define where his achievements will be displayed. It should also be enabled to define a source for the health related data (e.g., PHR) as well as needed authentication to retrieve data from there. Moreover, including location based services, e.g., to get an achievement for checking in into a fitness center, is considered.

The basic idea of this architecture (see Figure 2) will consist of an internal system (the achievement service and all required components) and an external system, which will include all systems where data will be imported from or displayed to externally. The architecture is divided into a server and a client part. On the client side a user can access the prototype, a web application, with a browser. The data is transferred through the Internet with HTTP/REST and stored in an SQL Database. In summary the architecture relies on the following tiers:

- Client: Through the frontend the test users and the administrator can access the application with a graphical user interface (GUI). It will hold an admin area to define and add achievements as well as the possibility to display reports (which user has added information and which achievements have been

reached, to use for the final evaluation) and a test user area (where the test users can view achievements, create and edit their profiles and to define where reached achievements will be displayed or posted).

- Application: Holds the application itself and acts as a communication layer between the achievement system and external systems (PHR, social networks and location based services).
- Backend: the backend will consist of the database to store the data.

V. CONCLUSION AND FUTURE WORK

This work presented a novel approach upon delivering insights into how and why people share their health related data with others. By means of a centralized achievement system an architecture and a methodology for the definition, development and analysis for such a system was given. Currently the evaluation is ongoing as well as the implementation of the basic requirements for the prototype of the achievement system in order to be tested afterwards.

Future work besides finalizing and evaluating the system includes an integration of such a system into the rehabilitation process for stroke patients using a serious game. People going through a rehabilitation therapy often experience a lack of motivation. By including an achievement system into such an online community, patients might be motivated and feel connected. That, in turn, might help them through their rehabilitation process and to achieve better results. Also, an evaluation should be conducted, finding out, if this approach might help people with their rehabilitation.

Being in good health and even more preventing illness is of utmost importance for each one of us. Hence, researching on it and support maintaining our health are worthwhile pursuing.

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