A method for eliciting and representing emotional requirements: Two case studies in e-healthcare

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***Abstract*—This paper describes a method for eliciting and representing emotional requirements for sociotechnical systems in a holistic manner along with eliciting and representing functional and quality requirements. As emotional requirements are crucial in designing sociotechnical systems for e-healthcare, the application of the method in two case studies of this problem domain is described.**

***Index Terms*—Sociotechnical system, emotional requirements, elicitation, modelling.**

I. Introduction

If people's interaction with the digital economy is to be as successful as it can be, people need to be encouraged to use technology effectively. Rather than presuming or mandating that a particular software application should be used in a certain way, software engineering methods need to involve end users in co-design to ensure that people will be engaged with the final solution so that it meets their needs, both functionally and emotionally. Awareness of emotions to be experienced by end users is of utmost importance in requirements engineering and emotional requirements should be distinctively addressed. Yet, it is not always instinctive for requirements engineers to explicitly consider emotional requirements or to ensure they are effectively elicited, represented and advocated for throughout the design process. To achieve software that is emotionally acceptable, we need to know basic theories about emotions and how they are constructed in our brain. Some of such theories are overviewed in Section II. In addition, we need methods for explicit elicitation and representation of emotional requirements, along with functional and quality requirements. A method for this purpose is put forward in Section III and is applied in two case studies of e-healthcare in Section IV. Finally, conclusions are drawn in Section V.

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II. Emotions and Human Brain

Some psychological frameworks are grounded in basic emotions such as fear, anger, or joy [1-2]. These frameworks can be used by technology developers to evaluate whether the emotions are incorporated into the technology itself [3]. However, basic emotions are often mixed up with affects, which are not emotions but much simpler *feelings* with two features: valence and arousal [4]. *Valence* characterises how pleasant or unpleasant one feels, while the feature of arousal is how calm or excited one feels. The immediacy of affects, and the subsequent bodily responses make them easier to detect automatically using physiological measures; such as detecting excitement with a heart rate measure. These reactions are often quantifiable after a single engagement with the technology in question, for purposes such as evaluating the effects of technostress [5] or pleasure during online trading [6]. In contrast to simpler affects, emotions are *constructed*, as claimed by recent studies in cognitive psychology, which are backed by findings in neuroscience [7]. According to the theory of constructed emotion [7], a human brain invisibly constructs everything one experiences, including emotions. Emotions are constructed in the brain, in concordance with the goals aimed to be achieved. For example, if the goal is romantic love, the emotions *Passionate*, *Longing* and *Lustful* might be constructed which make this goal more attainable. Differently, if the goal to be attained is tough love or brotherly love, respective instances of the emotions *Disciplined* and *Bonded* might be constructed [8]. The brain may also combine existing emotions to construct an instance of a new emotion. For example, the Japanese goal-based concept "omotenashi" (おもてなし) stands for treating others as whole-heartedly as possible without expecting any favour in return and giving people memorable and meaningful experi-

ences when they do not expect it. An instance of an emotion created to support achieving the goal to serve someone in an "omotenashi" way is natural for a Japanese but in a Westerner's mind, can be constructed, although not in a perfect way, as a combination of instances of simpler emotions *Whole-hearted*, *Generous* and *Unexpected*.

III. Motivational Modelling

Motivational modelling [22-24] is a method that allows ethnographers and requirements engineers to elicit and represent emotional requirements for sociotechnical systems [26] related to the goals to be achieved. In motivational modelling, three kinds of goals – *do*, *be*, and *feel* goals – are elicited from project stakeholders. *Do* goals or functional goals describe what the system to be designed should do, *be* goals or quality goals describe how the system should be, and *feel* goals or emotional goals describe how a user wants to feel when using the system or, in other words, what emotions should be constructed in the brain of the user when he or she uses the system. The difference between *do* and *feel* goals is that while functional goals characterize the system to be designed and created, emotional goals describe what emotions using the system should construct in the minds of its users, based on the theory of constructed emotion [7]. Initially, we attempted to elicit emotional goals as quality goals but did not succeed. This prompted us to elicit and represent emotional goals as first-class citizens, whereby we noticed that stakeholder reactions to quality goals and emotional goals were very different [14]. Motivational modelling should not be confused with eliciting and representing intrinsic and extrinsic motivations, such as leader boards, badges, points, avatars, and "time limits" [25].

The two main methods of eliciting requirements by motivational modelling are structured interviews and workshops [22-24]. Structured interviews were used in the context of the first case study reported in this paper. Workshops were used in the context of the second case study reported in this paper. The results of the requirements elicitation sessions are converted into a motivational goal model [9-11]. In a motivational goal model, hierarchically arranged parallelograms stand for functional goals representing what the system should *do*, whereby each sub-goal represents an aspect of achieving its parent goal. Corresponding quality goals representing how the system should *be* are associated with functional goals and are represented by clouds. Corresponding emotional goals, represented by hearts, indicate how stakeholders should *feel* when interacting with the system. Stakeholders are abstracted into roles of the surrounding sociotechnical system and are represented by person icons. The use of goal models has been refined in a variety of applications over recent years [12-14]. They contribute a practical way of communicating visually and verbally the functional, quality and emotional goals that need to be addressed in the design of new technology for adoption. Goal models can subsequently be used throughout the design process to steer exploration, experimentation and evaluation strategies [15].

IV. Case Studies

The case studies of this paper are concerned with e-healthcare because emotions are considered increasingly important in patient experiences [18-19]. We conducted two projects on e-healthcare – one in Australia and the other one in Estonia. We picked these countries because of the location of the involved researchers but also because of the unique opportunity to model requirements for e-healthcare in two countries that have chosen different paths for developing e-healthcare.

A. Application for Self-Managing Health in Australia

The project that was performed in Australia was concerned with eliciting and representing requirements for a prototypical application of processing and presenting electronic health records (EHRs) for self-managing health by patients. This research used semi-structured interviews to elicit from both patients and general physicians (GPs) requirements for the application as *do*, *be*, and *feel* goals. The interviews were conducted across various locations on the Hawthorn campus of the Swinburne University of Technology. A total of 10 participants were interviewed – of which 8 were patients and 2 were GPs based in Melbourne. In addition to the patients and GPs, the 2 members of the application's software development company were interviewed, who had a wealth of knowledge working with their target users over several years. The overall purpose of the project was to reconcile different points of view towards an application for self-managing health in the form of a cohererent set of functional, quality and emotional requirements for the application. A particular emphasis was put on emotional requirements because there are many emotions related to health.

The interviews consisted of two parts. The first part of the interview was related to EHRs as such whereas the second part was regarding remote consultations with the help of the application. A range of topics were discussed spanning: (1) the patients' health-related activities, (2) what health information they would see as important inside and outside of a GP consultation, (3) how they would like to access their health records, (4) how remote consultations may improve health outcomes, and (5) what was their overall opinion on EHRs and remote consultations, especially regarding the emotions that the usage of EHRs and remote consultations would create.

The results were analysed following a thematic analysis approach to find common themes in the data [16]. The results were used to construct a motivational goal model which is depicted in Fig. 1. Next, the model will be used to summarise the coherent set of functional, quality and emotional requirements that was elicited in the interviews.

The top-level functional goal Self-Manage Health represents the purpose of the application to be designed by comprising all goals that were elicited. All stakeholders interviewed sought to achieve the goal of self-managing health, and they wished to feel in control, resilient and capable while doing so. Based on the interviews, the goal Self-Manage Health was elaborated into five sub-goals. We will subsequently address separately each of the five sub-goals.

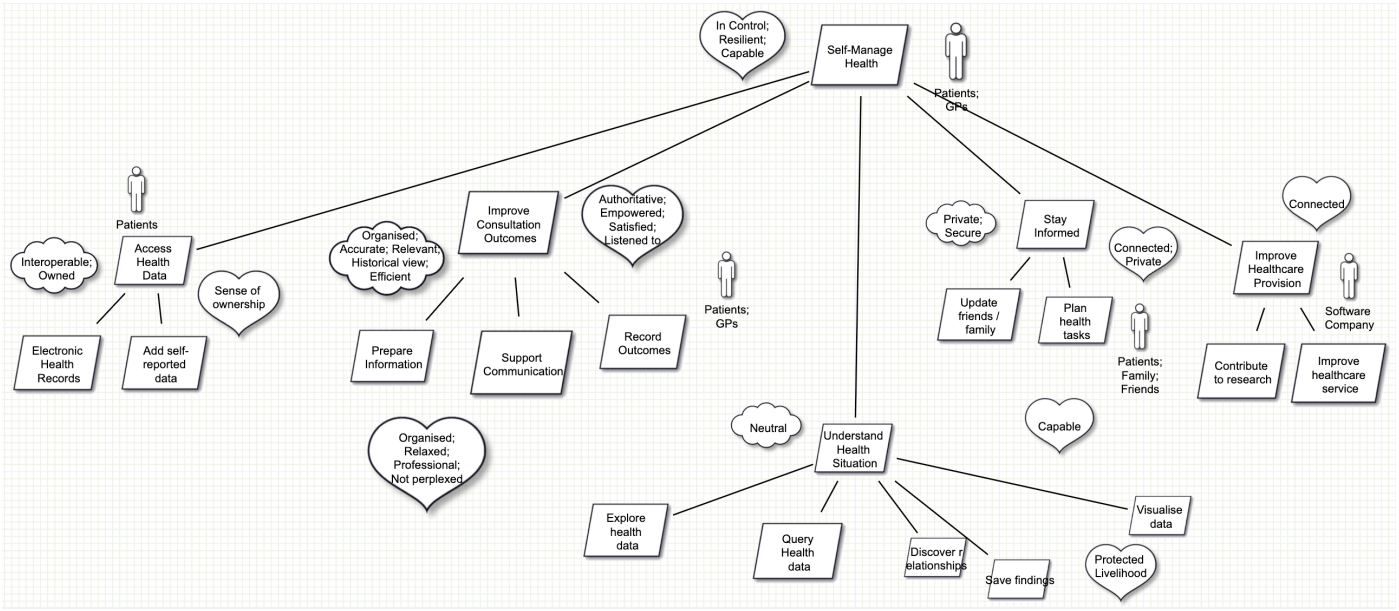

Figure 1. Goal model for self-managing health

Starting with the first functional sub-goal on the top left of Fig. 1 – Access Health Data – GPs already can achieve the goal to access health data in the form of EHRs but this goal is still new to many patients. A sub-goal of Access Health Data reflects that the application should enable adding self-reported data to EHRs. The need for patients to feel that they owned their own health data was considered by the stakeholders as a significant emotional goal. Therefore, *constructing a sense of ownership was added as an emotional goal to the functional goal Access Health Data*.

The second sub-goal modelled in Fig. 1 – Improve Consultation Outcomes – reflects the need to improve consultation outcomes for both GPs and patients. Most of the patients preferred visiting the doctor and having a face-to-face consultation. Some patients were apprehensive about remote consultations; however, they wouldn't mind if it was regarding something minor. In addition, remote consultations were seen as important in preparing for face-to-face consultations. Accordingly, further sub-goals of this goal represent different aspects of improving consultation outcomes: preparing relevant information with the application prior to a consultation, referring to their health information during a consultation to support communication, and recording advice and outcomes of their consultation to be referred to later on.

Based on the interview results, the functional sub-goal Support Communication is modified with the quality goals stating that the information communicated should be organized: accurate, relevant, considerate of a historical view, and efficient.

Fig. 1 reflects key emotional goals pointed out by GPs with respect to the functional goal Support Communication: they wanted to feel organised, relaxed, professional and not to feel perplexed. *The emotions of feeling organised and professional can be combined into the emotion of being conscientious and the emotions of feeling relaxed and not perplexed – into the emotion of being collected*.

An important finding from our study is that *the emotional goals expressed by patients with respect to the functional goal Improve Consultation Outcomes depended on the level of their general knowledge about health topics*. While patients less knowledgeable about health topics wanted to feel listened to and for the GP to take a greater responsibility for their health decisions, the patients with more health-related knowledge wanted to feel empowered to make these decisions by themselves. *A common emotional goal to be achieved for both kinds of patients was feeling satisfied*. Eliciting conflicting requirements for software applications is usual and even more common for emotional requirements because emotions are individually constructed.

The third sub-goal represented in Fig. 1 – Understand Health Situation – shows how patients are motivated to better understand their current health situation with as much of a neutral mindset as possible, which is an important quality goal. For a patient, achieving this functional goal along with the attached quality goal includes the ability to explore and query his or her health data with or without a specific question in mind. In addition, visualising health data and discovering relationships in health data and saving findings are believed to be core motivations for patients, *so that they would feel capable of managing their own health*, as is conveyed by the corresponding emotional goal. Differently, GPs expressed concerns that this new means of accessing information may threaten the traditional image of service provision. *GPs therefore have the emotional goal of protecting their livelihood and profession*. This can sometimes cause an arguably irrational resistance to e-healthcare solutions by healthcare professionals.

The fourth sub-goal modelled in Fig. 1 – Stay Informed – reflects that patients wanted to stay informed about important health information and events. The goal model includes two emotional goals that seemingly contradict each other. On one hand, patients would like to *feel connected to others*. They wish to update their friends and family with their health information

and plan health tasks required to self-manage health. At the same time, *they would also like to feel sufficiently private* when communicating their health information. These results show that selective social networking should be an important feature of the application to be designed.

Finally, the two interviewees from the software company expressed the broader goal to improve healthcare provision, which is accordingly modelled in Fig. 1 as the functional sub-goal Improve Healthcare Provision. The interview results also included two important aspects of improving healthcare provision – contributing to research and improving healthcare service – which are in Fig. 1 represented as the corresponding third-level functional sub-goals. Interestingly, also here *the stakeholders pointed out that they wanted to feel connected when improving healthcare provision*.

B. Systems for Supporting Decisions by e-Healthcare in Estonia

In Estonia, e-healthcare is considered an important domain of e-governance. In Estonia, patients own their health data and hospitals have made patients' health data available online since 2008. Today, over 95% of the data generated by hospitals and doctors has been digitized, and blockchain technology is used for assuring the integrity of stored electronic medical records. 99% of all medicines are issued to Estonian patients using digital prescriptions through an efficient system connecting every hospital and pharmacy in Estonia. e-Healthcare applications allow Estonia to offer more efficient preventative measures, increasing the awareness of patients and saving billions of euros. Each person in Estonia who has visited a medical doctor has his or her own online e-healthcare record, containing the person's medical case notes, test results, digital prescriptions and X-rays, as well as a full log file tracking who and when has accessed the data. In 2015, the feasibility study for the development of digital decision support applications for personalised healthcare was conducted, where clinical experts and experts in information technology architecture, design and data structures participated. The results of the study are reported in [17]. Differently from the case study conducted in Australia, the emphasis of this study was on supporting decision-making by stakeholders with the help of e-healthcare rather than on self-managing health by accessing electronic health records.

As a part of the study, a workshop of motivational modelling was conducted of eliciting requirements for digital decision support in e-healthcare. In the workshop, the initial goal models created by the first author based on the results of the feasibility study project achieved that far served as facilitators for the discussions led at the workshop of motivational modelling. The results of the workshop were recorded as the goal model represented in Fig. 2, which represents the overall goal model for decision support in healthcare. The goal model first presents the uppermost goal – "Support decisions" – with the attached quality goal representing that decisions in healthcare should be supported in individualised and *emotionally motivating* ways. The roles relevant for achieving the highest-level goal are GP, GP Nurse, Specialist, and Advisor.

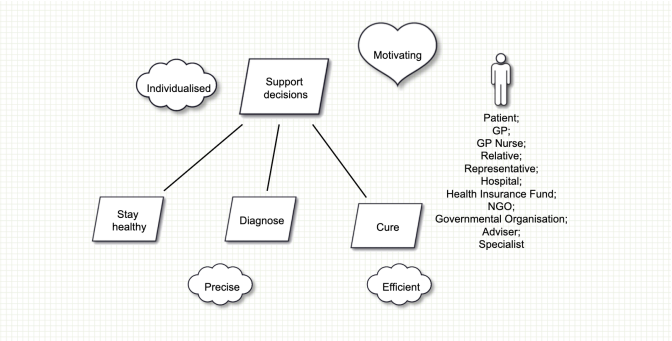

Figure 2. Goal model for supporting decisions in e-healthcare

In the workshop, also other more loosely related stakeholder roles were proposed, such as (the Estonian) Health Insurance Fund, Hospital, patient's Relative, patient's Representative, non-governmental-organisation (NGO) representing patients with a certain condition, and the related Governmental Organisation, such as, for example, the Estonian Road Administration. All of these roles are represented in Fig. 2.

At the stage of goal modelling it is of no importance who or what is going to perform the roles. For example, the role Advisor can be played by some "intelligent" piece of software or alternatively by a human. The main goal – "Support decisions" – has been divided into the sub-goals "Stay healthy", "Diagnose", and "Cure", each of which represents an important aspect of achieving the highest-level goal. The functional goal "Stay healthy" is characterized by the emotional goal meaning that staying healthy has to be emotionally motivating for a patient. The quality goals attached to the functional goals "Diagnose" and "Cure" respectively mean that diagnosing has to be precise and cure must be efficient. Achievement of these quality goals can be measured by the corresponding Key Performance Indicators, but this is of no relevance at the initial stage of the problem domain analysis overviewed in this paper.

In the discussions among the project team it was emphasized that most of the possible savings in healthcare can be obtained through offering decision support to meet the sub-goal "Stay healthy". Prompted by this, we have further elaborated the "Stay healthy" sub-goal in Fig. 3. As the figure reflects, in order to stay healthy, emotionally motivating drivers should be set for individuals. In order to be emotionally motivating, achieving the "Set drivers" goal should involve a feedback loop going back to the patient. *This is an important conclusion influencing the design of the decision support system to be created based on the requirements discussed in this paper.* The participants of the workshop found that it should be possible to relate drivers to "exemplary role models", such as "I would like to be like my grandfather." *This requirement also strongly impacts the design of the decision support system which should now be tunable for constructing different emotions for different individuals.* It is important to note here that drivers that motivate people are different for healthcare professionals and patients.

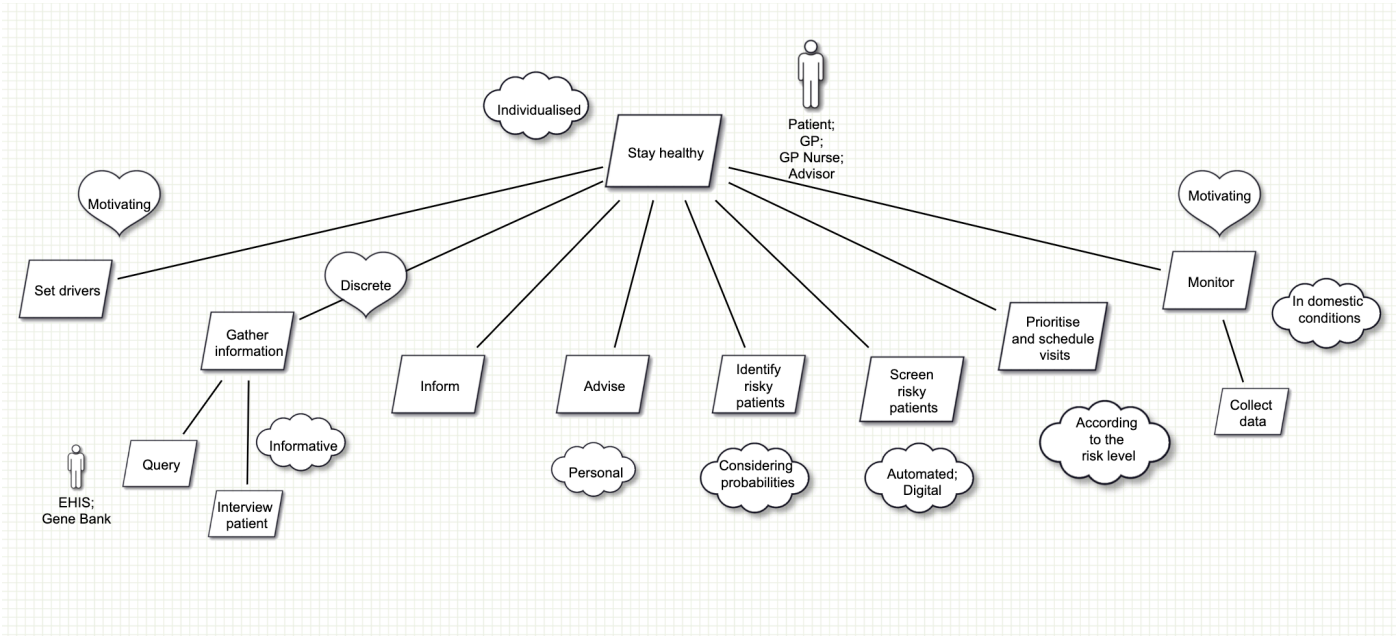

Figure 3. Goal model elaborating the "Stay healthy" sub-goal

To meet the goal "Stay healthy", different kinds of information has to be obtained by gathering data originating in sensors, querying the Estonian Health Information System and the Estonian Gene Bank, as well as by interviewing would-be patients in an informative way. Other aspects of staying healthy are informing patients *in a discrete fashion* about possible problems due to, for example, genetic background, personal advising of patients, identifying risky patients by considering probabilities for one or another condition or disease, and automated and digital screening of risky patients. Also, visits of risky patients to GPs and GP Nurses should be prioritized according to the risk level of each individual patient. Finally, risky patients should be monitored in domestic conditions in the way that would be emotionally motivating for them. An important sub-aspect of monitoring risky patients is collecting and analysing data. As monitoring should be *emotionally motivating*, one way to increase motivation would be to use smartphones for sensing, reading and collecting data. Collecting medical data that way is a lot more motivating for a patient than going out to have one or another test done. For example, a stress test app for smartphones should be developed, where young men at risk could test themselves with respect to the tolerance of physical stress, the related pulse dynamics, etc. *From this we can conclude that the need to meet this emotional goal will have a direct impact on the architecture of the decision support system to be created based on the requirements discussed in this paper.*

Based on the functional goals elicted and represented in Fig. 3, the scenarios for gathering information, identifying risky patients, screening risky patients, prioritising and scheduling visits, and monitoring were created. Whenever appropriate, the scenarios were informed by elicited emotional and quality requirements.

V. Conclusions

This paper is only a first step towards considering the emotional dimension of requirements in software engineering for e-healthcare. In our two case studies, we explicitly elicited and represented emotional requirements for e-healthcare systems as emotional goals incorporated into goal models. We can conclude based on both case studies that explicit elicitation of emotional requirements changes the conversation and the motivational model provides a reference point for improved conversation as design progresses. It also allows for easier reconciliation of different views. Additionally, we could see how the elicited emotional goals can have a direct impact on the design and architecture of the e-healthcare system to be created. The main novelty of the proposed approach is eliciting and representing emotional requirements in a coherent and holistic fashion together with eliciting and representing functional and quality (non-functional) requirements.

Both case studies reveal common insights – that focussing on emotions is valuable and changes the conversation. The goal models constructed in both case studies can be used to steer exploration, design, experimentation and evaluation strategies in subsequent activities. Both case studies also emphasized the importance of constructing a feeling of ownership of health data.

The emotional goals elicited for both e-healthcare applications will need to be further validated in surveys and interviews with patients. However, so far there is no research data available about emotional experiences of patients from engaging with e-healthcare solutions. One reason for this is pointed out by Barello, et al [18], according to whom, analysing the emotional dimension of patient engagement with e-healthcare needs further consideration with specific assessment tools. There is potential to use new technologies and self-reporting measures, asking the patient to report on different emotions [19]. For ex-

ample, the brief questionnaire developed for primary healthcare in Norway also contains questions for measuring emotions of a patient after a healthcare experience [19] and could easily be adapted to be used for experiences with e-healthcare solutions.

In the future, we plan to elicit emotional requirements from patients in co-design workshops of e-healthcare solutions and validate the emotional requirements by assessing the emotions that were constructed by the patients when using e-healthcare solutions. Our other ongoing projects include eliciting and representing emotional requirements for technology engagement in other areas, such as e-government [20], smart technologies for older adults [11], and winning "hearts and minds" in different cultural environments [21].

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