

# **Emotion-Oriented Requirements Engineering**

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# Abstract

In requirements elicitation and modelling, the current emphasis is predominantly on capturing functional requirements and quality goals. Evidence suggests that even though many software systems deliver most key functional and quality expectations, post-delivery user feedback highlights gaps. A key finding is that the emotional goals of users are an important determinant of the acceptance of a solution, yet they are not adequately addressed in many projects, causing them to fail. The importance of human emotions cannot be underestimated. Unfortunately, little consideration is given to how stakeholders *feel*, or would like to *feel*, when using a software product.

Incorporating user *emotional expectations* in software engineering can be very challenging, considering that emotions are complex and subjective. Additionally, existing software engineering methodologies or frameworks provide little guidance to software professionals on how to address emotional expectations. In this thesis, we argue that emotional goals are a critical determinant to the success of a technology and should, therefore, be considered with equal importance as functional and quality goals. Given that emotional goals describe the user's feelings, perceptions and emotions generated from users' experience with the technology, they relate mostly to non-functional goals but are different from other quality goals. Quality goals are properties of the system while emotional goals are the properties of the user. The importance of user emotional goals with regard to the acceptance of a technology cannot be ignored and we, therefore, argue that a new set of goals be created under the taxonomies of non-functional requirements to represent user emotional expectations.

We present two elicitation techniques to identify key emotional goals, along with functional and quality goals, at the very early stages of the software development life cycle. Next, we extend a set of agent-oriented models to represent the emotional goals from different view-

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points. We also provide a technique to generate emotion-informed personas to highlight the emotional goals identified during the elicitation process. Lastly, we present a simple validation tool, namely the emotion-oriented questionnaire, to validate the extent to which user emotional goals have been addressed by the system.

These emotion-oriented techniques have been trialed within three real life case studies in different domains. Our findings show that our elicitation techniques were successful in eliciting key user requirements. The emotion-oriented models have proved to be a helpful tool during discussions with different stakeholders while the emotion-informed personas were used by designers to bridge the gap between the requirements phase and the design phase. The emotion-oriented questionnaire, was designed after several iterations and the final version proved to be a successful emotion assessment tool. Given their lightweight nature, these techniques can be applied to any domain where user emotional goals are of paramount importance.

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Dedicated to my family



# Acknowledgements

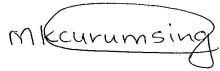
I would like to acknowledge with particular gratitude the assistance of my supervisors, Assoc Prof. Jean-Guy Schneider, Prof. Rajesh Vasa and Prof. John Grundy. I am also indebted to a number of other people, in particular, Prof. Leon Sterling, Dr. Tim Miller, Assoc Prof. Sonja Pedell, Dr. Antonio Alejandro Lopez Lorca, Dr. Antonette Mendoza, Dr. Neil Thomas, Prof. Michael Kyrios, Bambi Price and Frederick Price who collaborated with me on various research projects and provided much needed support. Thanks also to all the people who participated in my projects and provided valuable feedback.

Finally, I would like to thank my family for their loving forbearance during the long period it has taken me to conduct the research and write up this thesis.

Maheswarae Kissoon Curumsing, 2017

# Declaration

I declare that this thesis contains no material that has been accepted for the award of any other degree or diploma and to the best of my knowledge contains no material previously published or written by another person except where due reference is made in the text of this thesis.

Handwritten signature of M. K. Curumsing, enclosed in a hand-drawn oval.

Maheswaree Kissoon Curumsing, 2017

# Publications Arising from this Thesis

The work described in this thesis has been published as described in the following list:

1. M. Kissoon Curumsing, S. Pedell, R. Vasa. Designing an Evaluation Tool to Measure Emotional Goals. *IJPOP 3(1): 22-43*, 2014.
2. M. Kissoon Curumsing, A. A. Lopez-Lorca, T. Miller, L. Sterling, R. Vasa. Viewpoint Modelling with Emotions: A Case Study. *IJPOP 4(2): 25-53*, 2015.

Although the thesis is written as a linear document, the actual research work involved substantial exploration, idea formation, modelling, experimenting and some backtracking as we hit dead-ends. The following text outlines how the publications relate to this thesis.

Both articles helped lay the foundation and scope of the work presented in this thesis. Specifically, the first paper contributed to identify the gap in existing literature (Chapter 2), linked to the little consideration given to user emotional expectations when developing software. This paper introduced the concept of 'Emotional Goals' (Chapter 4). It also helped establish and refine the design of the emotion-oriented assessment tool (Chapter 7). The second paper contributed to the content presented in Chapter 6 of this thesis which describes the way agent-oriented models can be extended to represent user emotional goals.

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# Chapter 1

## Introduction

Software engineering literature provides software professionals with different sets of techniques and methods on how software should be constructed. This includes methodologies (Basili and Weiss, 1983, Bresciani et al., 2004, Jacobson, 2004, Jennings, 2000, Rumbaugh et al., 1991), modelling notations (Ambler et al., 2002, Warmer and Kleppe, 1998), as well as guidance on how requirements should be elicited to improve software systems (Pohl, 2010). This knowledge base keeps on evolving to meet the current needs of software professionals and, most importantly, the end-users. Despite this wealth of knowledge on how to construct software, evidence suggests that even though systems are developed following the rigorous methods of well-established methodologies, they are not always accepted by end-users (Hassenzahl, 2008, Lorence and Park, 2006, Meuter et al., 2005, Wood and Moreau, 2006).

One of the reasons identified for this failure is that software professionals often design a product from a set of desired functional and non-functional goals based on *their* understanding of the system, resulting in an end-product which fails to fulfill the needs of its intended users. A growing concern can be found in literature where researchers (Demiris et al., 2004, Mendoza et al., 2013, Pedell et al., 2013, Ramos et al., 2005) pointed out that software engineers fail to give adequate consideration to users' emotional needs when designing systems, leading to unhappy end-users. Even though the consideration of emotion is be-



coming predominant in the area of design, including human-computer interaction, this consideration has not been successfully mapped to the software engineering field (Miller et al., 2015). Evidence (Demiris et al., 2004, Mendoza et al., 2010, Norman, 2005, Pedell et al., 2013), on the other hand, suggests that user emotions play a determining role in the acceptance of a technology, particularly with regard to domestic and social systems.

In one of their works, Ramos and Berry (2005) presented four case studies to demonstrate how computer based systems can fail when they conflict with the emotions, beliefs and values of stakeholders. One of the case studies referred to an application designed to store information about mistakes and details about the person who was responsible for the mistake. Users felt so stressed with this feature that it had to be removed. Studies in the area of socio-technical systems have also highlighted the need to consider stakeholders' emotions during system design (Demiris et al., 2004, Miller et al., 2012, Pedell et al., 2013). Socio-technical systems, such as healthcare systems, smart home technologies and games, focus mainly on quality goals rather than functional goals. For instance, healthcare systems are designed with the aim to improve the quality of life or health of people. Therefore, to ensure high-quality end products, it is important to consider stakeholders' needs including their emotional needs. A study conducted by Demiris et al. (2004) investigated the way older adults perceive smart home technologies installed in their homes. The results revealed issues such as violation of *privacy* and *independence* which are mainly linked to the way the stakeholders *feel* about the system. Another study by Pedell et al. (2013) was geared towards the issues that older adults face when using emergency alarm pendants. Issues such as *lack of independence*, *feeling old*, *frail*, *stigmatised* and *uncared for* were some of the most common comments found from the interviews conducted with those older adults. Again these issues relate to the way users *feel* about using a technology or a system.

Addressing users' emotional goals in software engineering entails a number of challenges. First of all, emotion in itself is a very complex and subjective concept, making it hard to capture and measure. In addi-

tion, existing software methodologies barely address the concept of user emotional expectations (Lathia, 2013, Marks, 2013, Miller et al., 2015, Urken, 2013), leaving software engineers with little guidance on how to incorporate user emotional expectations within the existing software development life cycle. The literature involving emotion and software engineering is mainly focused on requirements gathering and modelling (Colomo-Palacios et al., 2010, Ramos and Berry, 2005, Ramos et al., 2005, Sutcliffe, 2011, Sutcliffe and Thew, 2010, Thew and Sutcliffe, 2008).

In some of these studies, researchers only acknowledged the importance of emotions within the requirements engineering phases and emphasised the impact emotions can have on the requirements engineering processes. For example, Thew and Sutcliffe (2008), Sutcliffe and Thew (2010) and Sutcliffe (2011) referred to people's feelings as '*soft issues*' and argued how vital it is to consider user beliefs and values for the success of a software. They proposed a taxonomy consisting of a set of values and motivations and determined the severity of their impact on the requirements. Proynova et al. (2011) considered personal values to find requirements which may have remained hidden. Ramos et al. (2005) argued about the need to consider the impact that emotions, values or beliefs can have on requirements. According to them, the identification of stakeholder emotions could lead to a better understanding of the reliability and stability of requirements definition. In the area of requirements modelling, Yu (2009) proposed the *i\** framework with an attempt to represent some aspects of social modeling which they termed *soft goals*. Along with the traditional non-functional requirements such as "reliability", soft goals such as "trustworthiness", which are more aligned with user emotional expectations, were also represented.

Even though there is some early progress on incorporating the concept of emotion in software solutions (Colomo-Palacios et al., 2010, Lathia, 2013, Marks, 2013, Ramos and Berry, 2005, Ramos et al., 2005, Sutcliffe, 2011, Thew and Sutcliffe, 2008, Urken, 2013), to the best of our knowledge, there is no structured software methodology or framework to capture, model and incorporate user emotional goals within the soft-

ware development life cycle. In recent work (Lopez-Lorca, Miller, Pedell, Mendoza, Keirnan and Sterling, 2014, Miller et al., 2015), the concept of emotional goals were extended to the agent-oriented models of Sterling and Taveter (2009), demonstrating how to model emotional goals in the early phases of the requirements engineering process, and to carry these emotional goals through to detailed design. Our work builds on the work of Lopez-Lorca, Miller, Pedell, Mendoza, Keirnan and Sterling (2014) and Miller et al. (2015) to derive techniques to incorporate user emotional goals at different levels within the software development life-cycle.

## **1.1 Research Goals**

This research aims to improve the current understanding of how user emotional expectations can be incorporated within the existing software methodologies, specifically by providing a set of techniques to address user emotions. Two main stages of the software development life cycle are addressed in this thesis, namely, (1) Requirements elicitation and modeling and (2) Software Validation.

The main focus of our research is to understand the importance of emotional goals with regard to the acceptance of technology and how inadequate consideration of emotional goals can lead to software failure. This knowledge can help in improving software design thus reducing the risk of software failure. Additionally, we investigate different techniques to elicit and capture user emotions with an attempt to incorporate them within the software that is being designed. We further identify techniques to validate the extent to which these user emotional expectations have been addressed within the system. Given the lack of knowledge surrounding user emotions during software design, these emotion-informed techniques could provide guidance to software professionals on how to incorporate user emotions at the early stages of the requirements engineering phase.

## **1.2 Research Methodology**

Given the subjective nature of emotions, our research relies heavily on qualitative data. We build on the existing works surrounding emotions and user emotional expectations in the literature to understand the importance of user emotions with regard to the adoption of technology. We study the issues surrounding existing software and investigate alternatives to these existing systems.

Our approach consisted of conducting surveys and interviewing end-users about their experience with a particular software system. We then analysed the data collected to derive techniques to elicit, model and validate emotional goals. In order to test the validity of our proposed techniques, we conducted a case study with a set of participants. The findings from this case study were used to refine the proposed techniques. These techniques were then applied in other case studies and further refined based on the findings. We use the information collected from these case studies to present a set of elicitation and validation techniques.

## **1.3 Key Research Contributions**

User emotional goals are a critical determinant to the success of a software-intensive system and should therefore be treated with equal importance as functional goals during design and implementation. Addressing user emotional goals during the early life-cycle phases of a software project improves the chances of these goals being considered in the later stages of the software development life cycle. In this dissertation, we present a set of techniques to capture emotional goals. These techniques build upon well-established elicitation techniques such as brainstorming and content analysis but focus more towards capturing the emotional requirements.

More specifically, the main contributions of this thesis can be summarised as follows:

- Firstly, we investigated the need to capture and represent user emotional goals. Our findings highlight the importance of emotional goals as being a critical determinant to the success of software. Given that emotional goals describe the users feelings, perceptions and emotions generated from users' experience with technology, they do not relate to functional goals and fall under the category of non-functional goals. Emotional goals such as "having fun" and "cared about" are different from conventional quality goals. Quality goals are properties of the system while emotional goals are the properties of the user. Emotional goals do not relate to any of the existing taxonomies of non-functional requirements. Given the importance of user emotional goals with regard to the acceptance of a technology, these goals cannot be ignored and have to be represented within requirements documents. Hence, we argue that a new set of goals be created under the taxonomies of the non-functional requirements to represent user emotional expectations.
- Secondly, we investigated different ways to elicit user emotional goals. We propose two elicitation methods to elicit emotional goals, along with functional and quality goals, at the early stages of the software development life cycle. These methods have been trialled within our case studies and our analysis showed that these techniques were successful in eliciting key user requirements. Given their lightweight nature, these techniques can be applied to any domain where user emotional goals are of paramount importance.
- Thirdly, we extended the existing agent-oriented models proposed by Sterling and Taveter (2009) to include emotional goals. We present a set of emotion-informed, agent-oriented models at different levels of the viewpoint framework. These models, especially the goal model, have proved to be a helpful tool during discussions with different stakeholders.
- Fourthly, we presented a technique to generate emotion-informed

personas. These personas were designed in an attempt to bridge the gap between the requirements phase and the design phase. Our analysis showed that these personas were helpful to convey the key emotional goals to the designers.

- Fifthly, we proposed a simple validation tool to validate the extent to which user emotional goals have been addressed by the system. This tool, namely the questionnaire, was designed after several iterations and the final version proved to be a successful emotion assessment tool. However, given that this tool assesses emotional goals only from the users' perspective, it is highly recommended that this tool is accompanied by other well established validation tools.
- Finally, we contributed three case studies based on real life situations which can be used for further research. We also contributed techniques to capture, model and evaluate user emotional expectations which can further be enhanced or adapted to cater for different situations.

## 1.4 Thesis Organisation

This thesis is organised into a set of chapters as summarised below:

**Chapter 2 - Background** provides an overview of existing research on user emotional expectations and builds the foundation for our own work.

**Chapter 3 - Research Methodology** describes the case study research methodology and explains how this methodology was adapted to our study.

**Chapter 4 - Emotional Goals** highlights the importance of emotional goals within the software engineering paradigm. We argue about the need to create a separate category of goals under the existing taxonomies of non-functional goals to represent emotional goals.

**Chapter 5 - Case Study 1: TouchFrame** describes our first case study, namely the TouchFrame, which was designed to connect older adults with their loved ones. We discuss why emotional goals are important when designing smart technologies for older adults and apply our elicitation techniques to elicit the key emotional, functional and quality goals for the design of the TouchFrame application. We describe the trial of TouchFrame with participants and explain how our validation techniques were used during the trial. The findings from this study are discussed within the chapter.

**Chapter 6 - Capturing Emotional Goals** presents a set of emotion-informed agent-oriented models, two emotion-informed elicitation techniques which can be applied under two circumstances (namely *with* or *without* user involvement) and a technique to derive emotion-informed personas. The models can be used to represent emotional goals along with functional and quality goals at different layers of the viewpoint modelling.

**Chapter 7 - Emotion-Oriented Software Validation Method** describes our proposed emotion-informed assessment tool, namely *questionnaire*. We present the different iterations used to derive the validation tool based on the findings from the different case studies.

**Chapter 8 - Case Study 2: SMART** presents the second case study which was designed to improve the quality of life of people suffering from psychosis. We highlight the importance of emotional goals during the design of such systems and apply our elicitation and modelling techniques to elicit and represent the emotional goals. We describe the design of the study and discuss our findings.

**Chapter 9 - Case Study 3: Supportive Technology for Monitoring Sleeping Difficulties** describes the third case study which consisted of the design of a mobile app for people suffering from sleep difficulties. We apply our elicitation and modelling techniques to elicit and represent emotional goals. The design of the case study is described and the findings discussed within the chapter.

**Chapter 10 - Discussion** discusses the findings arising from the three case studies described in Chapters 5, 8 and 9.

**Chapter 11 - Conclusions** provides a summary of the work done. We highlight our contributions and discuss possibilities for future work.

## **1.5 Disclaimer**

This thesis is part of a research conducted by a group of researchers led by Prof Leon Sterling at the Swinburne University Center for Computing and Engineering Software Systems. This team explored different techniques to design an improved and innovative emergency alarm system for older adults living at home, to support independent living. Several parts of this thesis have been developed in collaboration with other members of the group and, therefore, it is possible that some of the results presented here overlap with results presented by others, in particular with the publications of Tim Miller (Miller et al., 2015) and Antonio Lopez Lorca (Lopez-Lorca, Miller, Pedell, Mendoza, Keirnan and Sterling, 2014). The author's personal research contributions have been highlighted in different parts of the thesis.



# Chapter 2

## Background

Human emotions have been widely researched in many disciplines including psychology, philosophy, neuroscience, medicine and even in some areas of computer science such as affective computing and human computer interaction. Their importance cannot be underestimated. Unfortunately, so far in software engineering, little consideration is given to how stakeholders *feel* or *would like to feel* when using a software product. Before investigating the reasons why user emotions are not given due consideration within the area of software engineering, it is important to understand the core concept of emotion. What is emotion? How do we identify and classify emotion? How is emotion expressed? In this chapter, we provide the background literature on emotion, highlighting the different definitions, theories, classifications and measures of emotion. Related work and literature surrounding user emotions within the area of software engineering are presented within the context in various chapters of this thesis. In this chapter, we provide a brief overview on studies surrounding the integration of emotion within software systems to provide motivation for our research goals.

### 2.1 Emotion

Emotions play a crucial role in the everyday life of a human being. They determine who we are and how we cope with our environment. Cam-

bria et al. (2012) refer to emotions as being complex states of feelings that result in physical and psychological reactions which have an impact on the way the person thinks and reacts. For instance, strong emotions can cause a person to react in ways that he/she would not have expected under normal circumstances. Emotions is a challenging topic and has attracted many researchers from diverse fields such as psychology, philosophy, neuroscience, medicine, history, sociology, and computer science (Colomo-Palacios et al., 2011, Kay and Loverock, 2008, Martinez-Miranda and Aldea, 2005, Plutchik, 2001). A number of theories on emotion have also been proposed over time and the number of words classifying emotions has not ceased to increase (Cacioppo and Gardner, 1999, Cambria et al., 2012, Ortony and Turner, 1990, Plutchik, 2003).

### **2.1.1 Approaches to Defining Emotion**

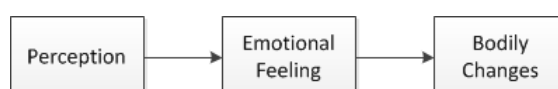
Plutchik (2003) provides a compilation of around 20 definitions of emotion from different researchers in the field of psychology between the years 1884 and 2000 where each theorist looked at emotion from a different perspective. Adolphs (2010) identified three approaches used by people to define emotion. The first one, most commonly used by psychologists, is to list the most salient attributes of emotions. For instance, the definition by James William in 1884 talked about the stimuli that trigger emotional bodily reactions and the way our perception of those changes generates emotions and feelings (William, 1884). His definition lists out the prominent features related to emotion. A second approach is to define emotion by contrast. For instance, compare emotion with cognition or feelings (Adolphs, 2010). The third approach consists of listing some examples of emotions like anger, joy, surprise and happiness.

### **2.1.2 Theories of Emotion**

Emotion is very often confused with the term feelings. However, Parker and Parker (2008) argue that *feelings* are only one aspect of emotion.

According to them, an emotion consists of four main components namely *cognitive processes*, *affect or subjective feelings*, *physiological arousal*, and *behavioural responses*. The relationship of cognition with emotion has led to a number of varying opinions among different researchers. According to Parker and Parker (2008), perception, learning and memory have an impact on the way people experience emotions. For example, just thinking about a close relative can generate a learnt emotion such as happiness. *Affect* is another component of emotion and relates to the subjective feelings of people. Many studies conducted over time (Chanel et al., 2008, De Bakker et al., 2011, Kay and Loverock, 2008, Nelis et al., 2011), revolve around researchers asking participants to describe the emotions they experience after or during a specific activity. The general answers obtained consist of words like *depressed*, *angry* and *happy*, which in reality relate to how people feel. This implies that most people relate their subjective feelings to emotion. *Physiological arousal* refers to the changes that are reflected in the person when experiencing emotions, for example, anger can lead to increased heart beat and changes in facial expression. *Behavioural responses*, on the other hand, refer to the effect of emotion on the way a person behaves or act.

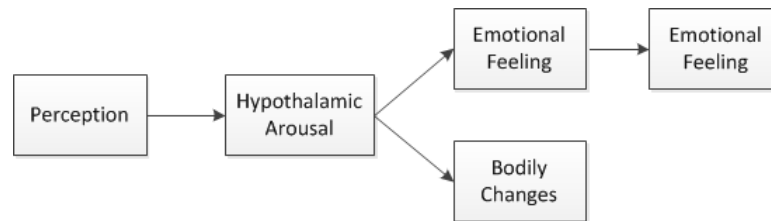
While most theorists agree that these four components, namely *cognitive processes*, *affect or subjective feelings*, *physiological arousal* and *behavioural responses* are important, debate is still going on regarding the mandatory presence of all four of them in every emotional event and the sequence in which they should occur. Different theories of emotion have been proposed over time which elaborate on the different sequence of components related to emotion, but in general most theorists agree that perception is at the beginning of each sequence of components. That is, perception is generally accepted as the trigger for an emotion. For instance, the “Commonsense View”, “James Viewpoint” and “Cannon Viewpoint” as illustrated in figures 2.1, 2.2 and 2.3 denote perception as the initial component leading to emotional reactions.



**Figure 2.1:** Commonsense viewpoint (Plutchik, 2003)



**Figure 2.2:** James viewpoint (Plutchik, 2003)



**Figure 2.3:** Cannon viewpoint (Plutchik, 2003)

According to Frijda (1986), emotions are viewed as outcomes of the process of assessing the world in terms of one's own concerns, which, in turn, modify action readiness. In other words, emotions result from events because people have a tendency to attribute events to be favourable or harmful to their own interests. Frijda considers emotion as a set of stages which starts with the **appraisal** of an event resulting in the **evaluation of the context**, leading to **action readiness** and ultimately resulting in **physiological change, expression and action**. After each event, a person starts by appraising the significance of the event with relevance to the goal. The second stage is thinking about how to cope with the event and the third stage involves action, for example making contact or feeling helpless. Ultimately, the emotion is expressed in terms of physiological changes in mood, facial expressions and/or actions of the person.

Plutchik (2001) identified emotion as not only a feeling but a complex chain of loosely connected events that begins with a stimulus and includes feelings, psychological changes, impulses to action and specific, goal-directed behaviour. In other words, emotions are the results of significant events in a person's life and also the motivation for actions. Plutchik further argued that if emotion is a chain of events, then cognition is at the beginning of that chain. He presented a chain of events starting with the stimulus event followed by the inferred cognition which results in the feeling state and the physiological arousal. The latter two leads to impulses to action resulting in overt behaviour and ultimately leading to effect. In other words, the way people perceive things has

a direct impact on the way that they react to it. For instance, hearing scary noises in the dark could be frightening for someone but could also be thrilling for someone else.

### 2.1.3 Classification of Emotion

Many theorists argue that some emotions should be classified as basic or primary and the remaining emotions should be grouped under these basic emotions. The research on emotions date back to ancient Greeks and Romans where Cicero organised emotions into four basic categories namely: *metus* (fear), *aegritudo* (pain), *libido* (lust), and *laetitia* (pleasure) (Cambria et al., 2012). Since then, many other classifications of emotion have emerged. Table 2.1 presents a collection of some existing definitions for basic, primary or fundamental emotions from different theorists. As ever, theorists disagree about the number of emotions that should be included within the basic category and also the terms that should be used within this list. While Weiner and Graham's theory propose only two basic emotions, Matsumoto provide a list of 22 basic emotions. The most widely used theory within affect recognition is Ekman's theory which consists of 6 basic emotions, namely *anger*, *disgust*, *fear*, *joy*, *sadness* and *surprise*. The differing views of theorists around the concept of basic emotions leads to doubts regarding the foundations of basic emotions.

In their review of basic emotions, Ortony and Turner (1990) analysed the list and came to the conclusion that most theorists consider *anger*, *happiness*, *sadness* and *fear* as basic emotions. They further pointed out that researchers use different words to define the same emotion. For example, where some theorists like Plutchik, Ekman and Arnold use the word *anger*, Watson, on the other hand, use the term *rage* to define the same emotion. Even though the gap between the different theories can be reduced through these arguments, they cannot be eliminated.

**Table 2.1:** Classification of Emotions

<b>Theorist</b>	<b>Reference</b>	<b>#Emotions</b>	<b>Basic Emotions</b>
Plutchik	Plutchik (2001)	8	Acceptance, anger, anticipation, disgust, joy, fear, sadness, surprise
Arnold	Arnold (1960)	11	Anger, aversion, courage, dejection, desire, despair, fear, hate, hope, love, sadness
Ekman, Friesen, and Ellsworth	Ekman et al. (1982)	6	Anger, disgust, fear, joy, sadness, surprise
Frijda	Frijda (1986)	6	Desire, happiness, interest, surprise, wonder, sorrow
Gray	Gray (1985)	3	Rage and terror, anxiety, joy
James	William (1884)	4	Fear, grief, love, rage
Matsumoto	Matsumoto et al. (2005)	22	joy, anticipation, anger, disgust, sadness, surprise, fear, acceptance, shy, pride, appreciate, calmness, admire, contempt, love, happiness, exciting, regret, ease, discomfort, respect, like
McDougall	McDougall (1926)	7	Anger, disgust, elation, fear, subjection, tender-emotion, wonder
Mowrer	Mowrer (1960)	2	Pain, pleasure
Oatley and Johnson-Laird	Oatley and Johnson-laird (1987)	5	Anger, disgust, anxiety, happiness, sadness
Panksepp	Panksepp (1982)	4	Expectancy, fear, rage, panic
Parrott	Parrott (2001)	6	anger, fear, joy, love, sadness, surprise
Tomkins	Tomkins (1984)	9	Anger, interest, contempt, disgust, distress, fear, joy, shame, surprise
Watson and Rainer	Watson and Rayner (1920)	3	Fear, love, rage
Weiner and Graham	Weiner and Graham (1984)	2	Happiness, sadness

### **2.1.4 Ways of Expressing Emotion**

It is challenging to determine the true feelings of a person merely through the words that he/she is using. For instance, if someone uses sarcasm, the meaning of the message can contradict the feelings of the person. On the other hand, a smile accompanied by crossed arms does not necessarily mean that the person is happy. Even though understanding emotions is very complex, humans are still able to identify common emotions like anger and happiness among others. In the early 1960s, Mehrabian (1968) came up with the claim that humans communicated their feelings more through non-verbal means than verbal means. This claim was further supported by a number of other studies over time (Adolphs, 2002, Argyle et al., 1970, Hsee et al., 1992, Joung and Do, 2011, Nakatsu et al., 2000). According to Mehrabian, considering the effect of the message as a whole, words accounted for only 7%, tone of voice accounted for 38%, and body language accounted for 55% of the effect of the spoken message. His theory was later challenged by Argyle et al. (1970) and Hsee et al. (1992) who came up with different values while trying to determine the effect that non-verbal communication had over verbal communication. They both, however, concluded that non-verbal communication had a greater impact over verbal communication with regards to determining the feelings of the person. Hence, it is important to understand the non-verbal means of communication. The most commonly known ways through which emotions are expressed are: body movements and posture, speech patterns, gestures, facial expressions and physiological cues (Adolphs, 2002, Argyle et al., 1970, Hsee et al., 1992, Joung and Do, 2011, Mehrabian, 1968, Segal et al., 2013, Trimarchi, 2013).

#### **Facial expressions**

Studies on facial expressions started way back in the 1800s where researchers like Darwin noted that when a person is experiencing a very strong emotion, the orbicular (eyelid) muscles of the eye contract strongly which becomes part of the facial expression. In 1984, Rinn described the face as a display of emotions and thus a medium to detect the emotional state of an individual (Rinn, 1984). Further research in recent years showed that irrespective of cultural differences,

all humans can unconsciously recognise the following 7 universal facial expressions which are anger, contempt, disgust, fear, happiness, sadness and surprise (Trimarchi, 2013). A number of studies in different areas have been conducted where facial expressions have been used as the medium to detect emotion (Adolphs, 2002, Benson, 1999, Jack et al., 2012, Mandryk and Atkins, 2007, Penton-Voak et al., 2013, Swinton and Kaliouby, 2012). Recent research in the area of psychology even studied the impact that wrinkles have on facial expressions and whether the identification of emotions is affected by the presence of wrinkles (Hess et al., 2012).

### **Speech Patterns**

Emotion can also be detected through speech patterns and words that a person uses to express himself/herself (Blasi et al., 2011, Mehrabian, 1968, Scherer, 1995). Little research exists in the field of emotion recognition through speech mainly because it is difficult to collect a large sample of utterances that contain emotions (Nakatsu et al., 2000). Trimarchi (2013) uses the example of “I am fine” to stress on the way a person might make others realise that he/she is not fine. The tone that an individual uses to utter words can relate to the way the person is feeling. Mehrabian (1968) emphasises the difference that exists between verbal and vocal information. Vocal information refers to intonation, tone, stress, length and frequency of pauses which are lost when the words are written down. A recent study by Krothapalli and Koolagudi (2013) defines speech as “a composite signal that mainly carries information about the message to be conveyed, emotional content of the message, speaker characteristics and language information”. This study was geared towards characterising and recognising emotions in speech.

### **Body Posture**

Body posture has been the interest of many researchers over time (Mehrabian, 1968, Segal et al., 2013, Trimarchi, 2013). Bending your head down all the time while walking or walking with chest up can indicate the emotional state the person is in. For instance, Trimarchi (2013) points out that standing too close to a person can indicate feelings of



love or aggression, dominance or submission. In the 1800s, Charles Darwin conducted some studies on the movement of man and animals to see whether emotions can be captured through body posture. Ever since, other studies have been conducted in the area (Aharonson and Amir, 2006, McHugh et al., 2010, Mehrabian, 1968, Montepare et al., 1999, Riskind and Gotay, 1982, Yildirim et al., 2011) and recently, Nele et al. (2012) conducted some experiments to show that emotions could be identified through different patterns of body movement.

### **Gestures**

Gestures, for example, waving, pointing and using our hands while talking, are strong indicators of the emotion that a human is experiencing (Montepare et al., 1999). Tan and Nareyek (2009) define gestures as actions/movements of body parts and termed them as another component of non-verbal communication of emotion. According to Trimarchi (2013) and Segal et al. (2013), gestures have different meanings in different cultures but in general they are non-verbal mediums to communicate emotions to others. Researchers conducted several experiments to understand the emotions related to specific gestures over time (Joung and Do, 2011, Montepare et al., 1999, Tan and Nareyek, 2009). A study by Joung and Do (2011) on hand gestures showed promising results with regards to the use of tactile hand gestures for the communication of emotions among people using online digital communication devices at a distance.

### **Physiological cues**

Another area of study has been in the field of emotion and physiological cues. Ekman et al. (1978) defined cues as non-verbal signals which involve either the movement/positioning of specific parts of the body or the movement/positioning of a group of body parts in concert with each other. For instance, raised fist, narrowing of the eyes, a subtle flush of the face, deep breathing, increased body temperature can be used for interpreting the emotional state of a person. A study conducted by Planalp (1996) required some participants to report cues that they used to detect emotions in other people they were living with. The results showed that most of them relied on vocal, facial, indirect verbal, context,

body and activity cues to determine the emotion being experienced by the person. Another interesting outcome of this study was that very few people considered direct verbal cues as the indicator of emotion. Segal et al. (2013) also talk about how eye contact and touch can be used to express. For instance, the expression “if looks could kill” certainly indicates that intense hostility can be expressed simply through eye contact. Other emotions like interest, affection or attraction can also be gauged from the way a person maintains eye contact with another. Similarly, a weak handshake, a tap on the shoulder or a controlling grip on the arm can be other means to determine the emotion a person is experiencing.

When it comes to identifying the emotions of a person, humans, generally base their conclusions on a combination of the above mentioned ways of communication. As mentioned earlier, a smile and crossed arms do not necessarily relate to a person being happy. It is important to take into consideration other things like, for example, the facial expressions, speech patterns, eye contact and body posture. The study by Planalp (1996) showed that very few participants relied on a single cue to determine the emotion expressed by the other person living with them. Also, many studies have been conducted where a combination of the non-verbal communication means have been used to determine the emotion being expressed by the participant (Mehrabian, 1968, Montepare et al., 1999, Tan and Nareyek, 2009).

### **2.1.5 Measures of Emotion**

A diverse range of objective and subjective instruments have been used over time to measure emotion in various fields of study including areas within the computer science field, such as affective computing, computer design and software engineering. The commonly used emotional assessment instruments includes self-report/questionnaires, observations, facial/speech recognition, heart rate, blood pressure, skin conductance and ECG (Allaire et al., 2013, Colomo-Palacios et al., 2011, Kay and Loverock, 2008, Lakens, 2013, Lisetti and Nasoz, 2004, Lottridge, 2008, Powers et al., 2011, Rani et al., 2006). The reasons under-

lying the divergence in the approach used to measure emotion is often linked to the existence of differing views and definitions of emotions (Plutchik, 2003, Thompson, 2011). Cambria et al. (2012) argue that even though numerous techniques have been used to measure emotion, there exists **no exact means or function to directly measure emotion or the intensity of emotion**. However, humans have the faculty to identify the emotional state that a person is experiencing. For instance, humans can easily detect emotions like happiness and sadness.

According to Adolphs (2010), studies of human emotion mostly measure the autonomic responses such as neurobiological processes, behaviour, social communication and bodily changes among others. However, there is no predefined set of what should be measured. Adolphs (2010) highlighted the importance of measuring emotions at the brain level but he also argues that other factors like environment and other physiological changes like heart beat, respiration or pupil dilatation should not be completely ignored. The measures of emotion provided in literature vary widely from simple subjective reports to observation of hand writing to the measuring of the heart rate. Plutchik (2003) compiled the different approaches used under four categories namely: (1) the self-reports of subjective feelings; (2) Judging emotions through ratings made of the behaviour of an individual; (3) Rating of the product of someone's behaviour, for example, through someone's handwriting or figure drawings; (4) Physiological recordings of bodily changes. Most of the studies (Allaire et al., 2013, Colomo-Palacios et al., 2011, Kay and Loverock, 2008, Lakens, 2013, Lisetti and Nasoz, 2004, Lottridge, 2008, Powers et al., 2011, Rani et al., 2006) indeed do make use of one or more of the four approaches proposed by Plutchik (Clancy and Noyes, 1976, Gough, 1960, Lisetti and Nasoz, 2004, Nelis et al., 2011).

### **2.1.6 Key Findings**

Emotion is a subjective and complex topic leading to the emergence of different theories and classifications over time. An important finding from the literature revealed that the terms used to identify emotion

such as *anger*, *disgust*, *fear*, *joy*, *sadness* and *surprise* do not relate to user emotional expectations. Our focus is to incorporate user emotional expectations within the software development life cycle, to ensure that users' emotional needs are addressed by the software. User emotional expectations for a particular system, say a smart home technology, could be "feeling cared for", "feeling connected" and "feeling independent". These terms do not fit under any of the classifications of emotion listed in Table 2.1. For instance, how do we map "cared for" to a list of emotions consisting of terms like *anger*, *disgust*, *fear*, *joy*, *sadness* and *surprise*. Even though user emotional expectations relate to the way users feel or want to feel, they are not emotions. User emotional expectations relate mainly to the way users perceive the end product. For instance, the term "feeling cared for" depends on how the users think that using a software can make them "feel cared for". Given the subjectivity and complexity of emotion, there is no way to guarantee that users will actually *feel cared for* after using the end-product. It all depends on the way they perceive the system.

Based on the theories of emotion, discussed in Section 2.1.2, perception is the trigger that generates emotion and, hence, our consideration of perception is justified. In this thesis, users' emotional expectations refer to how users perceive the end product.

## **2.2 Emotion in Relation to Software**

The role of emotion as relating to software has been investigated from various perspectives and across several domains of computer science including human computer interaction (HCI), game design, and affective computing. Since its emergence in the early 1980s, the studies surrounding HCI have focused on ensuring high quality user experience with computer systems and have since then evolved to look into different aspects of usability. Usability is the extent to which a system can be used by the end-users to achieve its intended objectives effectively, efficiently and satisfactorily. The current trend in HCI is user experience which investigates the effects experienced by end-users due to usability, usefulness and emotional impact factors (Benyon et al.,

2005, Dix, 2004, Hartson and Pyla, 2012). The designers of interactive systems are constantly finding innovative ways to ensure that the end-users have a great experience with the product. Interestingly, in the area of game design, designers have been doing the same thing for several years (Benyon et al., 2005). When designing games, one of their primary goals is to ensure *joy of use* among other intended emotions such as *excitement*, *fear* and *anticipation*.

Affective computing is another area where emotion has been widely researched. Affective computing is the study and development of systems and devices that can recognize, interpret, process and simulate human affects, that is, the experience of feelings or emotions (Boehner et al., 2007, Mao and Li, 2010, Reisenzein et al., 2013). The studies conducted in this area are mainly geared towards empowering software systems with emotional intelligence such that the software system can exhibit emotions like humans (Agrafioti et al., 2012, Calvo and D’Mello, 2010, Guo et al., 2013, Mao and Li, 2010, Mauss and Robinson, 2009, Ren, 2009).

Even though emotion has been widely researched within areas such as HCI, game design and affective computing, little consideration has been given to this concept within the area of software engineering. Evidence suggests that inadequate consideration of user emotional expectations is a major reason why end-users refuse to accept a technology (Demiris et al., 2004, Mendoza et al., 2013, Pedell et al., 2013, Ramos et al., 2005). Software engineers who are trained to develop systems based on a set of functional and non-functional requirements of the system, often fail to take into account what users actually desire from the system. But then not all user expectations can be easily converted into functional or non-functional requirements, a view expressed well by Paay et al. (2009) in their work where they present a multidisciplinary approach to engineering socio-technical design: “...As social beings we often have loftier needs, such as to experience social connection and empathy, to care for others and be cared for, and to share pleasure. These particular types of social requirements should not be easily reduced to functional specifications for information provision”. The current software methodologies fail to provide adequate guidance on how to incorporate users’ social and

emotional needs when constructing software and hence these needs are very often ignored or trivialised (Sommerville, 2010). The importance of user emotional expectations with regards to acceptance of technology can neither be ignored nor underestimated.

A growing appreciation can be found in literature surrounding the importance of emotions within the early requirements engineering phases. In their work, Thew and Sutcliffe (2008), Sutcliffe and Thew (2010) and Sutcliffe (2011) refer to people's feelings as '*soft issues*' and argue about how vital it is to consider user beliefs and values for the success of a software. They propose a taxonomy consisting of a set of values and motivations and determine the severity of their impact on the requirements. Proynova et al. (2011) consider personal values to find requirements which may have remained hidden. Ramos et al. (2005) argue about the need to consider the impact that emotions, values or beliefs can have on requirements. According to them, the identification of stakeholder emotions can lead to a better understanding of the reliability and stability of requirements definition. In the area of requirements modelling, Yu (2009) propose the *i\** framework with an attempt to represent some aspects of social modeling which they term as *soft goals*. Along with the traditional non-functional requirements such as "reliability", soft goals such as "trustworthy", which are more aligned with user emotional expectations, are also represented.

Even though there is some early progress on integrating emotions in software solutions (Colomo-Palacios et al., 2010, Lathia, 2013, Marks, 2013, Ramos and Berry, 2005, Ramos et al., 2005, Sutcliffe, 2011, Sutcliffe and Thew, 2010, Thew and Sutcliffe, 2008, Urken, 2013), to the best of our knowledge, there is no structured software methodology or framework that fully describes how to capture, model and incorporate user emotional goals within the software engineering software development life cycle.

## 2.3 Summary

In this chapter, we presented different aspects of emotion including definitions of emotion, theories of emotion, classifications of emotion, ways of expressing emotion and measures of emotion. Based on our findings from the literature surrounding emotion, we conclude that emotion is a subjective and complex topic and different theories have emerged to address this topic. Due to the diverging theories, emotion has not only been defined in various ways but has also been classified differently. Another key finding surrounding emotion is that there is no single measure of emotion. All the existing measures of emotion are designed to measure a single or a group of emotions. Also, user emotional expectations such as “feeling cared for”, “feeling connected” and “feeling relaxed” do not fit under any classifications of emotion. These terms, even though related to the way users want to feel, are not emotions. They relate mainly to perception. Given that perception is the trigger which generates emotion, when we refer to users’ emotional expectation, we therefore refer to users’ perception rather than users’ emotion. In other words, users’ emotional expectations refer to how users perceive the end product. Similarly when we refer to the evaluation of users’ emotional expectations we refer to the evaluation of users’ perception.

An important finding from the literature surrounding the integration of emotion in software systems is that even though emotion has been extensively researched in areas such as HCI, affective computing and game design, little consideration has been given to it in the area of software engineering. Evidence, on the other hand, suggests that user emotional expectations are a critical determinant to the acceptance of a technology. Incorporating user emotional expectations within the software development life cycle is very challenging given that the current software methodologies fail to provide adequate guidance to software engineers in this matter. Even though some studies have emphasised the need to introduce emotions within the software development life cycle, in particular, requirements elicitation and modelling, as far as we are aware, no methodology or technique has been proposed to integrate emotions fully within the software development life cycle. As part of our

research, we aim to address this major gap in the literature by investigating techniques to capture, represent and validate user emotional expectations.



# Chapter 3

## Research Methodology

There are two primary categories of research methodologies, namely quantitative and qualitative research methodologies (Clarke, 2005, Knowles and Cole, 2008, Wisker, 2007). Quantitative research methods suit studies where the theory being tested is composed of variables, can be measured and can be analysed using statistical techniques (Abawi, 2008, Thomas, 2003). On the other hand, qualitative research methods are used where the phenomenon under study generates subjective data in the form of words, pictures or narrative text which cannot be directly quantified.

Considering that emotion and user emotional goals are subjective and complex in nature, we explored different research methods proposed under the qualitative research methodology. There are various qualitative methods proposed in literature but commonly used methods are participant observation, structured observation, unstructured interviews, content analysis of documents, focus groups and case studies (Abawi, 2008, Mack et al., 2005, Trochim, 2006). Each of these qualitative methods has its own set of advantages and disadvantages. For instance, while interviews and content analysis of documents provide information about the subject of study, they are restricted compared to participant observation and structured observation techniques where a richer set of data can be obtained. But then when used individually, these observation techniques generate two major research problems

namely: *bias* and *reactivity* (Mack et al., 2005, Spradley, 2016). The data collected during observation is often done through extensive note taking by the researcher where a single observer's opinion is recorded. Additionally, when being observed, participants may not act naturally and thus the data recorded does not reflect the actual situation. Given that each method has its own set of limitations when used individually, we decided to use a research methodology which allows the use of different techniques to complement each other. The research methodology chosen was therefore the *case study research methodology*. This methodology provides the researcher with the flexibility to use a combination of different approaches allowing for a deeper insight into the phenomenon under study. In this chapter, we present the case study research methodology and its processes.

This chapter is organised as follows: Section 3.1 provides an overview of the case study research methodology. Section 3.2 presents the steps involved in designing the case studies followed by a summary of each case study used in this research. Section 3.3 describes the process involved for data collection. Section 3.4 provides an overview of the data collection process. Section 3.5 describes four criteria to judge the quality of research designs. Section 3.6 describes how the data collected is evaluated. Section 3.7 discusses how the findings of this study will be presented in this thesis.

### **3.1 Case Study Research Methodology**

Case study is used as a research methodology in various fields namely psychology, sociology, political science, social work, business and community planning (Robson, 2002, Runeson et al., 2012, Stake, 1995, Yin, 2013). According to Runeson et al. (2012), case studies are used in these fields to gain additional knowledge about the phenomena being studied. Interestingly, case studies have also found their place within software engineering and they are designed to achieve similar objectives to those in the other fields. Yin (2013) defines a case study as “an empirical inquiry that investigates a contemporary phenomenon (“the case”) in depth and within its real-world context, especially when the bound-

aries between phenomenon and context may not be clearly evident”. Yin also talks about how a case study inquiry relies on multiples sources of evidence to study various perspectives of the phenomenon and how the data collected during the process may converge in a triangulating fashion. This definition of a case study can be suitably applied in software engineering since many experiments in this area have shown that the existence of various factors have a major impact on the results of the study (Kitchenham et al., 2002, Runeson et al., 2012).

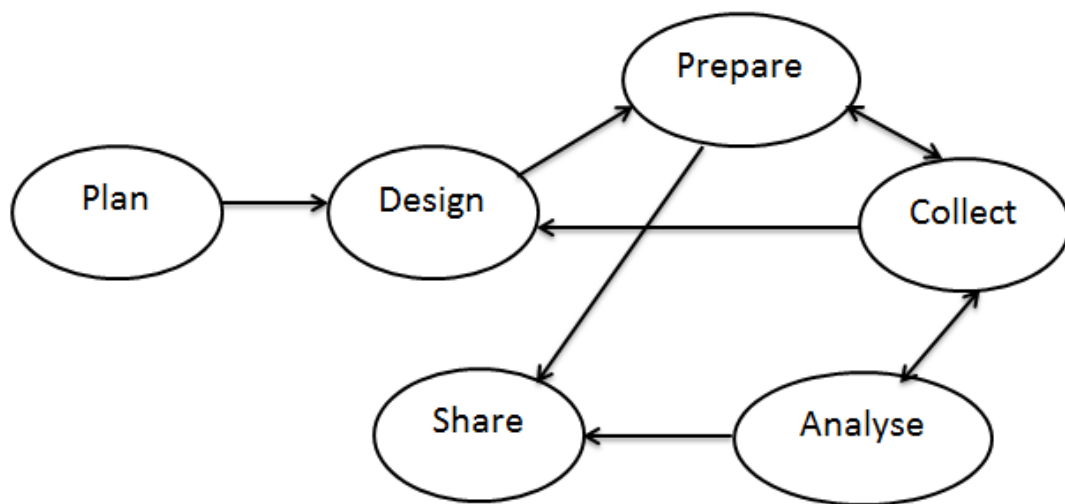
Different studies in the area of software engineering show the value of case studies (Darke et al., 1998, Godfrey and Tu, 2000, Runeson et al., 2012, Von Krogh et al., 2003). In general, software engineering case studies are designed to study a particular phenomenon in their real-life environment and, since the researcher has little control over changes that are bound to occur during the study, the design must permit flexibility. The flexibility presents challenges, in particular bias, that the design must address. Due to its flexible nature, case studies have attracted criticisms (Flyvbjerg, 2006). Some argue that the lack of rigor while performing research, influences research quality (Campbell et al., 1963). Others feel that the outcomes based on case studies are biased as it concentrates on a small sample size and therefore cannot be generalised (Abercrombie et al., 1984, Diamond, 1996). In addition, the data collected during case studies is in different formats making it complex<sup>1</sup> to analyse (Yin, 2013). No single method or technique can be used to collect data from case studies. Despite these challenges against the case study approach, research papers that rely on case studies from different fields are widely published and researchers use this approach successfully in carefully designed studies of real-life situations (Runeson et al., 2012, Sjoberg et al., 1991).

The case study methodology is ideally used in studies where an in-depth exploration of the phenomenon is required (Sjoberg et al., 1991, Tellis, 1997) or when the researcher is looking for answers to descriptive questions which are framed using *how* and *why* (Yin, 2013). Additionally, Yin (2013) advocates the use of the case study research methodology in situations where the investigator has little control over the events and

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<sup>1</sup>Lots of interconnected and unstructured data

when the study has to be conducted within some real-life context. The essence of a case study is that it tries to illuminate a decision or set of decisions; why they were taken; how they were implemented; and with what results (Yin, 2013). Over the years, researchers (Darke et al., 1998, Runeson et al., 2012, Stake, 1995, Yin, 2013) have presented techniques that should be adopted when using the case study research methodology in order to ensure successful completion of the research. In his book, Yin (2013) presents a linear but iterative process to conduct case studies which is illustrated in Figure 3.1. We apply this approach to our research.



**Figure 3.1:** Case Study Process (adapted from Yin (2013))

The first step when using a case study method is to plan for the study. Yin (2013) insists that researchers should be conversant with the case study method and understand the reasons why this research method is suitable for their study as compared to other research methods. In our situation, the study of user emotional goals entails subjective and complex data, since the study is directly linked to how users behave when it comes to adopting technology. As researchers we have little or no control over how the study will progress. Our research will involve several participants and each participant can react differently. We therefore require enough flexibility to adjust to the flow of events and maximise data collection. We cannot restrict ourselves to a particular process or technique as we have to cater for different situations throughout the study. Hence, the case study method best suits our research.

The remaining sections of this chapter present an overview on how the different steps involved in the case study process were applied in our research, and we describe how the common challenges of case study research were addressed in our work.

## **3.2 Designing Case Studies**

Yin (2013) describes the research design as being a logical plan which starts with the initial set of research questions and ends with a set of conclusions. The case study design requires careful planning and consideration because, as opposed to other research methods, literature does not provide a standard process on how to design case studies (Runeson et al., 2012, Yin, 2013). The following five components are considered important in any case study research:

- a case study's research questions
- its propositions, if any
- its unit(s) of analysis
- the logic linking the data to the propositions
- the criteria for interpreting the findings

### **3.2.1 The Research Questions**

Even before starting the study, it is important to understand the rationale for the study (Runeson et al., 2012) and also determine the focus of the study (Foss, 2007). In our case, the rationale for conducting a study on user emotional expectations is mainly to bridge the existing gap in the literature. As mentioned in the previous chapter, even though emotions have been explored in different fields, it is yet to be embraced in the area of software engineering beyond HCI. Additionally, user emotions which are critical to the acceptance of a technology are often ignored during the design of technology. Hence, the rationale for

our study is to explore this phenomenon in more depth. We set the focus of our study by defining the following research questions based on the gaps identified in the literature with regards to user emotional expectations.

**RQ1** Why should user emotional expectations be elicited?

**RQ2** How can user emotional expectations be elicited?

**RQ3** How can user emotional expectations be validated?

The questions identified for our research are mainly of an exploratory nature, which requires an in-depth investigation of the phenomenon within a real-life environment involving real users, hence justifying the use of the case study method as a research approach.

### **3.2.2 Unit of Analysis**

The unit of analysis identifies what a “case” should be within each case study. This is an important step requiring careful analysis of what or who to include and exclude in a case. Since we are dealing with user emotional expectations, which are subjective, we plan to conduct our study with a group of users who are willing to adopt a technology for a specific period of time. We prefer to study a group of users rather than a single user with the intention to capture data from different sources which may then be useful to compare at a later stage before drawing conclusions. In addition, we plan to conduct multiple case studies rather than a single one as they may give us additional insight on the problem being studied and also enable cross data comparison. For each case study, the criteria used to identify the cases and the study has been discussed in the chapter dedicated to that particular study.

In general, our objective was to consider the following situations when selecting case studies:

- real life situation where acceptance of technology is widely influenced by user’s emotional expectations

- different areas, such as health care and smart home technology to increase variation in data collected and improve validity
- stakeholders are from different age groups and backgrounds

Not all the case studies that were conducted during our study were designed to answer all the three research questions. The reason being mainly due to the diversity of the environment within which the case studies were being conducted. In this chapter, we provide a brief overview of each case study in tables 3.1, 3.2 and 3.3. Detailed information on each case study is presented in the chapter dedicated to that case study.

### **3.2.3 Linking Data to Propositions**

There are different techniques proposed to link data to propositions, namely pattern matching, explanation building, time-series analysis, logic models and cross-case synthesis (Yin, 2013). We plan to use the explanation building technique which is mainly relevant to explanatory case studies such as ours. Additional information on this technique will be provided in Section 3.6.

<b>Case Study Title</b>	<b>Touch Frame Application: Designing for connectivity for older adults at home</b>
Description	This research project examines how older adults interact with wellbeing systems without the user feeling monitored, controlled or dependent on others. We introduce a basic prototype in the form of a digital photoframe application showcasing how technology can be integrated in older adults' lives with the merits of feeling safe, having fun and staying in touch with family members and peers.
Chapter	5
Our involvement	<ul style="list-style-type: none"> <li>• Early stages of the requirements elicitation process - the identification of functional, quality and emotional goals of the users;</li> <li>• Generation of a goal model to represent the different types of goals;</li> <li>• Evaluation of the prototype in the homes of older adults</li> </ul>
Unit of Analysis	Participants include anyone living alone in their home and who are 65 years of age or over
Participant involvement	<ul style="list-style-type: none"> <li>• Taking part in interviews;</li> <li>• Using the digital photoframe application for a period of 3 months or more;</li> <li>• Filling up the Niko Niko calendar and evaluation questionnaire;</li> </ul>
Data Collection Tool	Interviews, Questionnaires and Niko Niko Calendar
Research Questions Addressed	<p><b>RQ1</b> Why should user emotional expectations be elicited?</p> <p><b>RQ2</b> How can user emotional expectations be elicited?</p> <p><b>RQ3</b> How can user emotional expectations be validated?</p>

**Table 3.1:** Case Study 1: TouchFrame Application



<b>Case Study Title</b>	<b>Self Management and Recovery Technology (SMART): Use of online technology to promote self-management and recovery in people with psychosis</b>
Description	This research project examines the potential of using online (Internet-based) educational and multimedia resources in mental health services. It involves the development of a website consisting of a series of educational modules containing textual information, exercises, audio, and video clips designed to promote self-management and recovery in people with a history of persisting mental illness.
Chapter	8
Our involvement	<ul style="list-style-type: none"> <li>• Early stages of the requirements elicitation process - the identification of functional, quality and emotional goals of the users;</li> <li>• Generation of a goal model to represent the different types of goals;</li> <li>• Generation of emotion-informed personas;</li> <li>• Informal evaluation of the prototype through an interview with a user.</li> </ul>
Unit of Analysis	Participants include anyone who has experienced psychosis or who is working with/ caring for someone who is experiencing psychosis
Participant involvement	<ul style="list-style-type: none"> <li>• taking part in focus groups and interviews;</li> <li>• using the website to share their experiences and/or as a tool for self-recovery</li> </ul>
Data Collection Tool	Focus Groups and Interviews
Research Questions Addressed	<p><b>RQ1</b> Why should user emotional expectations be elicited?</p> <p><b>RQ2</b> How can user emotional expectations be elicited?</p>

**Table 3.2:** Case Study 2: Self Management and Recovery Technology (SMART)

<b>Case Study Title</b>	<b>Supportive Technology for Monitoring Sleeping Difficulties: Developing a Mobile Application for Addressing Users' Needs</b>
Description	In this project, we aim to improve the quality of life of people encountering sleeping difficulties through the development of a mobile app designed to take into account user's emotional needs and preferences.
Chapter	9
Our involvement	<ul style="list-style-type: none"> <li>• Early stages of the requirements elicitation process - the identification of functional, quality and emotional goals of the users;</li> <li>• Generation of a goal model to represent the different types of goals;</li> <li>• Generation of emotion-informed personas;</li> <li>• Conducting interviews with participants prior to the trial.</li> </ul>
Unit of Analysis	Participants include anyone who is 18 years of age or above and who have been experiencing sleep difficulties for more than 3 months
Participant involvement	<ul style="list-style-type: none"> <li>• Taking part in interviews;</li> <li>• Using the mobile app for a period of 4 weeks or more</li> </ul>
Data Collection Tool	Interviews and focus groups
Research Questions Addressed	<p><b>RQ1</b> Why should user emotional expectations be elicited?</p> <p><b>RQ2</b> How can user emotional expectations be elicited?</p>

**Table 3.3:** Case Study 3: SleepWell

### **3.2.4 Criteria for Interpreting a Case Study's Findings**

Since case studies generate non numerical data, it is hard to set a criteria based on statistical analyses. Hence, Yin (2013) recommends the identification of rival explanations for our findings at this stage. The more rivals addressed the stronger will be the findings. Given that our study is of an explanatory nature we formulate only one rival explanation at this stage:

- The adoption and acceptance of technology is dependent on a number of factors as described in the Technology Acceptance Model (TAM). This theory considers two primary factors for the adoption of technology namely the perceived usefulness and the perceived ease of use of the product (Davis, 1989).

## **3.3 Preparing for Data Collection**

Successful case study data collection requires that a researcher has a set of skills which includes asking good questions, being a good listener, being adaptive and flexible, having a firm grasp on issues being studied and being unbiased by preconceived notions. In addition, the researcher should be clear about the reasons why the study is being done, what evidence is being sought, what variations can be anticipated, and also what could constitute supportive or contrary evidence for any given proposition (Yin, 2013).

Yin (2013) and Runeson et al. (2012) recommend the setting up of a case study protocol which consists of the following elements:

- Overview of the case study project
- Case study questions, hypothesis and propositions
- Theoretical framework for the case study
- Data collection procedures

- Details of the site where study will be conducted
  - Details of participants
  - Data collection plan
  - Expected preparation prior to the site visit
- Case study questions
  - Outline of the case study report

At this stage, a pilot study can also be conducted to ensure the validity of the data collection tools and the established protocol. The difference between a pilot study and the actual case study is that the inquiry in the pilot case is not only generic but also less focused. The pilot study also highlights potential gaps or issues which might be encountered during the actual case studies. An overview of the data collection techniques used for each case study is provided in tables 3.1, 3.2, and 3.3.

### **3.4 Data Collection**

In this step, the researcher not only has to master the data collection procedures, but also has to manage the data collected and maintain a chain of evidence. Yin (2013) discusses four overriding principles when it comes to data collection for case studies. The first principle is to collect data from multiple sources. This helps in the analysis process when evidence of data converging to the same findings can be found. The second principle requires the creation of a database to store the data collected during the case study in one place thus facilitating the analysis process. The third principle is to maintain a chain of evidence, thus increasing the reliability of the information in the case study. The fourth principle relates to the use of electronic sources to capture and store data. Yin (2013) warns researchers against the overwhelming data that can come through electronic sources and therefore recommends researchers to set limits on the data to be recorded.

Data collected from our case studies comes from three main sources, namely: literature reviews, interviews and questionnaires/surveys. Tak-

ing into consideration the principles proposed by Yin (2013), we stored all the data collected for each study in a database and also set a limit to the use of electronic devices when it came to recording the interviews. The approaches used during the data collection process for each case study will be further described in their respective chapters.

### **3.5 Criteria for Judging the Quality of Research Designs**

In order to check the quality of the research design, four tests which are common to all social science methods (Yin, 2013) will be used, namely:

- Construct Validity
- Internal Validity
- External Validity
- Reliability

The construct validity refers to the extent to which the outcomes of the study reflect what the investigator has in mind with regards to the research questions. For instance, if the interviewees interpret the interview questions differently from what the researcher has in mind, there is a threat to the construct validity. The internal validity is the extent to which the researcher can guarantee that no other variables except for the one under study have an influence on the results. For example, in our study we are considering how user emotions influence acceptance of technology. We are not considering other factors such as cost of technology, and this can be a threat to the internal validity of the results. The external validity refers to the extent to which the results can be generalised and extended to other people. That is, the cases should be designed to represent a sample population which is representative of the whole population. Reliability is linked to the extent to which the findings of the study are dependent on the specific researchers. In

other words, it checks whether the degree of subjectivity that exists in the interpretation and analysis of the data.

While evaluating and analysing data obtained from each case study, care will be taken to ensure that all four validity constructs are maintained.

### **3.6 Evaluating and Analysing Case Study Evidence**

Data analysis involves “examining, categorizing, tabulating, testing, or otherwise recombining evidence, to produce empirically based findings” (Yin, 2013). Throughout the analysis, the researcher should consider different alternatives and interpretations of the data collected in order to find a logic linking the data to its propositions with regards to the research questions. Yin (2013) proposes four general strategies to analyse data. These are (1) relying on theoretical propositions, (2) working your data from the “ground up”, (3) developing a case description, and (4) examining plausible rival explanations. Since our study is of an exploratory nature and does not have many propositions nor rival explanations, we propose to use the strategy of “working your data from the ground up”. This entails using an analytic technique to look for a pattern in the collected data.

Out of the five analytic techniques proposed in the literature, namely pattern matching, explanation building, time-series analysis, logic models and cross-case synthesis (Runeson et al., 2012, Yin, 2013), we opt to use the explanation building technique. Explanation building is a special type of pattern matching which analyses the case study data by explaining about how and why the whole study took place.

### **3.7 Presenting the Report**

Literature provides four ways to present case study data namely: *Single-case study*, *Multiple-case study*, *Series of question and answer* and *A single cross-analysis chapter*. Since our research consists of multiple case studies, we will use the multiple-case study approach to report our findings. A chapter will be dedicated to each case study presenting all the steps involved from the case study design onto the findings. Another chapter will be dedicated to present the cross-case analysis and results from all case studies.

# Chapter 4

## Emotional Goals

One of the major causes of software failure is the result of inadequate consideration of requirements (El Emam and Koru, 2008, Hofmann and Lehner, 2001, Lutz, 1993). When it comes to gathering requirements from stakeholders, traditional software development methodologies focus mainly on functional and non-functional requirements (Dick et al., 2017, Kotonya and Sommerville, 1998, Pfleeger and Atlee, 2010, Sommerville and Sawyer, 1997). Functional requirement is defined as the “*statements of services the system should provide, how the system should react to particular inputs and how the system should behave in particular situations*” (Sommerville, 2010). Non-functional requirements refer to the “*constraints on the services or functions offered by the system such as timing constraints, constraints on the development process, standards, etc*” (Sommerville, 2010). In short, functional requirements relate to what a system is supposed *to do* while non-functional requirements, often termed as *quality requirements*, refer to how a system is supposed *to be*. For example, a functional requirement for an airport would be to *transport people* while a quality requirement would be for the airport to *be safe*.

In many projects, non-functional requirements take a secondary place to functional requirements as they are very often viewed as modifiers to the way the system functions (Chung et al., 2012). It has been observed that in some cases, even though the main functional and quality



requirements are included during system design, stakeholders are not entirely satisfied with the end product (Ramos and Berry, 2005). Literature around technology adoption suggests that users refuse to use a technology, or limits its usage, if their needs are not addressed (Mendoza et al., 2013). One of the reasons identified for this failure is the fact that emotions of stakeholders have been ignored during software development (Hassenzahl, 2008, Lorence and Park, 2006, Mendoza et al., 2013, Meuter et al., 2005, Ramos and Berry, 2005, Wood and Moreau, 2006). Even though emotion is a well-researched topic in disciplines such as design (including human computer interaction) and affective computing, it has been barely explored in the area of software engineering.

In this chapter, we highlight the importance of the concept of the *emotional goal* within the software engineering paradigm. The chapter is organised as follows: Section 4.1 talks about the existing work on emotions within areas such as affective computing, information systems, design and requirements engineering. Section 4.2 presents the arguments for why emotional goals should be treated as a separate category of goals from quality goals. Section 4.3 provides a summary of the contents in this chapter.

## **4.1 Background and Related Work**

In this section, we present background and related works on emotions within the areas of affective computing, information systems, design, requirements engineering and agent-oriented requirements engineering.

### **4.1.1 Emotions in Affective Computing**

Affective Computing is a multidisciplinary field which includes computing, psychology, physiology and cognitive sciences (Tao and Tan, 2005). The term emerged in the second half of the 1990s where the need to incorporate emotion in computer systems and to build emotionally intel-

ligent interactive systems were felt (Armony, 1998, Zimmermann et al., 2003). A major contribution in this area was made by Picard (1997) who strongly argued that computers could be instilled with emotional intelligence in order to better support users. In affective computing, emotion is often termed as affect, which Boehner et al. (2007) defines as “*discrete units or states internal to an individual that can be transmitted in a loss-free manner from people to computational systems and back*”.

A number of studies in the area have been conducted since then which concentrates on how emotion can be integrated within software systems (Agrafioti et al., 2012, Calvo and D’Mello, 2010, Guo et al., 2013, Mao and Li, 2010, Mauss and Robinson, 2009, Ren, 2009). Some researchers also focused on how emotion could be modelled and measured by using different approaches, such as the agent-oriented modeling concepts (Boehner et al., 2007, Mao and Li, 2010, Reisenzein et al., 2013). Over the past decade, research in this area has witnessed an increasing awareness of the impact of affective states on work performance and on team collaboration (Feldt et al., 2008, Fisher and Ashkanasy, 2000, Graziotin et al., 2014, Lyubomirsky et al., 2005). This study of affective states is highly relevant in the area of software engineering, which involves people in a broad range of activities where personality traits, moods and emotions play an important role. As identified by Graziotin et al. (2014), a way to improve software developer’s productivity and software quality is to ensure that software developers are happy.

Even though research involving affective states in the area of software engineering has been conducted (Feldt et al., 2008, Fisher and Ashkanasy, 2000, Graziotin et al., 2014, Lyubomirsky et al., 2005), till date, as per our knowledge, those studies have been restricted to the software development team and have not been extended to include the users. Affective computing therefore does not consider the emotional expectations that users have from software systems and neither does it provide ways to consider nor include emotional needs into software systems.

### **4.1.2 Emotions in Information Systems**

Within the area of Information Systems, there are many theories and models related to the adoption and acceptance of technologies (Davis, 1989, Venkatesh et al., 2003). The most commonly used theories and models are Theory of Reasoned Action (TRA) and the Theory of Planned Behaviour (TPB), Technology Acceptance Model (TAM) and Diffusion of Innovations Theory (DOI) (Gücin and Berk, 2015). TRA suggests that human behaviour is determined by their attitude and subjective norm (Fishbein, 1979). TPB extends the TRA by including the perceived control variable, that links beliefs and behaviour (Ajzen, 1985). TAM is another theory which emerged from TRA (Davis, 1989). TAM and its revised studies consider the perceived usefulness, perceived ease of use, social and gender influences as being the factors impacting the technology usage of an individual (Mendoza et al., 2013). DOI considers some features of innovations, such as relative advantage, complexity, compatibility, trialability and observability to be the underlying factors influencing technology acceptance (Rogers, 2003).

The main focus of these theories has been on technology benefits, cost, relative advantage over other competing alternatives and complexity of use (Davis, 1989, Rogers, 2003, Venkatesh et al., 2003). A significant body of work within this area has focused on the role of emotions and how they affect the adoption of innovation and decision-making (Anderson and Agarwal, 2011, Komiak and Benbasat, 2006, Wood and Moreau, 2006, Zeelenberg et al., 2008). These studies highlight the idea that the act of decision making is often an emotional process, and that people's emotions have an impact on the adoption of innovations. Even though the concept of emotion has been addressed within these studies, it has been with limited focus on, or even understanding of, the role emotions plays on the adoption and ongoing use of technologies (Agarwal and Meyer, 2009, De Guinea and Markus, 2009, Mendoza et al., 2013). This is especially true when emotions are an integral part of user experiences (Lorence and Park, 2006).

Additionally, the necessary deeper knowledge about the types of emotions experienced by people, the needs (both functional and qualitative)

which is desired in technology and the way these impact on both the adoption and ongoing use of technology, has not been explored. In fact, much of the literature has noted that the neglect of specific cohorts and their individual socio-technical needs (for instance, older people in aged-care facilities) is of concern in this area (Mendoza et al., 2013). It is this failure to address the emotional requirements of older people which has resulted in the lack of adoption of existing technologies for the elderly (Lorence and Park, 2006, Mendoza et al., 2013).

### **4.1.3 Emotions in Software Design and User Experience**

Software design is an area which has witnessed an increasing awareness of user emotions within its processes. Since the emergence of *Human Computer Interaction* in the early 1980s, many studies have been conducted to ensure quality user experience with computers. Over time, a computer was no longer confined to a desk but evolved to find its place everywhere in phones, cars, meeting rooms, and coffee shops. The studies surrounding human computer interaction also evolved to look into different aspects of usability and even beyond. With the cut throat competition within the software industry, many companies have not only embraced and integrated the concepts of usability, but are also looking at a new concept: *user experience* (Benyon et al., 2005, Dix, 2004, Hartson and Pyla, 2012).

User experience goes beyond usability to investigate (1) the effects experienced by end-users due to usability factors, (2) the effects experienced by end-users due to usefulness factors and (3) the effects experienced by end-users due to emotional impact factors (Hartson and Pyla, 2012). Even though user experience considers user emotions during product design, Hartson and Pyla (2012) state that “*user experience is the totality of the effect or effects felt (experienced) internally by a user as a result of interaction with, and the usage context of, a system, device, or product*”. They further assert that user experience cannot be designed but only experienced through repetitive use of the technology or product. Also, the user experience will vary from user to user, depending

on a number of factors such as the user's background, context of use and environment. Yet, designers of interactive systems are constantly finding themselves going beyond the usability threshold to ensure that the end-users have a great experience with the product.

Interestingly, in the area of game design, designers have been doing the same thing for several years (Benyon et al., 2005). When designing games, one of their primary goals is to ensure *joy of use* among other intended emotions such as *excitement*, *fear* and *anticipation*. A recent work by Marshall (2012) in this area, introduced the concept of *emotional goals* to refer to user emotions with regards to system design. According to him, emotional goals are different from quality goals in that they are properties of the user, not of the system. Emotional goals are subtle, ambiguous and difficult to measure. Marshall argues that when it comes to designing a game, it not only has to fulfill specific functions but more importantly, it has to be *engaging* and *fun* as well. Given the existing categories of goals, the goal *fun* neither falls under functional nor quality goals. But then making a game that is *fun* overrides all other system requirements, irrespective of whether the goal *fun* is clearly definable or measurable. Therefore, since emotional goals play a crucial role to design considerations, another category of goal was proposed by Marshall (2012) which was called an *emotional goal*. From a design perspective, Marshall (2012) models the emotional goals with equal importance to functional and quality goals using the models proposed by Sterling and Taveter (2009). An icon set was developed to represent the different goals as illustrated in Figure 4.1 where the conventional parallelogram and cloud was used to represent the functional and quality goals. The heart shape was introduced to signify the emotional goals.



**Figure 4.1:** Icon set for functional, quality and emotional goals

#### 4.1.4 Emotions in Requirements Engineering and Agent-oriented Requirements Engineering

While the consideration of emotions has been prevalent in the design field, it has been little explored in software engineering. Most of the research done in this area are restricted to the requirements engineering phase (Colomo-Palacios et al., 2011, Ramos and Berry, 2005, Sutcliffe, 2011) and some of it only acknowledges the need to include emotions within the requirements engineering process (Proynova et al., 2011, Sutcliffe, 2011). In this perspective, the work of Ramos et al. (2005) is better aligned with our approach in that they present examples of projects failing due to requirements being affected by emotions. They further advocate the need to identify such issues as soon as they arise and to handle them through a number of psychological techniques.

A recent work more aligned to our approach is that of Miller et al. (2015) and Lopez-Lorca, Miller, Pedell, Mendoza, Keirnan and Sterling (2014) that adapts the work of Marshall (2012) in the area of software engineering. In this context, Miller et al. (2015) refer to emotion as a feeling that characterises a state of mind and includes examples such as feeling of *joy*, *terror* or *safety*. Based on this definition, an emotional goal was defined as “*the way people feel about a system and also captures their engagement in the greater socio-technical system*”. Miller et al. (2015) further categorise emotional goals into two types, namely *personal emotional goals* and *system-dependent emotional goals*. Personal emotional goals refer to “the way a person wants to feel such as feeling *loved*, *safe* or *angry*” and are independent of the existence of a system. System dependent emotional goals refer to “the way a person feels about a system for example, feeling *engaged* or *frustrated* with the system”. Unlike personal emotional goals, system dependent emotional goals rely on the existence of the system and if the system is removed, these emotional goals are eliminated. For instance, Miller et al. (2015) uses the example of gift giving to elaborate on personal and system dependent emotional goals. In this scenario, a personal emotional goal for the giver would be to feel a tightened bond with the gift receiver while a system dependent emotional goal for the giver would be to feel appreciated by the receiver’s

acknowledgement.

## **4.2 Emotional Goals as a Separate Category of Non-Functional Goals**

In this section, we outline our arguments why user emotional expectations, which we refer to as “emotional goals” should be considered as a separate category of non-functional goals from other quality related goals. The concept of *user emotions* has received insufficient attention in the area of software engineering even though strong evidence exists to support its importance within the field (Demiris et al., 2004, Miller et al., 2012, Pedell et al., 2013, Ramos and Berry, 2005, Ramos et al., 2005). Even though many researchers have made a case for emotions within software engineering (Bentley et al., 2002, Callele et al., 2006, Colomo-Palacios et al., 2011, 2010, Ramos and Berry, 2005, Thew and Sutcliffe, 2008), to the best of our knowledge, no methodology or framework exists to support the integration of emotional considerations of software users within current software development processes. Hence, it is challenging for software professionals to address user emotions during the development life cycle. We therefore argue that user emotions, a key determinant for the success of a technology, should be considered as first-class citizens in the software engineering methodology. In other words, emotional goals should be treated with equal importance as functional and quality goals when designing technology.

We build our argument based on that put forward by Miller et al. (2015). In their paper, Miller et al. (2015) refer to Norman’s model of emotional design to differentiate emotional goals from usability and quality goals. Norman’s model of emotional design (Norman, 2013) argues that designers should elicit desired user emotions through the three levels of the human brain that affect emotion. These are (1) visceral processing, (2) behavioural processing and (3) reflective processing. The *visceral processing* relates to the automatic, pre-conscious processing that makes fast judgements and visceral design can be achieved by providing users with aesthetically appealing interfaces. The *behavioural process-*

*ing* is sub-conscious and is the part that controls “everyday” behaviour. Behavioural design can be achieved by ensuring that the functionalities of the system are efficient and useful. Lastly, *reflective processing*, which is conscious, relates to that part of the brain which deals with the highest levels of feelings, emotions and cognition. Reflective design is achieved with software that appeals to users on a personal level based on their experience of use.

We agree with the view of Miller et al. (2015) that modern software engineering methodology does not sufficiently support reflective design. Based on the description of Norman’s model of emotional design, we support Miller’s arguments that emotional goals are not a component of usability nor are they a component of other quality goals. Both usability and quality goals relate to the behavioural-level experience, while emotional goals refer to a reflective level experience. For example, consider the *LinkedIn* application whose main goal is to enable users to create their professional profiles and engage with other professionals in their area. While the goal “create professional profile” can be considered as a functional goal, “engaging with other professionals” cannot be treated as a quality goal. The system can promote and support engagement but the success of this goal is dependent on users establishing contacts with other users and maintaining a relationship. While we can produce systems that help with this goal, it is almost spurious to consider this a property of the system. Measuring such properties requires us to measure the emotional state of people while using the system (i.e. representative end-users), unlike other qualities, for example, performance, which can be measured directly, or even usability, which can often be measured using well-defined metrics and qualitative observation from system logs. For this reason, we propose that emotional goals be treated separately from other quality goals and as first-class citizens in software engineering.

Given that emotional goals are abstract and subjective, they cannot be specified as software requirements as per the recommended practice put forward by the IEEE (IEEE Computer Society. Software Engineering Standards Committee and IEEE-SA Standards Board, 1998). They can neither be implemented directly but they can act as drivers to elicit new

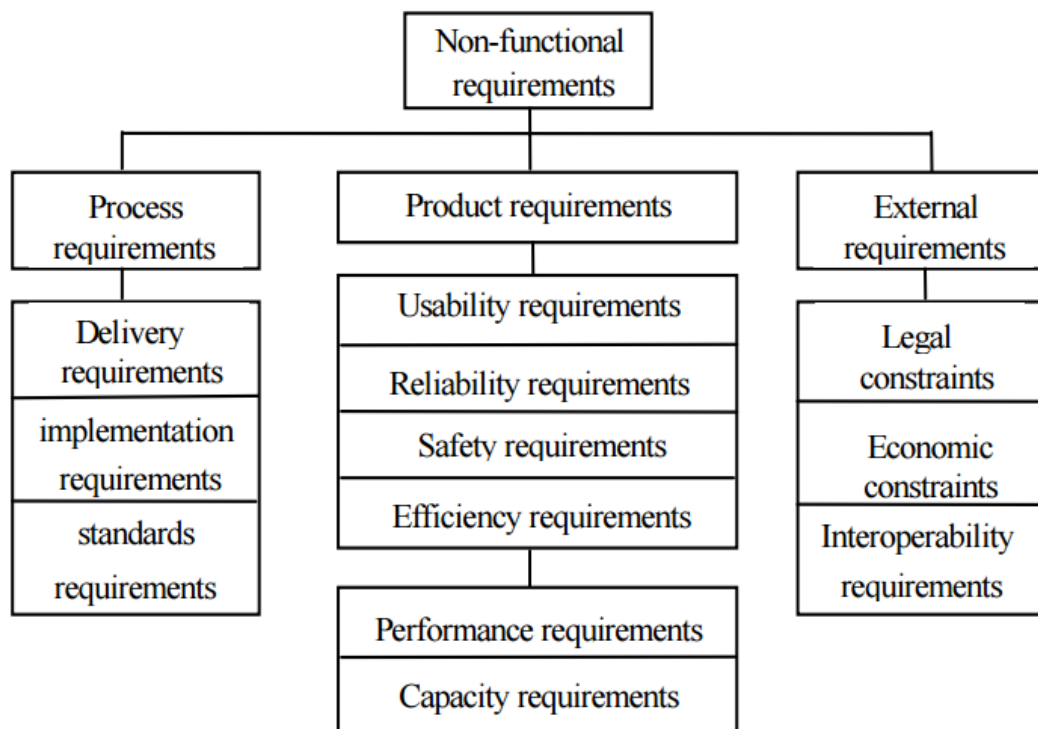


requirements, either functional or non-functional. For instance, one of our case studies aims at connecting older adults with their loved ones through the use of a digital photoframe. An important emotional goal for the person is to *feel cared for*. This goal cannot be implemented in the system as it relates to the property of the user but the functionalities of the system can be designed to support this goal. In this system, this goal is supported through the sending of text messages and photos by the relatives to the older adults.

In addition, it is hard to measure emotional goals, other than asking the users directly about how they feel when they use the system. Hence, emotional goals cannot be treated as software requirements. However, we argue that they should still be considered as a separate category of goals. We believe that if emotional goals are not given sufficient attention and importance within the software engineering paradigm, they will be completely ignored as we proceed from one process to the other within the software development life cycle. As Miller et al. (2015) argues, emotional goals will be the first things to be foregone during tight deadlines if they are not explicitly considered. Given their importance with regards to the success of a project, they cannot be ignored.

Further, Miller et al. (2015) define emotional goals as “*non-functional goals that describe a desired reflective-level emotion of a role*”. We agree that emotional goals are indeed non-functional goals in that they relate to users’ feelings, perceptions and emotions generated from their experience with the technology. However, if we consider the well established international standards that define the taxonomies of non-functional requirements (IEEE Computer Society. Software Engineering Standards Committee and IEEE-SA Standards Board, 1998), none of them relate to emotional goals. IEEE provides a list of 13 non-functional requirements to be included in a Software Requirements Document. These are performance requirements, interface requirements, operational requirements, resource requirements, verification requirements, acceptance requirements, documentation requirements, security requirements, portability requirements, quality requirements, reliability requirements, maintainability requirements and safety requirements. If we consider the examples used previously, emotional

goals such as ‘engaging’ and ‘cared for’ cannot be included under any of these existing categories. Similarly, if we have a look at another classification of non-functional requirements as proposed by Sommerville (2010) and represented in Figure 4.2, these emotional goals cannot be represented under existing categories. We therefore argue that given its importance for the success of a project, emotional goals should be treated as a separate category of non-functional goals under the existing umbrella of non-functional requirements.



**Figure 4.2:** Classification of non-functional requirements (Sommerville, 2010)

### 4.3 Summary

In this section, we highlight the importance of emotional goals within the software engineering paradigm and also present the arguments to consider emotional goals as a first class citizen within software engineering. We based our arguments on the existing work of Miller et al. (2015) who highlight the difference that exists between emotional goals and usability as well as quality. They also identify the need to con-

sider emotional goals explicitly given that they can act as drivers to identify functional and quality requirements. In addition, we propose to treat emotional goals as a separate category of non-functional goals given that the existing taxonomies of non-functional requirements do not cater for such goals.

In the next chapter, we describe our first case study *TouchFrame*, an iPad based photoframe application, designed to promote interaction between older adults and their loved ones while taking into account the emotional needs of the older adults with regards to technology use. The design process of the *TouchFrame* case study and its findings were used to develop the emotion-oriented elicitation and evaluation methods which we describe in chapters 6 and 7 respectively. These methods were then applied and refined in the remaining two case studies, namely *SMART* and *SleepWell*, which we describe in Chapters 8 and 9 respectively.

# Chapter 5

## Case Study 1: TouchFrame

The first case study, namely *TouchFrame*, was conducted at the beginning of this PhD. The design of this case study and its findings were used to derive our emotion-oriented methods, which were further trialled and refined in the SMART and SleepWell case studies. In order to present the work done linearly, we describe the TouchFrame case study in this chapter, then use the TouchFrame case study as an example to explain our emotion-oriented methods in Chapters 6 and 7, and then describe how these emotion-oriented methods were applied and trialled in the SMART and SleepWell case studies in chapters 8 and 9 respectively.

TouchFrame is a smart digital photo frame application for iPads, which was designed to promote interaction between older adults and their loved ones. The main aim of this project was to showcase how technology can be integrated in older adults' lives with the main objectives of making users feel safe, have fun and stay in touch with family members and peers. Part of the research project consisted of the validation of the application and the suitability of the surrounding support system from a users' point of view. Key questions of the research relate to the emotional needs and barriers preventing the take-up of assistive technology by older people. We explored these aspects via interviews, and a validation of the TouchFrame from the users' perspective was conducted using a questionnaire. This case study was designed to explore

all the research questions in this thesis:

**RQ1** Why should user emotional expectations be elicited?

**RQ2** How can user emotional expectations be elicited?

**RQ3** How can user emotional expectations be validated?

The key findings from this case study show that when it comes to designing technology for older adults, many factors other than the older adults' feelings come into play. These factors include policy and compliance consideration, family dynamics, the motivation of the older adults to learn new technology, the support mechanism and the older adult's personal background. Detailed information on the findings of the case study is provided at a later stage in this chapter.

This chapter is organised as follows: Section 5.1 presents the rationale and objectives of the case study. Section 5.2 discusses how the case study was designed and highlights how the research questions were addressed by this case study. Section 5.3 presents the pilot study and its findings. Section 5.4 highlights the revisions made to the case study design based on the findings from the pilot study. Section 5.5 provides a detailed account of the main study including the participants involved. Section 5.6 discusses the findings of the study. Section 5.7 discusses the validity of the evaluation tool. Section 5.8 presents an assessment of the validity of this case study by highlighting the threats to internal, construct and external validity. Section 5.9 provides a summary of work presented in this chapter and highlights the author's personal research contribution within the team. Section 5.10 highlights the author's research contributions within this case study.

## **5.1 Rationale and Objectives of the Case Study**

The TouchFrame case study was designed based on the findings from a field study conducted by Pedell et al. (2013), which investigated the barriers that prevent older adults from using emergency alarm systems

(EAS). We therefore provide an overview of this field study in this section to highlight the rationale behind conducting the TouchFrame case study. A complete account of the EAS field study can be found in Pedell et al. (2013).

This section is split into two parts: the first part provides an overview of the emergency alarm systems while the second part presents the rationale and objectives of the TouchFrame case study.

### 5.1.1 Emergency Alarm Systems (EAS)

EAS are designed to support people, particularly elderly adults, who live on their own despite having some physical or mental health issues such as dementia, diabetes, heart problems and osteoarthritis (Chung-Chih et al., 2006). In general, these systems are designed as a bundle of two components namely:

1. An emergency alarm (as shown in Figure 5.1) which the older person uses to alert the authorities when they require emergency assistance; and



**Figure 5.1:** Emergency Alarm Pendant

2. A wellbeing check (as shown in Figure 5.2) to monitor the person's wellbeing.



**Figure 5.2:** Emergency Alarm Wellbeing Check - Base Station

The emergency alarm mechanism is typically implemented as a pendant or wristband that the older adult is expected to wear at all times. The device has a button which, upon pressing, immediately establishes connection with the service provider to ask for help. The coverage area of the emergency alarm is normally limited to the older adult's home.

The wellbeing check normally consists of a base station which is connected to the landline. The elderly person is required to press a button on the base station on a daily basis to inform the service provider of their wellbeing. In the case where no signal is received at the time specified by the service provider, the older person receives a phone call to check whether they need help.

Technically, the system satisfies the following key requirements:

1. In cases of emergencies such as a fall or sickness, the user notifies the service provider by pressing the button on the emergency alarm pendant or wristband which they are wearing.
2. Once the service provider is notified, they contact the emergency services and/or the relative of the user to provide help.
3. Pressing the button on the base station on a regular basis allows the service provider to monitor the user's wellbeing and caters for cases where the user is in an emergency situation (for example, is unconscious after a bad fall) and is unable to press the button on the alarm pendant or wristband. In a situation where the button

is not pressed at the right time, the service provider calls the user to check on them and if no response is obtained, they contact the emergency services and/or the user's relatives.

In practice, many situations have been encountered where elderly adults have ended up in emergency situations and could not alert the authorities because they were not wearing their emergency alarm pendants or wristbands. Evidence (Pedell et al., 2013) suggests that many users refuse to wear the emergency alarm pendant or wristband leading to its failure. Service providers and government authorities are concerned about this failure given that the ageing population is growing and requires a lot of resources.

In order to understand the reasons behind the failure of the emergency alarm system, a field study was conducted by Pedell et al. (2013) which consisted of interviewing 12 elderly people about emergency alarms and technology in general. The findings from this study revealed a number of issues linked to the way people feel about using emergency alarm systems such as *lack of independence, feeling old, frail, stigmatised* and *uncared about*. The personal alarm systems are designed with reliability and robustness as priority concerns, completely ignoring the older persons' *emotional needs* or any aesthetical consideration. Because of this, many users have some serious emotional concerns regarding the use of the emergency alarm pendants (Demiris et al., 2004, Heo et al., 2011, Pedell et al., 2015). For instance, some older adults refused to wear the pendant in public since they thought that it made them look *old* and *frail*, they felt *stigmatised* and *dependent* on others (Pedell et al., 2015). Even the relatives of the pendant wearers highlighted the *stress* that its use entailed. In some cases, older adults reported that they were forced to use the EAS by their children who wanted to feel reassured that their older parents were being taken care of. In reality, most of them only wear the pendant or wristband when their children came to visit them, which actually defeated the whole purpose of the EAS. According to these older adults, their children were passing off their responsibility (which was looking after their parents) to a technology and this made them feel *rejected* and *uncared about*.



### **5.1.2 Objectives of the TouchFrame Case Study**

The findings from the EAS field study strengthened our proposition that emotional expectations are important when it comes to adopting a technology. We therefore decided to conduct a case study in this particular area mainly to study how technology can be integrated in older adults' lives by taking into account their emotional expectations. One of the findings from the EAS field study showed that older adults kept many family pictures around their house and were keen on talking about their family members. In one house, the base station was being used as a stand to hold several photo frames. These observations highlighted that family relations held a high importance in their lives and that is how we got the idea to develop a picture frame application to connect them to their loved ones. Some of the emotional goals identified in the field study for the emergency alarm system were used to inform the development of a prototype to promote interaction between older adults and their loved ones.

This case study involved:

- Identifying the emotional needs and barriers preventing the take-up of assistive technology by older people
- Providing a technology which can be integrated in older adults' lives by taking into account their emotional expectations such as having fun and staying in touch with their family members.
- Developing a tool to evaluate the extent to which user emotional expectations were achieved through this technology

## **5.2 Case Study Design**

In this section, we describe the design plan for the pilot study. We then present the revisions made to the design based on the findings from the pilot study in Section 5.4.

### 5.2.1 Research Questions

This case study was designed to answer all the three research questions namely:

**RQ1** Why should user emotional expectations be elicited?

**RQ2** How can user emotional expectations be elicited?

**RQ3** How can user emotional expectations be validated?

The way these research questions were addressed within this case study are described below:

#### **RQ1 Why should user emotional expectations be elicited?**

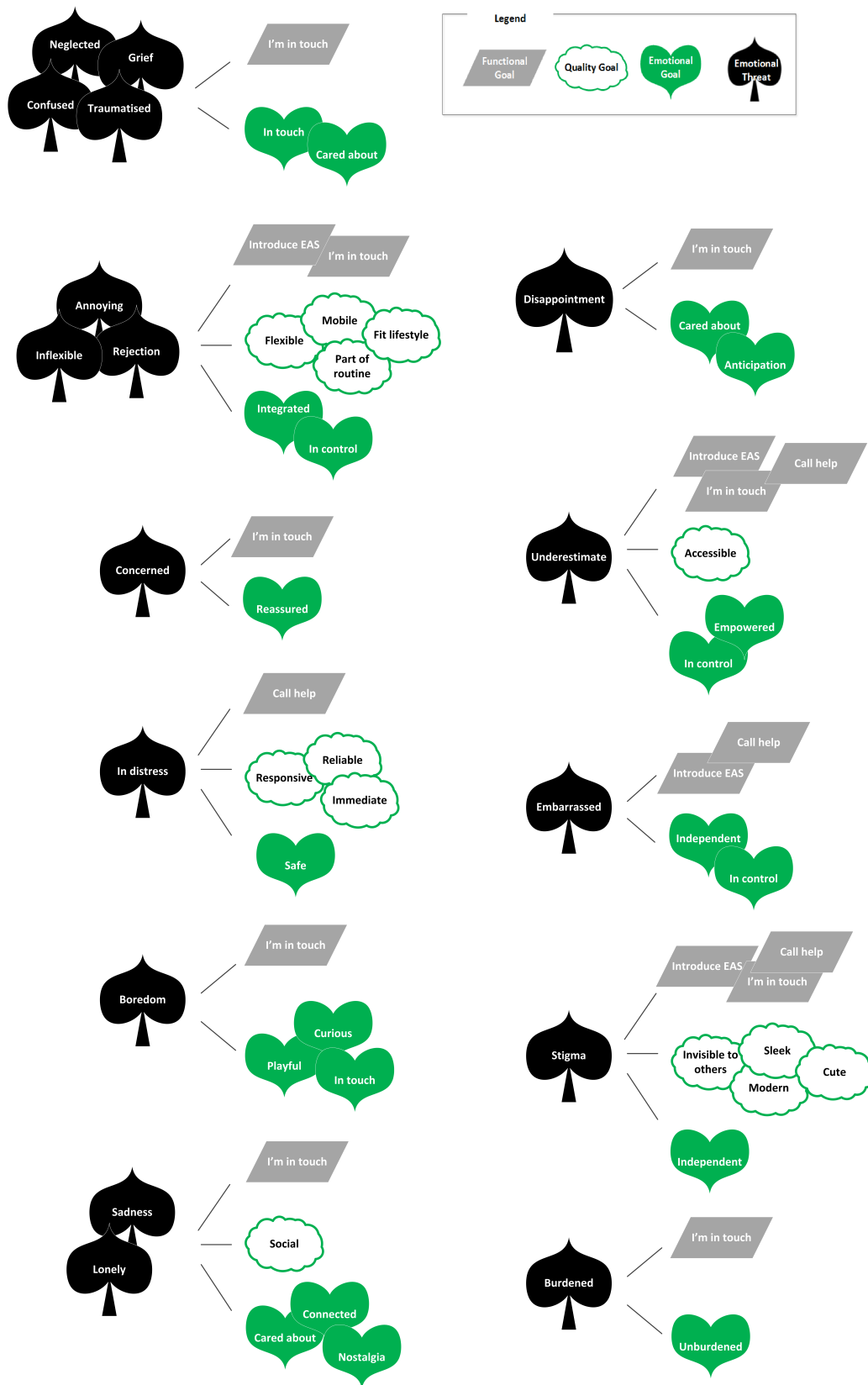
The findings from the EAS field study conducted by Pedell et al. (2013) revealed several issues which were linked to the way people feel about using emergency alarm systems such as *lack of independence, feeling old, frail, stigmatised, stress, rejected and uncared about*. The findings also showed that these people wanted to be feel connected to their loved ones and cared about. These issues and expectations clearly do not relate to a functional or quality goal of a system. They refer to the emotional expectations that users have from a system. Given that these emotional issues act as barriers to the adoption of technology, they cannot be ignored and have to be somehow represented within the requirement documents. These identified terms refer to non-functional requirements rather than functional requirements. In Chapter 4, we discussed the limitations of the existing taxonomies of non-functional requirements to cater for emotional goals. In that same chapter, we argued about the need to represent emotional goals as a separate category of goals under non-functional requirements. In this chapter, we reiterate our argument that emotional goals are a key component to the success of a system and should be represented as a separate category of goals under non-functional goals.

**RQ2 How can user emotional expectations be captured?**

The findings from the EAS field study and existing literature around technology adoption by older adults (Courtney et al., 2008, Demiris et al., 2008, Fischer et al., 2014, Mynatt et al., 2004, Pedell et al., 2015) provided us with valuable information regarding features that older adults appreciate and also highlighted several issues linked to the use of emergency alarm pendants. While going through these documents, we applied the *content analysis* technique to analyse the data and made use of an *affinity diagram* to organise the data.

Content analysis is a technique used to analyse content that may consist of words, meanings, pictures, symbols, ideas, themes, or any message that can be communicated (Patton, 2002). The affinity diagram is a graphical tool used to organise ideas into subgroups where each subgroup have a common theme or relationship (Tufte, 1991). The terms content analysis and affinity diagram along with the approach used to identify the goals from these documents are further described in Section 6.3.2.

The data from the affinity diagram consisted of both positive and negative emotions. Very often when asked about what they want from a system, users tend to describe their expectations by highlighting features that *they do not want*. In other words, they describe their requirements in terms of pain points or in terms of negative emotions (Lopez-Lorca, Miller, Pedell, Sterling and Curumsing, 2014), for example, “*I don’t want to feel stigmatised*” and “*I don’t want to feel dependent on others*”.



**Figure 5.3:** Emotion Model for the Emergency Alarm System

One of our recent works (Lopez-Lorca, Miller, Pedell, Sterling and Curumsing, 2014) described how these negative emotions can be mapped to one or a group of functional, quality and/or emotional goals that the system should achieve in order to counteract these negative emotions through an emotion model. A similar *emotion model*, as presented in Figure 5.3, was derived based on the findings of the content analysis. The spades were used to represent negative emotions while hearts were used to represent the emotional goal. The functional and quality goals were represented by the parallelograms and clouds, respectively.

Additionally, we extended the existing models proposed by Sterling and Taveter (2009) to represent the identified emotional, functional and quality goals. A complete description of how these existing models have been extended to include emotional goals is presented in Section 6.2. In this chapter, we present only one of the models, namely the *goal model* (refer to Figure 5.4) to represent the emotional goals along with the functional and quality goals for the emergency alarm system. The emotional goals of the model played a significant part in the design of the digital picture frame. It is, thus, relevant to describe them briefly:

- *Reassured*: The main goal of relatives and carers of the older adults was to feel reassured of the well-being of the older person.
- *Cared about*: The older adults wanted to feel that their families care about them.
- *Independent*: The older adults wanted to feel independent by being able to live as they please.
- *In touch*: Older people wanted to feel emotionally connected to families and friends.
- *In control*: The older adults wanted to have full control over how they interact with the system rather than be guided by the system.
- *Safe*: Knowing that help was just a button press away made the older person feel safe.
- *Integrated*: The system had to be well integrated into the daily lives of the older adults.

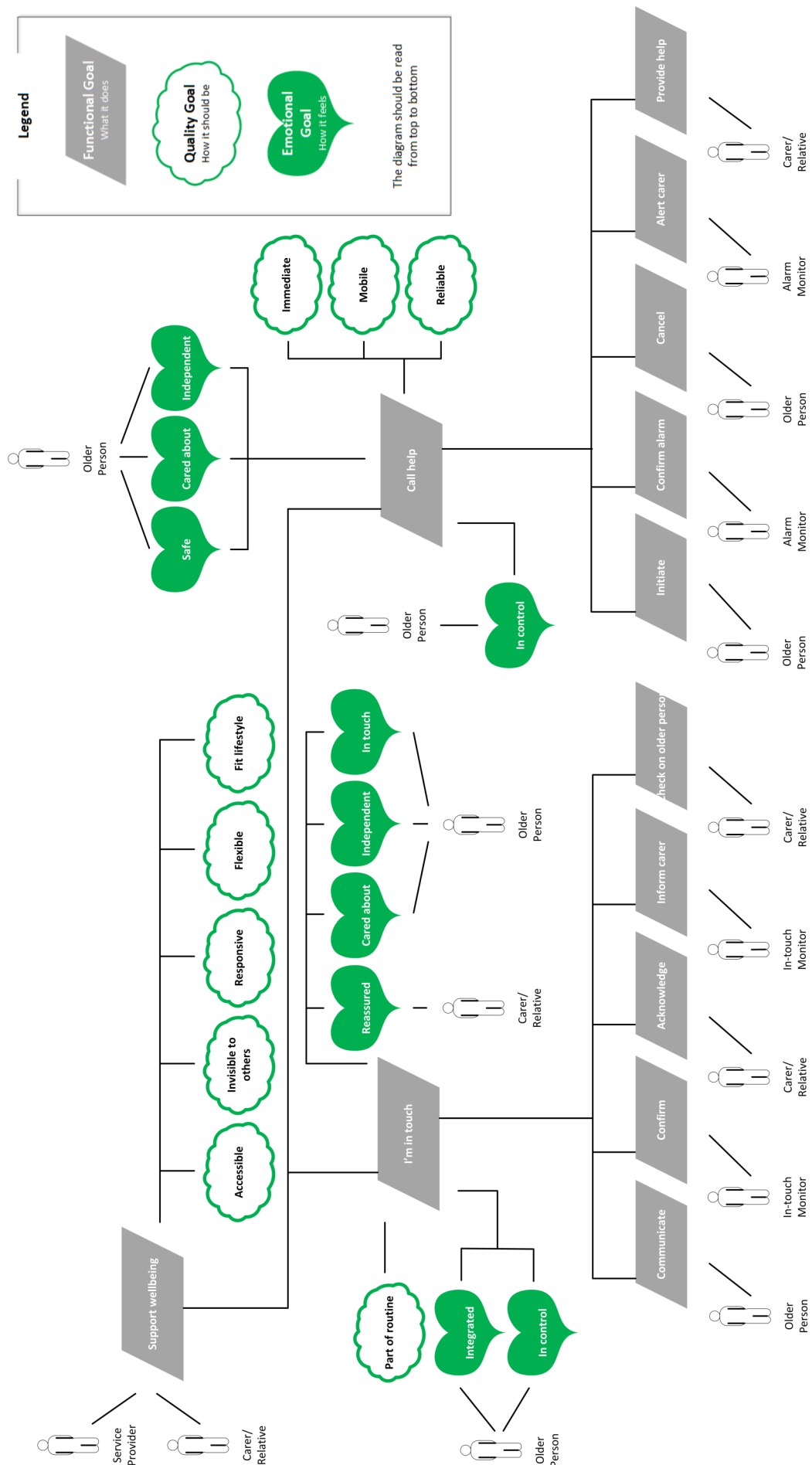


Figure 5.4: Goal Model for the Emergency Alarm System

**RQ3 How can user emotional expectations be validated?**

Different techniques have been used to measure emotion namely facial and speech recognition, blood pressure, skin conductance, interviews and questionnaires among others (Allaire et al., 2013, Colomo-Palacios et al., 2011, Lakens, 2013, Lisetti and Nasoz, 2004, Lottridge, 2008, Powers et al., 2011, Rani et al., 2006). Despite the existence these various measures, Mauss and Robinson (2009) argue that measuring a person's emotional state is one of the most complicated issues. In addition, it is unclear how the measured emotion can inform further system development or improvement. After going through different measures of emotions used in psychology and software engineering, we found that no exact measure of emotion exists which can be used to measure user emotional expectations. Even though emotion is a well-researched topic in psychology, to the best of our knowledge there are no general purpose tools to measure emotions. The tools that are available tend to measure only a particular emotion or a set of emotions. Since emotions are driven by perception, we changed our focus towards the way people view the system from an emotional perspective rather than concentrating on their emotions. That is, we targeted to measure people's perception of emotion instead of their emotions.

For the purpose of our study, we chose a simple but well-established tool namely the *questionnaire*. Ever since its invention in 1838 (Foddy, 1994), questionnaires have been widely used as a research instrument in both qualitative and quantitative research (Bryman, 2015, Neuman, 2011, Ritchie et al., 2013). Several studies in the area of psychology (Folkman and Lazarus, 1985, Garnefski and Kraaij, 2007, Wiedemann et al., 2002) and even computer science (Diana and Febrian, 2016, Kallinen et al., 2007, Venkatesh, 2000) have used questionnaires as an instrument to measure people's emotions. In contrast to other emotion measuring tools, such as facial and speech recognition, blood pressure and skin conductance which require the participants to use wearable devices, a questionnaire is a simple tool which consists of a series of questions designed to gather information about a particular phenomenon.

Given the demographics of our participants, the below mentioned benefits of questionnaire use, in particular “being non-invasive” are important selection criteria.

1. easy of use and delivery;
2. easily understood by people;
3. quick way to gather information;
4. low cost;
5. non-invasive.

Just like any other instrument, the use of a questionnaire as an evaluation instrument does have some limitations. The main criticisms of using a questionnaire in qualitative research are:

1. it is inadequate to fully understand some forms of information, for example, changes in emotions, feelings or user’s behaviour
2. the information gathered lacks validity
3. there is no guarantee that the participants have put in enough thought in filling out the questionnaire

The above mentioned drawbacks do not affect us since we are supplementing the data collection and evaluation processes with other qualitative methods, namely interviews.

The process involving the design of the questionnaire was a lengthy one and we ended up having different versions. We provide a complete account of the questionnaire design in Chapter 7 where we also present a formal evaluation technique to evaluate user emotional goals from a user’s perspective based on the findings from the TouchFrame case study. The questionnaire that we used for the TouchFrame case study consisted of a list of emotional goals and an analog measure next to each goal. The users had to plot a point on the analog measure to indicate how far the emotional goal was achieved by the system.



### **5.2.2 Participants**

The unit of analysis consisted of setting up the criteria to recruit the participants for the study. Two criteria were established whereby each participant had to be:

- 65 years of age and over; and
- living alone in their own home.

In addition, for each participant we recruited a relative or friend who was 18 years of age or over and who was willing to interact with the main participant by sending photos and messages.

### **5.2.3 Ethics**

The case study was supported by the Smart Services CRC and has received ethics approval at Swinburne (2012/274 Designing an improved and innovative emergency alarm for older adults at home). According to the ethics requirements, no person will be identifiable from the results. Further details on the ethics requirements for this case study are available in Appendix A.

### **5.2.4 Data Gathering Techniques**

Two data gathering tools were designed namely:

- Interviews, and
- Questionnaire

The interview questions were designed to find out about (1) the participants' backgrounds; (2) use of technology; and (3) support mechanisms required to support the new technology. Each participant was

asked to describe their daily routine within a typical day and provide details about their living circumstances. In terms of technology use, participants had to provide information about how far they are conversant with using technology and how they see technology as an everyday support. In order to provide support throughout the project, information about which support mechanism best suits the participant was collected. A complete set of the interview questions is available in Appendix A.

The questionnaire was designed using the emotional goals identified from the findings of the field study with the emergency alarm pendant users in Section 5.1. Each emotional goal was represented within a simple statement, for example, “I feel cared about”. Participants were then asked to state the extent to which they felt that these emotional expectations have been met by the system on an analog measure. The design of the questionnaire was based on one of our evaluation techniques which we describe in detail in Section 7.1. A copy of the questionnaire is available in Appendix A.

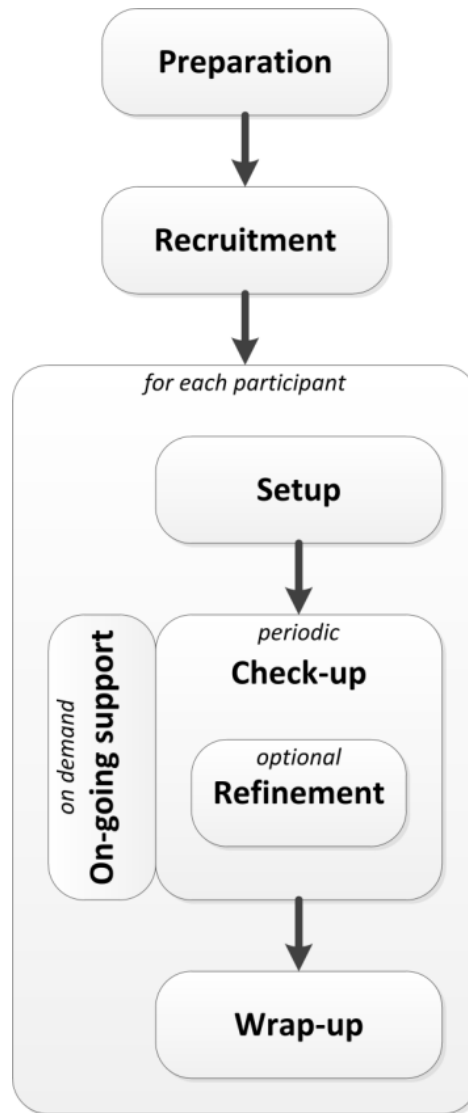
### **5.2.5 Prototype Deployment and Evaluation Methodology**

As part of our case study design, we established a *prototype deployment and evaluation methodology* which generalised the approach used to evaluate the prototype with participants in trials. The different steps involved in the methodology are illustrated in Figure 5.5.

The *preparation* step entailed activities such as defining the case study parameters, for example, the duration of the study, the number of participants to be recruited, the profile of the participants and the sought results. This stage also involved the preparation of any data gathering instruments such as interview scripts and questionnaires. The preparation of a tailored call for participants formed part of this step as well.

The *recruitment* which included all the activities related to the recruitment of participants, starting with the submission of call for partici-

pants in specific forums. In this stage, queries from potential participants were answered and interested participants were registered. Once a pool of potential participants was formed, the selection of the participants was done based on the study criteria set in the preparation stage.



**Figure 5.5:** Prototype deployment and evaluation methodology

The *setup* occurred when the participants were identified and willing to start the study. This process was repeated for each participant and involved an initial discussion with the participant, followed by the technical deployment of the prototype. In some cases, training was also provided to the participants.

The *check-up* occurred at different intervals whereby the researchers contacted the participants to gather data regarding their experience with the prototype.

Based on the feedback obtained, data gathering instruments and/or the prototype was refined. In case a *refinement* was done, the prototype had to be redeployed and in some cases training had to be provided again.

The *on-going* support referred to the support that was provided to each participant on demand throughout the duration of the study.

The last stage, namely the *wrap-up*, consisted of a final discussion with the participants regarding their overall experience throughout the study, the uninstallation of the prototype and a data analysis of the data collected from all the participants.

The next section describes how the pilot study was conducted.

## **5.3 Pilot Study**

As mentioned earlier, we conducted a pilot study prior to the main study to assess the validity of our case study design. A prototype was developed which was trialled with nine older adults. Details of the prototype, the way the study was conducted and the results of the study are discussed in this section.

### **5.3.1 PictureFrame**

A digital picture frame prototype was developed by a software developer and focused mainly on the “I am in touch” functional goal. This prototype, which we initially named as *PictureFrame*, was conceived with the main objective to act as a well-being check for the older adults while acknowledging the social needs and surrounding emotions of the older adults. This application, designed for tablets, enables the older person to interact with a digital photo frame which receives messages and

photos from their families or carers. The frame displays the photos and messages in a circular manner one after the other, as a carousel. The details of the person who sent the photos and messages are also displayed.

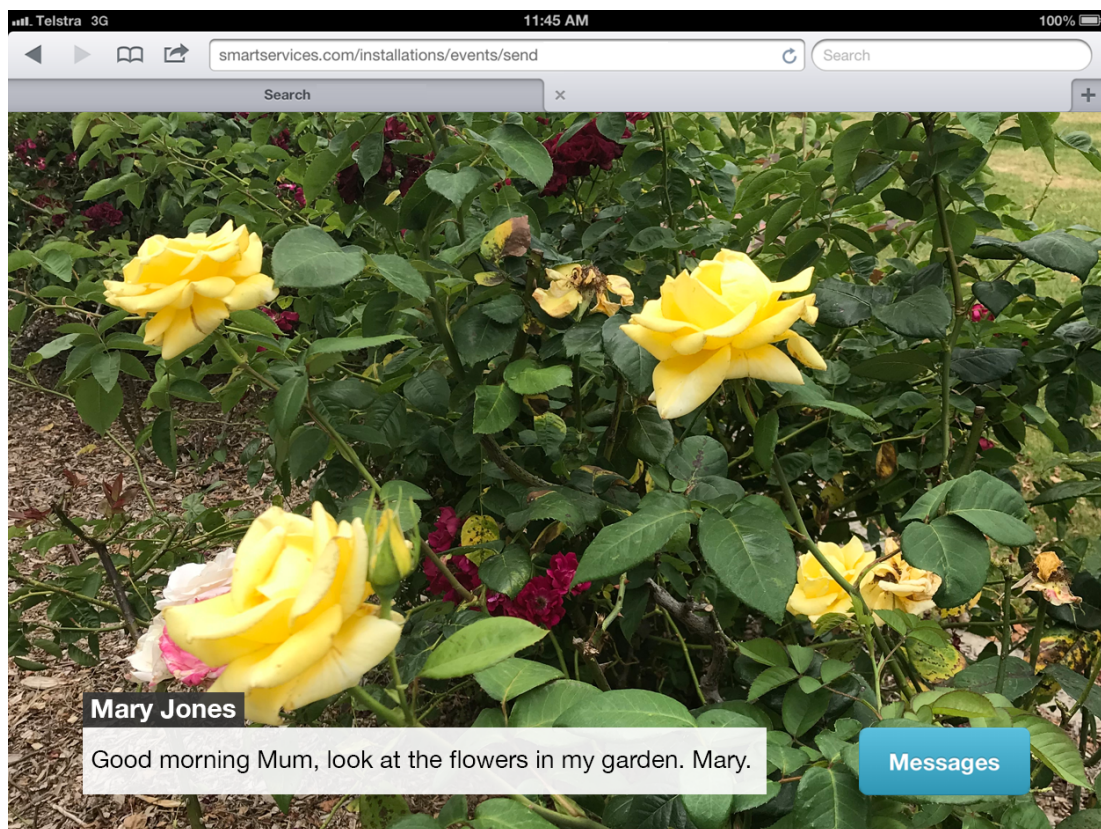
When a new message or image is received, the start of a new conversation is indicated and the older person can decide to reply to the messages or images. By sending photos and messages to others, the older person provides an indication of their wellbeing. In case no message or interaction with the picture frame is received, and hence, no indication of wellbeing is obtained during a specified period, the system generates a message to enquire if the user is ok. This application is not only designed to act as a well-being check but also intends to cater for the emotional goals identified in the previous section. For instance, by receiving images and messages on a regular basis, older people feel in touch with their loved ones and also cared about. Since the system did not impose any specific time period to reply to messages, older adults feel independent and in control of their lives. Also, the interaction between both parties was expected to reassure families of the wellbeing of the older person. A snapshot of the PictureFrame prototype is presented in Figure 5.6.

### **5.3.2 Evaluation of the PictureFrame**

PictureFrame was tested in a field study which was conducted over a period of two weeks in the homes of older adults. We recruited nine older adults, six women and three men aged between 69 and 92 years who all lived on their own, except for one who lived with her husband. These participants had different capabilities and limitations which included visual problems, dementia and mobility problems. Since the study involved the close relatives or carers of the older adults, each participant was requested to nominate one or more persons who could play the role of the relative or carer. In some extreme cases where no relative was ready to cooperate, a researcher took on this role.

The prototype was installed in the homes of the older adults for the

duration of two weeks allowing the participants sufficient time to get acquainted with the technology. The older adults and relatives or carers were made acquainted with the different features of the system at the very beginning of the study. Throughout the two weeks, all the interactions that the participant had with the iPad were monitored by the system. This data was analysed to see whether it can be used to check the wellbeing of the older person.

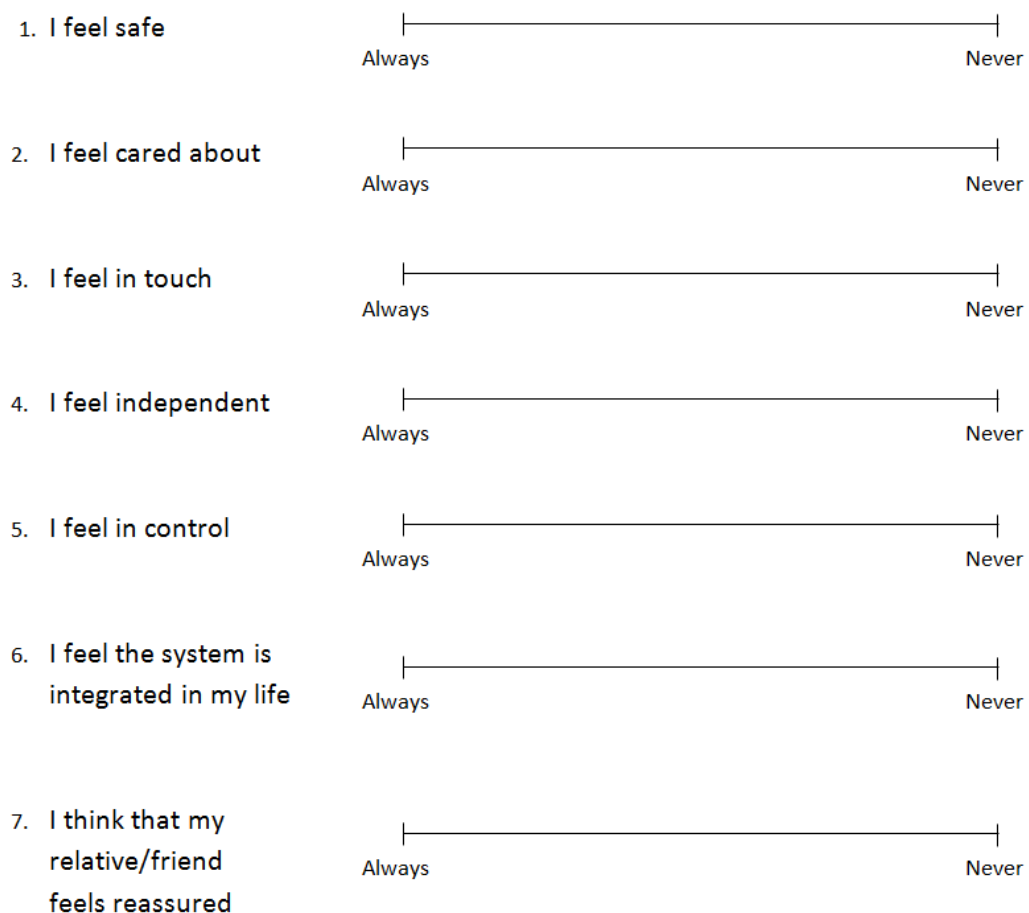


**Figure 5.6:** Snapshot of PictureFrame








At the end of the two weeks, an interview was conducted with both the older adults and the relatives or carers with the aim to find out how the participants felt about using the system. Also, issues encountered during the trial were discussed along with recommendations for further improvements. In addition to the interviews, participants were requested to fill out our evaluation tool. The intention of this process was to assess the validity of the questionnaire as an emotional evaluation tool.

Two sets of the questionnaire were therefore designed; one for the older adults (Figure 5.7) and another one for the relatives/carers (Figure 5.8). The questionnaire for the older adults consisted of the six emotional goals identified earlier, namely safe, cared about, in touch, independent, in control and integrated. The second questionnaire designed for the relatives and carers included only one emotional goal, namely reassured.

Since all the participants did not start using the application at the same time, we had the flexibility to modify the questionnaire throughout the study based on the feedback obtained by the participants. A first set of questionnaires was given to the first participant and her relative at the end of the two week trial.



**Figure 5.7:** Questionnaire for the older adults

1. I feel reassured that my relative/friend is ok	
	Always <span style="float: right;">Never</span>
2. I think that my relative/friend feels safe	
	Always <span style="float: right;">Never</span>
3. I think that my relative/friend feels cared about	
	Always <span style="float: right;">Never</span>
4. I think that my relative/friend feels in touch	
	Always <span style="float: right;">Never</span>
5. I think that my relative/friend feels independent	
	Always <span style="float: right;">Never</span>
6. I think that my relative/friend feels in control	
	Always <span style="float: right;">Never</span>
7. I think that my relative/friend feels that the system is integrated in his/her life	
	Always <span style="float: right;">Never</span>

**Figure 5.8:** Questionnaire for the relatives

Following the feedback obtained during the interview and the ratings on the questionnaire, it was decided to include all the emotional goals in both sets of questionnaires. That is, the emotional goals directed at the older adult were included in the questionnaire of the relatives and vice-versa. This was done with the objective to study the way relatives and older persons perceived each other's feelings. For instance, in addition to the six emotional goals, the older adults also had to give their



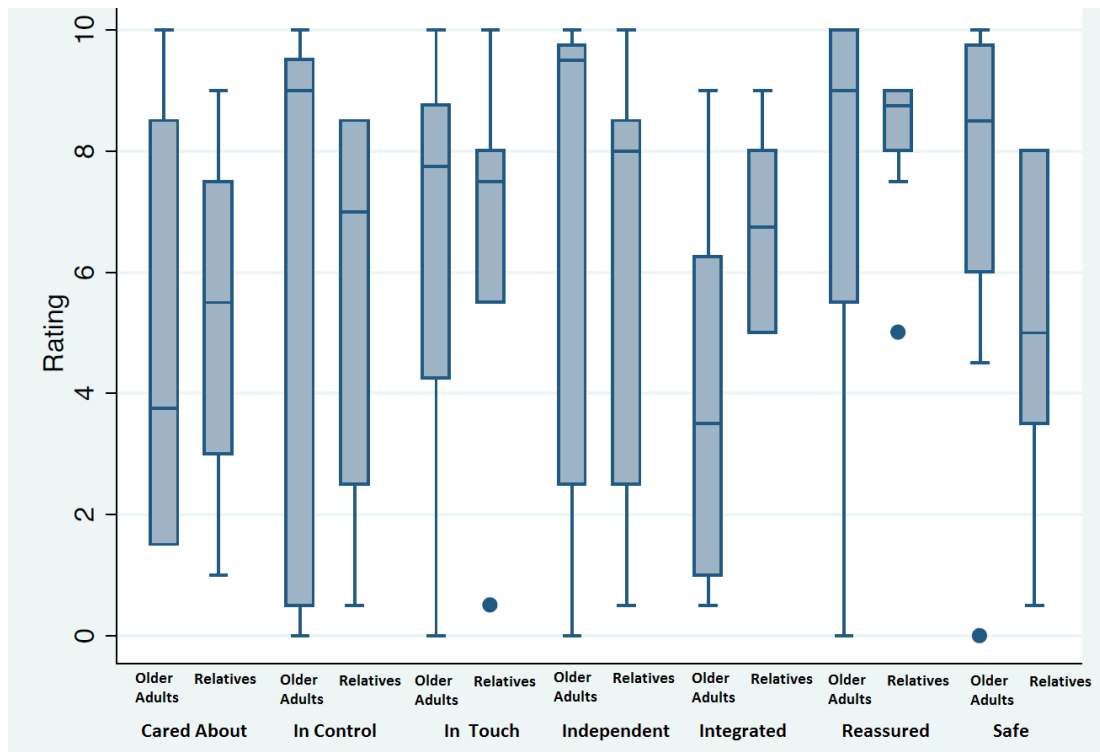
opinion on whether their relatives felt reassured or not. The modified questionnaires were given to the remaining participants at the end of the two week trial and the results are described in the next sub section.

### 5.3.3 Discussion of Results from Pilot Study

The data from the questionnaires was analysed along with the feedback obtained from the participants during the interviews. The whole process led us to interesting insights on the way people perceived the feelings of others. Based on our analysis, we figured out that relatives very often misunderstood the feelings of their older relatives. In other words, what relatives perceived as being the feelings felt by their older relatives were not necessarily the ones experienced by the older relative and vice-versa. For instance, older adults had the impression that their relatives were highly reassured when in many cases it was not true. Similarly, relatives felt that their older relatives felt safe around such a system but the responses from the older adults did not match the opinions of the relatives. In most cases there was a significant disparity between the perception of emotions between the relatives and the older adults. Figure 5.9 provides a summary of the ratings for each emotional goal by both the older adults and the relatives. In the diagram, 0 stands for Never and 10 for Always. Figure 5.9 also provides an overall picture of the difference that was found between the ratings of the older adults and those of their relatives for each emotional goal. For instance, for the emotional goal integrated, the ratings given by the relatives showed that they strongly believed that their older relatives were able to integrate the application in their everyday lives without major difficulty. On the other hand, the ratings obtained from the older adults show that many of them were not able to integrate the system in their daily lives straight away.

In some cases, it was found that the participants had difficulty interpreting the terms used for the emotional goals. For instance, when it came to rate the emotional goal *independent*, a participant questioned the validity of this goal by mentioning that he never had any issues with his independence so how does this relate to him. In these cases, the

interviewer had to explain the goal to help the participant understand what was being expected from them.



**Figure 5.9:** Ratings of emotional goals

An issue encountered during the evaluation of the emotional goals was that problems related mostly to functional and quality goals had a major impact on the way the participant viewed the application from an emotional perspective. For instance, in one case the application did not respond for a day due to some technical reasons. That caused the older adult to feel *confused*, *lost* and *scared* as he had the impression that he was responsible for the failure of the application. The influence of functional and quality goals over emotional goals was not considered at all during the design of the tool.

Another conclusion of the data analysis was that since the evaluation was done at the very end of the trial it did not capture the emotional responses of the participants while they were actually using the system. The ratings given by the participants were based on their memory rather than the feelings that they experienced during the use of the

system. Daily evaluation could have provided a better insight on the way people integrate technology in their everyday life.

Lastly, the study showed that the responses of participants were based on a number of other factors such as their personal situation, age, computer literacy, past experiences and physical disability. For instance, older people who had some previous notion of how technology works found the system easy to use compared to those who had never used a computer before. Also, people who were still very actively involved in social activities did not really feel the need to be connected to their loved ones, compared to those who spent most of their time on their own. In short it can be said that the responses obtained were subjective to a large extent. Emotion being a very subjective issue, it was expected to have a certain degree of subjectivity in the responses.

The findings from the pilot study led us to refine the initial case study design presented in Section 5.2. The revised case study design is presented in Section 5.4.

## **5.4 Revised Case Study Design**

The research questions and unit of analysis were maintained. The data collection techniques were modified to accommodate the feedback obtained during the pilot study. Detailed description of the revised version of the questionnaire is provided later in Section 7.2. In this section, we briefly highlight some of the major modifications made.

One of the major problems encountered while filling in the questionnaire was that the terms used for the emotional goals were confusing. We therefore came up with a brief description for each emotional goal in order to ensure that the participants had the same understanding as the researcher.

In order to further support the questionnaire and capture daily feedback, we used a Niko Niko calendar. The latter, also known as smiley calendar or happiness index, is a tool commonly used in the agile envi-

ronment to track the mood of the people working within a team. Each team member is required to draw a smiley on the calendar, on a daily basis, to portray their current mood. The Niko-Niko calendar is considered as an effective tool to detect any problems within a team. By including the Niko-Niko calendar as a complement to the questionnaire, we intended to capture the emotional responses of the participants on a more frequent basis.

Our plan was to provide these calendars to all participants and encourage them to add a smiley along with some comments to the calendar on a daily or weekly basis. This additional information could add value to our evaluation process by providing us with a deeper understanding of the ratings on the questionnaire. We customised the Niko Niko calendar to allow the participants to add a smiley on a daily basis and also added comments to justify the reasons for their mood on each specific day. A snapshot of the Niko Niko calendar is available in Figure 5.10. A set of three smileys were provided to the participants which depicted “happy”, “sad” and “neutral” as shown in Figure 5.11.

**Week 1**  
Mood Updates

**Monday**   **Tuesday**   **Wednesday**   **Thursday**   **Friday**   **Saturday**   **Sunday**

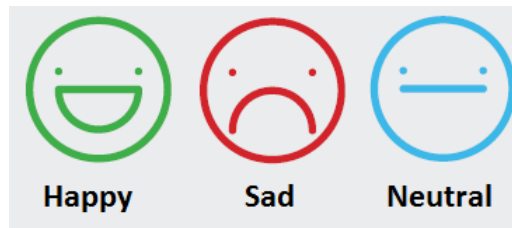
Sticker Here   Sticker Here   Sticker Here   Sticker Here   Sticker Here   Sticker Here   Sticker Here

Comments:   Comments:   Comments:   Comments:   Comments:   Comments:   Comments:

**To Use**  
Please apply an emotion sticker to the calendar each day you have used the TouchFrame. You can also provide details about your feelings in the comments section. The reason for using the calendar in our study is to have a deeper view on how the user's (you) mood states change over time, with regards to technology use.

Any questions regarding the Calendar or Application please contact TouchFrame: support@touchframe.com.au Phone: +61 9214 6079

**Figure 5.10:** Niko Niko Calendar



**Figure 5.11:** Niko Niko Smileys

## 5.5 Main Study

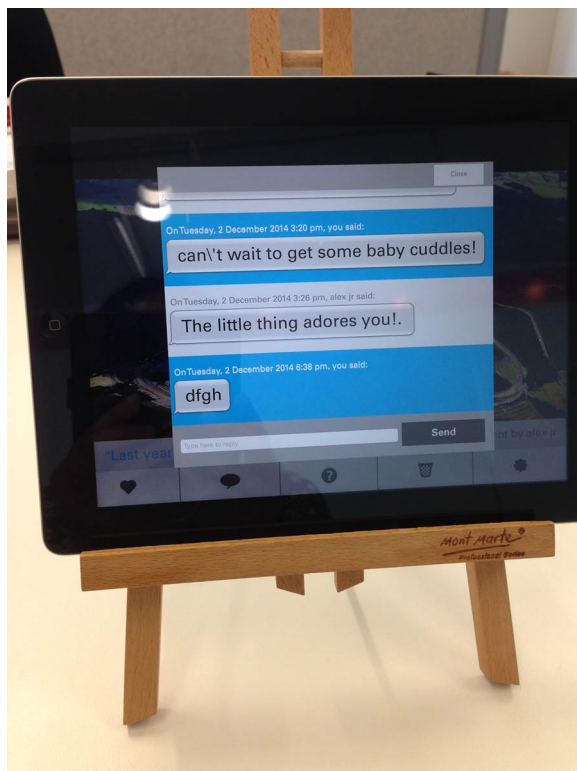
In this section, we present details on the refined version of the digital photo frame and the main study. The findings and discussion of the case study are also presented within this section.

### 5.5.1 TouchFrame

Following the feedback from the participants of the pilot study, the digital photo frame was modified and the new version was named *TouchFrame*. TouchFrame included a refined help feature providing users with simple step by step instructions to perform a task. Changes were made to the way the photos were displayed and the bugs identified during the trial were fixed. A settings feature was provided to allow for minor customisation such as having the delete option on the screen. It also allows the users to add new contacts to their already existing contact list. Only contacts in the contact list are allowed to interact with the older adult. The earlier version was restrictive without this feature and each time the older adults wanted to receive photos or messages from a new person, they had to request the researcher who had to request the developer to add the new person. Snapshots of TouchFrame are presented in Figure 5.12 and Figure 5.13.



**Figure 5.12:** Snapshot of TouchFrame



**Figure 5.13:** Snapshot of TouchFrame Messaging feature

### **5.5.2 Evaluation of the TouchFrame**

TouchFrame was trialled during the main study which was conducted with seven older adults, five females and 2 males, who were recruited based on the predefined set of criteria. Prior to the setting up of the app in the homes of the participants, we had a phone conversation with each participant to give them an overview of what the project was about and also to get the names of the relatives who will be sending them photos throughout the trial. The app was then configured in the iPad to allow the nominated relatives to interact with the older participant.

The first visit consisted of a detailed explanation of what TouchFrame was about and participants were acquainted with the different features of the application. The participant was then interviewed and the questions were centered around their background, living circumstances, use of technology and preferred support mechanisms when using technology. We also introduced to them the Niko Niko calendar which they were requested to fill in daily.

The study was conducted over a period of three months during which relatives were required to send the older adults some photos and messages regularly. We communicated with the participants on a weekly basis over the phone and conducted a face-to-face interview at the end of each month. In addition, they were requested to fill the evaluation questionnaire at the end of the interview. Two sets of questionnaires were designed for the older adult and their relatives as presented in Appendix A.

Information about each participant is provided in Table 5.1. In order to maintain confidentiality, the participants' names and addresses will not be disclosed. We give them the following fictitious names Sarah, Jane, Paula, Mary, Lorine, John and Tom.

<b>Profile</b>	<b>Social Bg</b>	<b>Technological Bg</b>	<b>Experience with TouchFrame</b>
Sarah, 67 years old, lived with her husband	socially active and cheerful	keen on learning new technology, attended computer classes to build up her confidence	Distressed because her sons did not send her pictures regularly, quit the trial after 2 weeks Refused to take participate. "I don't want it. I am happy how I live..." .
Jane, 80 years old	lived in an elderly village, surrounded by older people. Native language not English. Son suggested that she participated in the trial		
Paula, 84 years old, lived with her husband who had dementia.	Not many friends, spent most of her time with her husband at home	using a computer for over 10 years to communicate with family members all around the world	showed a lot of appreciation for the iPad but could not differentiate it from the TouchFrame app
Mary, 72 years old	Liked communicating with her daughter regularly	Owned a computer - mainly for emails	Very pleased and happy to receive pictures from her daughter and granddaughters.
Lorine, 58 years old, lived with her husband	socially active	scared of using technology	Could not figure out the purpose of the TouchFrame app when she could use Skype to talk to her granddaughters and daughter who lived abroad
Tom, 73 years old	socially active	very technology savvy	provided suggestions for improving the app
John, 80 years old, looked after his wife who had dementia	Lively person, enjoyed interacting with his family members	basic computer skills	Liked the iPad but he encountered a number of technical issues

**Table 5.1:** TouchFrame Participants Details



## 5.6 Findings and Discussion

The main findings of the study show that designing a technology to care for people is not an easy task. Policy and compliance considerations are in the foreground of decision makers. How can we in technology development for older people, implement our user-centered ideas and respect the feelings of older people? For instance, during the pilot study one participant commented “I wouldn’t want to have any automatic checking on me. I want to be in control whether someone is coming. I want to make a conscious decision. Last year I had really high blood pressure and I went to bed and thought ‘either I will wake up or not and that is fine.’” If people do not want to use a technology, even when forced by their close relatives, they always end up finding a way to work around it.

Another interesting finding was that some older people feel that by giving them a technology to use, their close relatives are passing off their responsibility to the technology rather than assuming their own responsibility. For instance, during the pilot study, one participant mentioned “this gives my son the excuse not to visit me now”. Similarly, during the main study, Jane refused to use TouchFrame since the beginning because she preferred to interact with people directly rather than through a technology. She knew that her sons were pushing her to use TouchFrame as a medium of checking on her rather than visiting her personally.

In addition, family dynamics play an important role in the introduction and adoption of technology. Our solution requires commitment from relatives and carers to spend some time in communicating with the older person. Often it was difficult to find people who would send a photo a day to the older person. While we try to meet the emotions of older people we are aware that we rely on other people whose emotions or time allowance might not be in alignment with the ones of the older person. During the study, we witnessed different cases where TouchFrame was introduced and adopted successfully due to relatives’ active participation throughout the trial. For instance, Mary was happy with TouchFrame because her daughter kept sending her photos of the fam-

ily every day. Similarly, Paula and Lorine loved seeing pictures of their grand daughters who lived abroad. On the other hand, Sarah became distressed because her sons stopped sending her photos which led to her quitting the trial.

An interesting finding showed that the consideration of emotional goals should not only be restricted to the design of the software but should also be extended to the supporting documents or mechanisms provided to the users. During our case study, we found that the support mechanism (which consisted of a user manual and phone conversations) did not support some of the participants as the user manual was written in English which was not the native language for many people. One of Mary's comment was "the pictures on the user manual look good but I could not use it because I don't know how to read English". Lorine who was clearly scared of technology mentioned "..I panic when something stops working....need someone to fix it for me....don't like the user manual or over phone".

The motivation behind adopting a technology plays an important role in the success of the technology. Sarah and Mary used the TouchFrame because they wanted to be part of the new era of technology where people are using iPads and smartphones. Sarah commented "I always wanted to have an iPad and feel part of the new era...I might buy one of my own if this works". Lorine was keen to give technology a try as it was the only way that she could be in touch with her daughter and granddaughter who lived abroad. For her, "I am using it because I can see pictures of my granddaughter". Jane on the other hand refused to use it from the beginning because she could not see any benefit from integrating TouchFrame into her life.

The background of the participants with regard to technology use has an influence on how much they used the different features. Participants with little or no technological background restricted their interactions to the main features of the app. For example, Paula, Lorine and Mary limited themselves to viewing the photos and used the favourite option. They did not explore the message options and preferred to use other communication medium such as the phone and Skype to com-

ment on the photos or communicate with her relatives. Sarah who had some previous experience with technology but was still scared to use it, did explore some additional functionalities upon the request of the researcher to add her second son into her contact list. She also tried to send them messages. John managed to add some more contacts in his contact list with the help of his son. Tom, on the other hand, who is very tech savvy explored all the features and even proposed new functionalities that could be added to the app.

Interestingly, the relationship between technology, people and content is so seamless that most participants had a hard time differentiating between the iPad and TouchFrame. When asked about how they found the features, some comments were “Oh I like the mail and weather features”, “I used Skype and tried reading the news”.

Also, in one case, the study turned out to be stressing to one of our participants. During our Ethics application, we had not anticipated such an eventuality. We therefore recommend that Ethics applications for similar projects should be treated as high risk.

In addition to the above findings, we figured out that neither the questionnaire nor did the Niko Niko calendar worked as an evaluation tool to measure emotional goals.

## **5.7 Reflections on the Evaluation Tool**

Unfortunately, the participants did not know how to fill in the calendar. We expected participants to share the experience they had with the technology on a particular day. For instance, if they had difficulty using a feature, they could write about their frustration. Similarly, if they were able to use a feature successfully, they could write about how the technology made them feel empowered or happy. Instead, Paula provided details about each picture she received rather than her experience with the technology. Sarah was happy when she received pictures and depressed when no picture arrived.

They did not understand the importance of the Niko Niko calendar for the study. For older adults "smilies" may look like fun or joke and they feel above it. The whole idea of a wellbeing check related to their lives, but for them communicating to their loved ones is an important aspect of their well being. We realised that the smileys were not suited for them when John made a comment about "these stickers are for kids, they ain't for me, old man".

Our initial findings during the EAS field study conducted by Pedell et al. (2013) showed that older adults prefer to talk to people and by providing them with measuring tools we take that away from them. Our research purpose and research evaluation turned out to be contradictory in this context. Paula referred to it as being her "homework" and was doing it as a favour to the researchers. Also, Tom's comments at the end of the study were "Thanks for relieving me from filling these". As identified in the previous section, emotional goals cannot be restricted to the software but should also be extended to any supporting documentation and survey instruments which are provided to the users.

The questionnaire statements turned out to be hard to explain to older adults. For instance, it was hard to explain terms such as nostalgic to participants like Mary, John and Lorine whose first language was not English. In addition to that, there were too many statements in the questionnaire and the participants started getting distracted half way.

Lastly, the evaluation tools were not easily quantifiable. It turned out that the data we collected could not be represented in a clear format, thus making analysis hard.

## **5.8 Threats to Validity**

In this section, we assess the validity of the study by conducting four tests which are common to all social science method (Yin, 2013) namely:

- Construct Validity

- Internal Validity
- External Validity
- Reliability

### **5.8.1 Construct Validity**

Based on our findings, the data collection instruments used (namely the questionnaire and the Niko Niko calendar) failed to serve their purpose. Participants interpreted the statements on the questionnaire differently from what they were actually intended to mean. This refers to a threat to the construct validity of our research.

Another concern identified during the trial was that some participants failed to differentiate between the iPad and the TouchFrame app. This threat to validity highly questions the validity of the responses captured during the validation process. Where they in relevance to the TouchFrame app or to the iPad in general?

### **5.8.2 Internal Validity**

Our research proposition states that “user emotional expectations play a critical role in the acceptance of a technology”. While our findings do prove that user emotional expectations are a critical determinant of the success of a technology, we cannot ignore the other factors that influenced the success or failure of the TouchFrame application. These factors namely family dynamics, user’s motivation and user’s previous computer expertise are *threats to internal validity*. Even though the application was designed taking into account users’ emotional expectations, these three mentioned factors highly influenced the acceptance of the technology.

### 5.8.3 External Validity

Regarding the external validity, even though this study was conducted with only 7 older adults, we argue that this study can be extended to other people. The participants involved in our case study were reflective of the population of elderly adults and, therefore, if this study was extended to more participants, similar results would be anticipated.

### 5.8.4 Reliability

Even though user emotional expectations is a subjective concept, the data analysis process was conducted objectively using the process of content analysis to eliminate subjectivity as much as possible. Each interview script and questionnaire was analysed by more than one researcher and the compilation of the synthesised notes was conducted by a group of 8 researchers. Hence in terms of reliability, we can say that the findings of this study were not dependent on any specific researcher. This study could be conducted by any other group of researchers and similar outcomes would be anticipated.

## 5.9 Summary

This case study was designed to answer the three research questions namely (1) Why should user emotional expectations be elicited?; (2) How can user emotional expectations be elicited? and (3) How can user emotional expectations be validated?

In Section 5.1.1, we provided an overview of the Emergency Alarm System and also presented the findings from the field study conducted by Pedell et al. (2013) to identify the reasons why older adults refuse to use the Emergency Alarm System. The key findings from the field study revealed several issues which are linked to the way *people feel* about using emergency alarm systems such as *lack of independence, feeling old, frail, stigmatised, stress, rejected and uncared about*. As argued in Section 5.2.1, given that these emotional issues act as barriers to the

adoption of technology, they cannot be ignored and have to be somehow represented within the requirement documents. We further argued that these emotional concerns refer to non-functional requirements rather than functional requirements. Given the limitations of the existing taxonomies of non-functional requirements to cater for emotional goals as discussed in Chapter 4, we reiterate our argument that emotional goals are a key component to the success of a system and should be represented as a separate category of goals under non-functional goals.

Having established the importance of user emotional expectations, we then addressed the second research question in Section 5.2.1 where we described how *content analysis* can be applied to existing documents to retrieve key information related to users' emotional expectations and concerns. The issues/negative emotions identified during the process were mapped to emotional goals through the use of an *emotion model*. We also described how emotional goals can be represented within a goal model.

In order to validate the emotional goals, we proposed the use of a simple tool, namely the *questionnaire*. As argued in Section 5.2.1, even though questionnaires have some limitations as an evaluation tool, these limitations do not affect our study as we are supplementing our data collection and evaluation processes with other qualitative methods such as interviews.

Once the emotional goals and objectives of the case study were derived, we established the case study design and prototype deployment methodology. A digital photoframe application was developed to allow older adults to connect with their loved ones. The key aim of this project was to showcase how technology can be integrated in older adults' lives with the merits of feeling safe, having fun and staying in touch with their loved ones. A pilot study was conducted with nine older adults for a period of two weeks and the findings from this study were used to refine the prototype, the data collection tools and the prototype deployment methodology.

The main study was then conducted with seven older adults over a

period of three months. The key findings from this case study show that when it comes to designing technology for older adults, many factors other than the older adults' feelings come into play. These factors include policy and compliance consideration, family dynamics, the motivation of the older adults to learn new technology, the support mechanism and the older adult's personal background. Additionally, the findings also show that the way relatives think about their older relative differ from what the older person actually thinks. Most importantly, the success of such technologies requires commitment from both the older adults and their relatives.

The design process of the TouchFrame case study and its findings were used to formalise the emotion-oriented elicitation and evaluation methods which we describe in chapters 6 and 7, respectively. The elicitation methods used during the TouchFrame case study namely content analysis and affinity diagram were further applied and refined in the remaining three case studies namely SMART, and SleepWell which we described in Chapters 8 and 9 respectively.

## **5.10 Research Contributions in this Case Study**

As mentioned in the introductory part of this thesis, the research conducted in this thesis was done in collaboration with a team of researchers at the Swinburne University Center for Computing and Engineering Software Systems (SUCCESS). In this particular case study, 8 researchers were involved but the case study was mainly designed and trialled by the author of this thesis.

The author's contributions in this project consisted of:

1. applying an elicitation technique to identify the key emotional, quality and functional goals from the interview transcripts generated from the EAS field study in collaboration with the other members of the team;
2. developing a validation tool to assess the extent to which user emo-



tions were addressed by the prototype;

3. conducting the pilot study which included the setting up of the prototype in the homes of the older adults, interviews and questionnaires;
4. refining the trial protocol based on the findings from the pilot study;
5. running the main study with the seven participants. This included the setting up of the application in the homes of the older adults, follow ups with the participants, interviews, questionnaires and Niko Niko calendars;
6. analysing the data from the interview scripts, questionnaires and Niko Niko calendar

# Chapter 6

## Capturing Emotional Goals

Evidence suggests that failure to consider human, social and organisational factors along with technical factors when building socio-technical systems, is a major reason to software project failure (Baxter and Sommerville, 2011, Demiris et al., 2004, Miller et al., 2015, Pedell et al., 2013). Building socio-technical systems have never been more challenging with the increasing need to understand the social requirements of users. Most people-oriented systems involve a number of stakeholders, and each stakeholder has their own perspective of how the system should be developed. The differing views of stakeholders often conflict (Easterbrook and Chechik, 2001), meaning that there exists no set of requirements to satisfy all stakeholders. Additionally, when it comes to developing socio-technical systems, the system design should focus on both the social and technical factors (Baxter and Sommerville, 2011). As social beings, users have emotional needs, such as to be connected to their loved ones, to feel cared about and feel secure. Given that these needs cannot be easily converted into functional or non-functional requirements using the existing software engineering methodologies, they are often ignored or trivialised within the current software development processes (Paay et al., 2009). As argued in Chapter 4, these needs (which we refer to as “emotional goals”) cannot be ignored and have to be conveyed to software engineers. To accommodate these challenges and meet customer demands, many organisations are looking for innovative ways to change their strategic business processes (Baxter and

Sommerville, 2011, Cernosek, 2004, Demoly et al., 2010).

One solution as proposed by Andrade et al. (2004) to solve the problem of differing views is to understand the problem through acquisition and conceptualisation activities. That is, we need to start by gathering as much information as we need about the context and then organise or model this information to provide a meaningful picture of the problem at hand. This model, termed the *conceptual model* of the problem, represents the problem from the viewpoint of the *problem owner* (Andrade et al., 2004). Since there are multiple stakeholders in projects, we may have different, and possibly conflicting, models representing the different viewpoints of the stakeholders involved. It is therefore important to ensure that the conceptualisation process considers everybody's views and addresses any discrepancies that can result during this process. Another approach used by a group of researchers (Lopez-Lorca, Miller, Pedell, Mendoza, Keirnan and Sterling, 2014, Miller et al., 2015, 2012, Paay et al., 2009, Pedell et al., 2014) to address the issue of representing emotional goals within software development processes, is to use agent-oriented models to understand and portray the roles and goals within a social domain.

In this chapter, we start by providing a rationale for the use of agent-oriented software engineering to represent user emotional expectations. We then present a systematic and repeatable process and method to represent emotional goals through the use of agent-oriented models from different viewpoints. We describe two emotion-oriented elicitation techniques to capture users' emotional expectations at the initial stages of the software development phase. Finally, we provide an overview on how emotion-informed personas can be generated. This chapter is organised as follows: Section 6.1 provides a background on Socio-technical systems design and the rationale behind the suitability of agent-oriented models to represent emotional goals within such systems. Section 6.2 provides a description of how agent-oriented models can be extended to represent emotional goals at different levels of the conceptual space; Section 6.3 presents two elicitation techniques which can be applied under two circumstances namely *with* and *without* stakeholders' involvement respectively; Section 6.4 presents a

method to derive emotion-informed personas from requirements; Section 6.5 summarises the methods discussed in its chapter.

## 6.1 Background

### 6.1.1 Agent-Oriented Software Engineering

Socio-technical or people-oriented systems take into account social, human, organisational and technical factors (Baxter and Sommerville, 2011, Miller et al., 2015, Paay et al., 2009). The key principle of socio technical system design is to consider both *social* and technical factors (Baxter and Sommerville, 2011). Evidence (Demiris et al., 2004, Mendoza et al., 2013, Pedell et al., 2013, Ramos et al., 2005) and our previous arguments have highlighted that one of the major causes of software project failure is due to the lack of consideration given to human needs, in particular human emotions, when designing systems for them. Existing system methodologies fail to fully address this problem (Baxter and Sommerville, 2011, Miller et al., 2015) and even software engineers, who are trained to develop systems from a set of requirements which relate mainly to functional and non-functional properties of the system, are unable to address this issue. How can software engineers be expected to understand the social or emotional needs of stakeholders by merely listening to the needs of stakeholders. As Baxter and Sommerville (2011) expressed in their review of design methods for socio-technical systems, *“it is not enough to simply analyse a situation from a socio-technical perspective and then explain this analysis to engineers. We also must suggest how socio-technical analyses can be used constructively when developing and evolving systems. [...] We must avoid terminology that is alien to engineers, develop an approach that they can use, and generate value that is proportionate to the time invested”*.

Baxter and Sommerville (2011) further pointed out how the existing software engineering methodologies and processes (such as Soft Systems Methodology, Cognitive Work Analysis, Contextual design, use-cases, prototyping and object-oriented among others) fail to fully ad-

dress the social objectives of stakeholders. These concerns were shared by other researchers (Miller et al., 2015, Paay et al., 2009, Rahwan et al., 2006, Walenstein, 2003) who reflected on the shortcomings of existing software engineering methods with regards to social objectives. In their work, Paay et al. (2009) criticised traditional systems design methodologies, such as the object-oriented software engineering approach for developing systems based on structured requirements elicitation processes and their inadequacy to address the social needs of users. They also argued that even though recent software engineering development methods, for example Iterative Design, Agile Development and Extreme Programming, have questioned the traditional systems with regards to user roles, they focus mainly on designing systems for the workplace and therefore focus on functional requirements.

With the advent of the agent paradigm, Agent-Oriented Software Engineering (AOSE) has been a focus of much research (Miller et al., 2015, Paay et al., 2009, Sterling and Taveter, 2009). AOSE focuses on the development of complex systems by making use of agents or a combination of agents (Sterling and Taveter, 2009). The agent paradigm provides more flexibility and a higher level of abstraction compared to the previous paradigm of object orientation (Sterling and Taveter, 2009, Yu, 2002). Additionally, agents are autonomous, situated and adapt dynamically to their changing context (Paay et al., 2009), hence, making them more applicable to socio-technical or people-oriented systems.

There are several methodologies for AOSE that have been proposed namely Tropos, Prometheus, Gaia, INGENIA and ROADMAP (Sterling and Taveter, 2009). Even though these methodologies have differing processes and methods to develop a system, they share several common concepts, such as agents or roles to represent how people interact with the system; goals rather than functional requirements to demonstrate desired behaviour; and quality goals to portray non-functional requirements. These concepts are used within AOSE as they relate closely to the socio-technical system (Miller et al., 2015, Sterling and Taveter, 2009), offering a strong foundation for modelling the broader goals of the user, rather than purely the system. In previous work (Lopez-Lorca, Miller, Pedell, Mendoza, Keirnan and Sterling, 2014, Miller et al., 2015,

2012, Pedell et al., 2014), the agent-oriented models proposed by Sterling and Taveter (2009) have been used to represent systems pertaining to different domains and involving different stakeholders. For example, Miller et al. (2012) used these models to illustrate a socially oriented system involving interactions between grandparents and grandchildren who are separated by distance. In recent work, the use of emotional goals were investigated to model the emotional viewpoint of different stakeholders in a project involving emergency alarm pendants (Miller et al., 2015). User emotional goals were linked to roles, which represent stakeholders within the system, and specify a desired state of emotion or wellbeing of someone playing those roles. Given that emotional goals represent how people feel, they are the property of people, not of the system and were hence associated with the roles. In recent work (Lopez-Lorca, Miller, Pedell, Mendoza, Keirnan and Sterling, 2014), the concept of emotional goals were extended to the models of Sterling and Taveter (2009), demonstrating how to model emotional goals in the early phases of the requirements engineering process, and to carry these emotional goals through to detailed design. These extensions support straightforward traceability of emotional goals through the development lifecycle.

Given that the agent paradigm provides a higher level of flexibility and abstraction as compared to previous paradigms such as object orientations, we therefore apply the concepts of the agent paradigm within our work. In this thesis, we extend the work of Miller et al. (2015) and Lopez-Lorca, Miller, Pedell, Mendoza, Keirnan and Sterling (2014) and use the notations of Sterling and Taveter (2009) to represent user emotional goals within each of our case studies. The work of Sterling and Taveter (2009) focuses on how to reduce the complexity of high-level agent-oriented models through the use of straightforward and minimal syntax and semantics, such that they are easily understood by non-technical stakeholders (Miller et al., 2012).

## 6.2 Modelling Emotional Goals

Previous work (Lopez-Lorca, Miller, Pedell, Mendoza, Keirnan and Sterling, 2014, Miller et al., 2015, 2012, Pedell et al., 2014) illustrated some of the agent-oriented models which were developed to describe the personal alarm system problem. In our work (Kissoon-Curumsing, Lorca-Lopez, Miller, Sterling and Vasa, 2014), we provided a comprehensive set of models for the Emergency Alarm System from early-phase requirements to detailed design demonstrating how to use the viewpoint framework proposed by Sterling and Taveter (2009) to capture the viewpoints of stakeholders, in particular the emotional viewpoints, throughout the entire process from early-phase requirements to detailed design. *Viewpoint modelling* has been a commonly used technique by software professionals to resolve discrepancies during the requirements specification process. This approach enables the specification of a complex system by providing different viewpoints, thus facilitating communication with stakeholders at different stages (Andrade et al., 2004, Enders et al., 2002, Finkelstein et al., 1992, Sterling and Taveter, 2009, Tan and Vasa, 2011). The framework proposed by Sterling and Taveter (2009) provides models at different stages of the software life cycle starting with the early-phase of requirements elicitation. The models proposed by Sterling and Taveter (2009) provide software professionals with the flexibility to model the problem statement at different layers in the conceptual space. These layers consist of:

1. The Motivation layer. In this layer the goals of the system to be designed are identified along with the roles for achieving these goals. Goal models and role models are often used at this stage.
2. The System Design layer. This layer consists of modeling agents and their activities. Different models can be used at this level, namely agent and acquaintance models, interaction models, scenarios, behaviour models and service models.
3. The Deployment layer. This layer refers to the environment wherein agents and activities are situated.

In this section, we briefly describe how agent-oriented models can be extended to showcase the emotional viewpoints of stakeholders. We use the EAS field study, described in Section 5.1.1 to demonstrate the extensions made to the agent-oriented models. As mentioned in the previous Chapter, the TouchFrame case study originated from the EAS field study. After analysing the data captured from the interviews conducted during the EAS field study, the identified emotional, functional and quality goals were represented through a set of agent-oriented models, originally proposed by Sterling and Taveter (2009). These models were structured according to the viewpoint framework proposed by Sterling and Taveter (2009). The complete set of models have previously been published in Kissoon-Curumsing, Lorca-Lopez, Miller, Sterling and Vasa (2014).

### **6.2.1 Emotion-Oriented Viewpoint Framework**

The three abstraction layers defined by the viewpoint framework that contain the models are the (1) conceptual domain modelling, (2) platform-independent computational design and (3) platform-specific design and implementation. Each layer presents the models from the *interaction*, *information* and *behaviour* viewpoint aspect.

The conceptual domain modelling layer also known as the motivation layer depicts how the system is motivated. Sterling and Taveter (2009) propose the use of the *role models* and *organisation models* from an interaction viewpoint aspect; the *domain models* from an information viewpoint aspect; the *goal models* and *motivational scenarios* from a behaviour viewpoint aspect.

The platform-independent computational design layer, also referred to as the design layer, consists of the notions required for modelling and designing a system. The models presented in the first abstraction layer of the framework represent the problem domain in abstract terms which is easily understandable to customers and external stakeholders. System designers, on the other hand, need to have a different view of the system in order to be able to design the system. At this stage, Ster-



ling and Taveter (2009) recommend the use of the *agent*, *acquaintance* and *interaction* models from an interaction viewpoint aspect; the *knowledge* models from the information viewpoint aspect; the *scenarios* and *behaviour* models from the behaviour viewpoint aspect.

The platform-specific design and implementation layer, also termed as platform-dependent, refers to the deployment layer which means that the models developed at this stage rely heavily on the technology that is used for the implementation of the system (Sterling and Taveter, 2009). A number of solutions can be adopted to implement the final system, and the models to describe them will vary accordingly. Sterling and Taveter (2009) mostly focus on the transition from computation-independent models to platform-independent models, as this is the pain point that is avoided by other approaches and could benefit the most from the concepts defined by agent-oriented modelling. In contrast, the transition from platform-independent models to platform-dependent models has been well explored by software design approaches such as Model Driven Architecture (Kleppe et al., 2003). In this level, the models proposed by Sterling and Taveter (2009) are the *agent interface* and *interaction specification* from an interaction viewpoint aspect; the *data* and *service* models from the information viewpoint aspect; the *agent behaviour* specifications from the behaviour viewpoint aspect. These models are mostly placeholders for technology-specific models, such as UML models for object oriented developments.

Table 6.1 summarises how we extended the agent-oriented models, originally proposed by Sterling and Taveter (2009), to include emotion modelling. Models belonging to the platform-specific layer are not included in Table 6.1 as the implementation models should cater for the emotions through the appropriate design decisions.

The rest of this section provides an overview of the emotion-informed models under each layer from the interaction, information and behaviour viewpoint aspect.

**Table 6.1:** Modifications made to existing models to include emotional modelling

<b>Abstraction Level</b>	<b>Model</b>	<b>Emotional Goals</b>
<b>Conceptual Domain Modelling</b>	Role Model	Included as new sections for <i>Personal emotional goals</i> and <i>System-dependent emotional goals</i>
	Organisation Model	Not included
	Domain Model	Not included
	Goal Model	Included as new symbols (hearts) attached to functional goals
	Motivational scenario	Included as new row namely <i>Emotional description</i>
<b>Platform-Independent Modelling</b>	Agent Model	Not included
	Acquaintance Model	Not included
	Interaction Model	Included as annotations for the relevant interactions
	Knowledge Model	Not included
	Scenario Model	Included as new rows to describe generally the emotional goals achieved by the scenario and as new columns for each activity to highlight the relevant emotions
	Behaviour Model	Included as annotations for the relevant states

## 6.2.2 Conceptual Domain Modelling

### Interaction Viewpoint Models

The **role model** provides an overview of the different roles involved in the system by listing out the responsibilities, constraints and emotional goals associated with each role. Six roles have been identified for the EAS namely (1) the older person (as depicted in Figure 6.1); (2) the Carer/Relative; (3) the Service Provider; (4) the Technician; (5) the In-touch Monitor; and (6) the Alarm Monitor. In this case study, the older person is an adult who lives on their own at home and who uses the emergency alarm system to support their wellbeing (description). As part of their responsibilities, the older person has to interact with the service provider to personalise the system based on their needs, communicate with the system on a regular basis to keep in touch with their carer or relative, activate the alarm in case of emergency and deactivate the alarm in case of a false alarm (responsibilities). In order to ensure proper functioning of the system, the older person is required to carry the emergency alarm device with them at all times (constraints). The expectations of the older adult is to feel cared about, safe, independent, in touch and unburdened with the obligation of routinely getting in touch with their relative/carer (personal emotional goals). In addition, they want a system that feels integrated in their life and they also want to feel in control of the system (system-dependent emotional goals).

The **organisational model** depicts the relationship that exists between the different roles. In our case, the control and peer relationship has been identified. A peer relationship means that the roles involved have the same level of authority within the system and none of these roles can control the other. For instance, the older person shares a peer relationship with the carer/relative and the service provider. This means that neither the older person nor the carer/relative nor the service provider can control each other. A double arrow is used to depict this relationship. On the other hand, a control relationship means that a particular role can have control over another role. For example, the service provider has control over the technician as depicted by the arrow pointing towards the technician.

<p>Role ID: R1 Name: Older Person Description: The older person is an adult that lives independently in their own home and adopts the use of the emergency alarm system to support their wellbeing. Responsibilities: 1. Take responsibility in maintaining their wellbeing. 2. Collaborate with the service provider to personalise the system. 3. Periodically communicate with the system to keep in touch with their carer/relative. 4. Activate the alarm in case of emergency. 5. Deactivate the alarm in case of a false alarm. Constraints: 1. The older person must carry the emergency alarm device with them at all times. Personal Emotional Goals: 1. The older person wants to feel cared about. 2. The older person wants to feel safe. 3. The older person wants to feel independent. 4. The older person wants to feel in touch with their relatives and carers. 5. The older person wants to feel unburdened of the obligation of routinely get in touch with their relative/carer. System-related Emotional Goals: 1. The older person wants a system that feels integrated in their life. 2. The older person wants to feel in control of the system.</p>
---

**Figure 6.1:** Role Model - Older Person

### Information Viewpoint Models

The **domain model** provides information about the environment in which the agents of the system will be situated. In our case study, the older person lives in their own home and is surrounded by a home surrounding, for example the garden around the house. The older person carries and uses the alarm monitor which monitors the emergency call activator. The latter covers the home of the older adult and its surroundings.

### Behaviour Viewpoint Models

The **goal model** represents the functional goals of the system to be developed along with any quality and emotional goals linked to the functional goals. The main functional goal of the EAS consists of providing technology-supported care to older persons and the roles which are responsible for achieving this goal are relatives, service providers and older persons as shown in Figure 6.2.

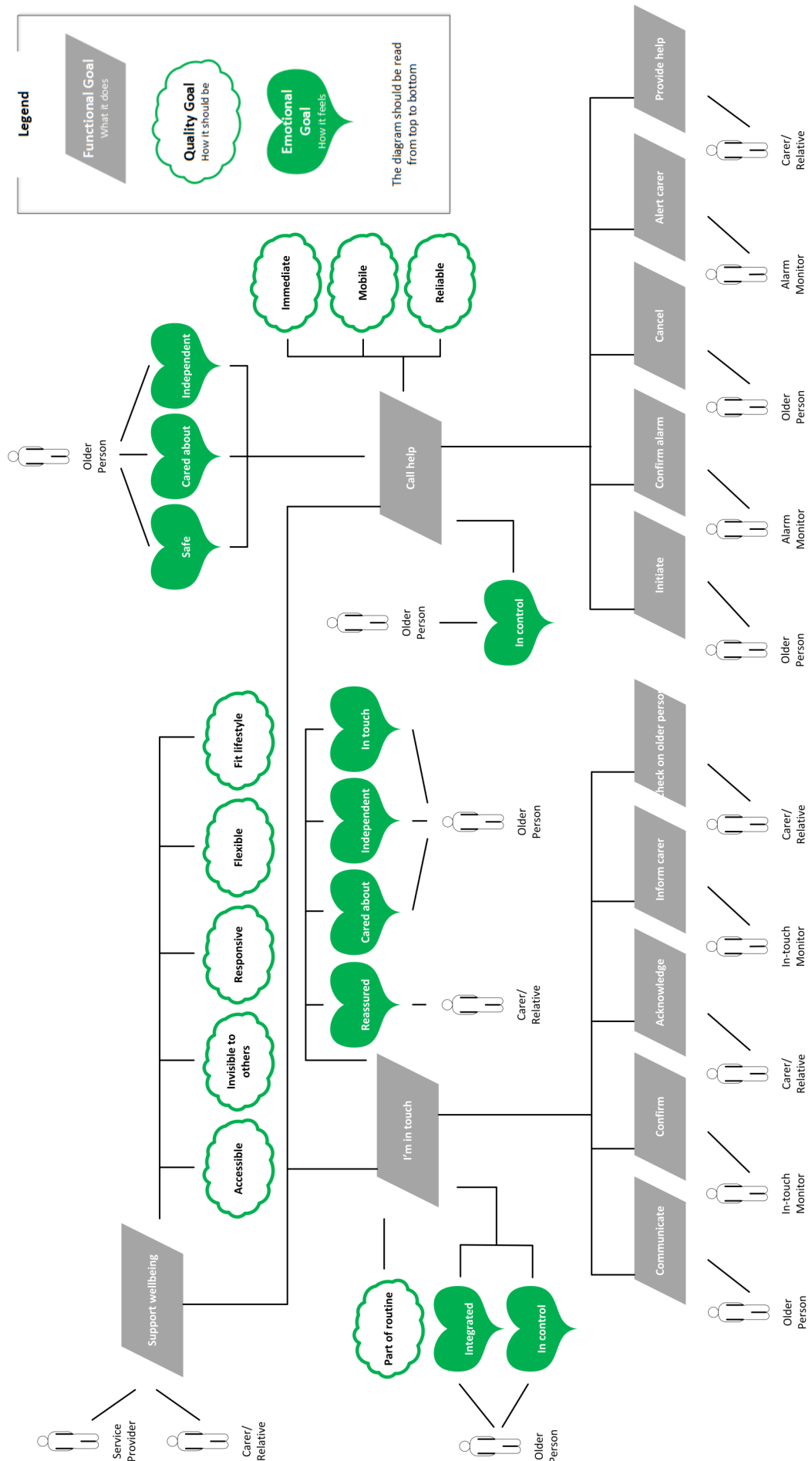


Figure 6.2: Goal Model for the Emergency Alarm System

The model also identifies the quality goals and emotional goals attached to each particular functional goal. These are represented as clouds and hearts, respectively. Each functional goal can further be decomposed into sub goals. For example, the “provide technology-supported care” goal is decomposed into (1) Introduce emergency alarm system, (2) I’m in touch and (3) Call for help.

The **Motivational Scenario** provides the high-level description of the purpose of the system in terms of functional, quality and emotional goals. It reflects how the agents enacting a particular role are going to achieve the goals assigned to them. We present only one scenario of the emergency alarm system in Figure 6.3.

Scenario name	Provide technology-supported care
Scenario description	Neighbours and relatives keep an eye on a person who lives at home to ensure that everything is fine. Technology-supported care is added to these mechanisms to further support the person’s wellbeing. The technology-supported care consists of a keep in touch activity that the older person performs periodically, and an emergency alarm that can be activated by the older person when in need of help.
Quality description	The system must be accessible to the older person and invisible to everyone else. The system must be responsive and flexible to adapt to the specific needs of the older person, in particular it must fit in their lifestyle.
Emotional description	The relative wants to feel reassured that the older person’s wellbeing is maintained. The older person wants to feel that the system is integrated in their life and under their control. The system will help maintaining the feeling of independence for the older person. By using the system, the older person will feel safe, cared about and in touch with their carers/relatives. Both, the carer/relative and the older person want to feel unburdened of the obligation of getting in touch to instead enjoy doing it.

**Figure 6.3:** Motivational scenario - Provide technology-supported Care

### 6.2.3 Platform-Independent Computational design

#### Interaction Viewpoint Models

The **agent model** is used to map the abstract constructs from the analysis stage to design constructs known as agent types. In this model, each role identified in the role model is mapped to one or more agent type whereby the agent is responsible to fulfill certain roles. The acquaintance model complements the agent model by outlining interaction pathways between the agents of the system.

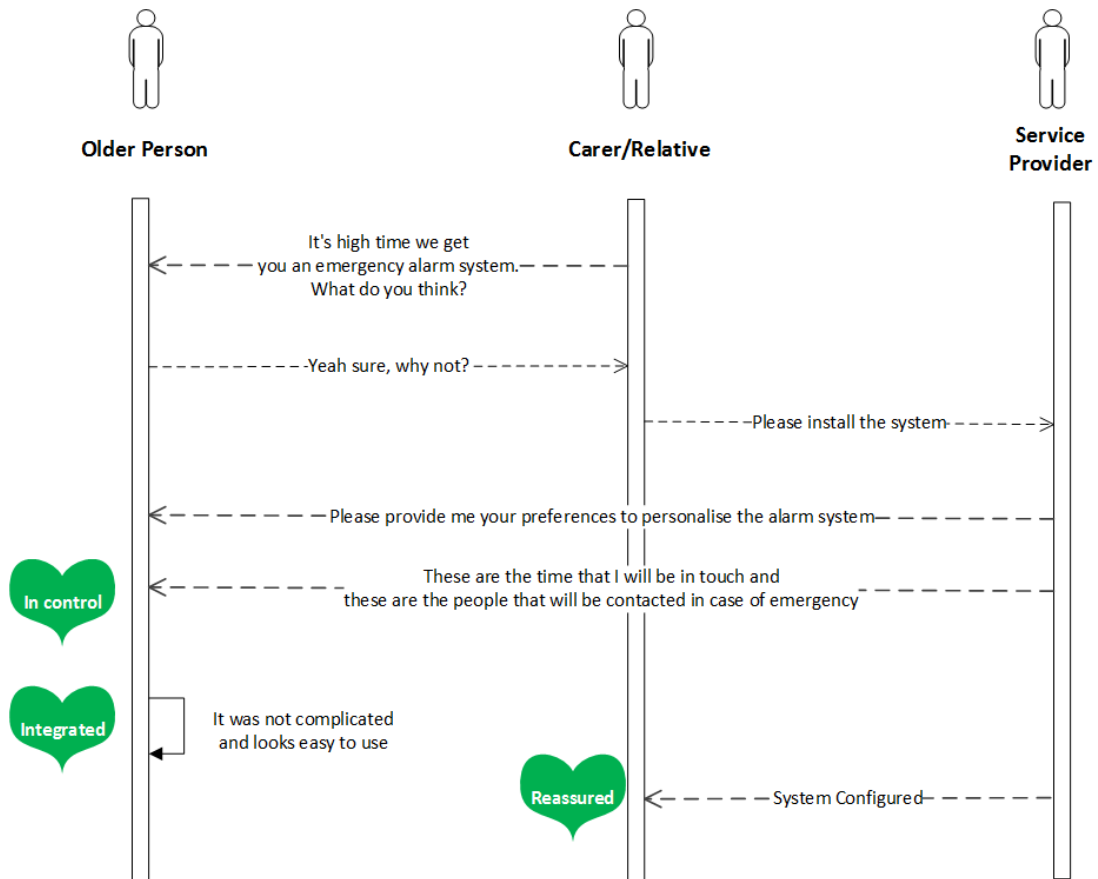
The **interaction model** represents a set of interactions that exist between the different agents within the system. It is expected to have several interaction models for a particular system whereby each model represents a particular scenario or functionality of the system. We present one of the interaction models for the emergency alarm system in Figure 6.4 to show some of the interactions that take place during the introduction of the EAS. Along with the flow of interactions between agents, software practitioners can easily identify how the emotional goals associated with each agent can be achieved. For example, the model demonstrates a scenario of how certain interactions, which are part of the introduction of the emergency alarm system, can make the older person feel in control and feel that the system is integrated into their life. It also shows how relatives or carers feel reassured with the introduction of the system.

Human icons are used to depict the agents within the system, pointed arrows show the flow of interactions between the agents and the heart shape depict the emotional goals.

### **Information Viewpoint Models**

At this second level of the abstraction layer, more concrete knowledge about the agents involved in the system is required. The **knowledge model** is a model which represents the knowledge that agents have about their environment and about themselves. There are two approaches that have been proposed by Sterling and Taveter (2009) to present this information namely, (1) using ontology-like notation and (2) using UML-like notation. In both cases, information about the agent and the agent's environment are identified. For instance, the knowledge models for the emergency alarm system both provide the same set of information about the older person such as their details, their emergency contact list, the current time and the time that they have to contact the in-touch monitor. The same information is also known to the in-touch monitor. The alarm monitor on the other hand is only aware of the older person's details and emergency contact list. These two approaches for the knowledge model illustrate the flexibility of the models to adapt to

different modelling styles. The ontology-like style uses semantic relationships, whereas the UML-like style borrows elements from the UML class diagram to express the relations in a way more oriented for the development.



**Figure 6.4:** Interaction model - Introducing the emergency alarm system

### Behaviour Viewpoint Models

A **scenario** is a behaviour model which represents a collective activity that models how a particular goal is achieved by agents enacting particular roles. A system can have more than one scenario depending on its complexity and number of functionalities involved. Each scenario provides information about a particular functionality by identifying the associated quality and emotional goals, the initiator of the function, how the function gets triggered and the set of activities linked with this function. One of the scenarios is available in Figure 6.5.



Scenario	1						
Functional goal	Provide technology-supported care						
Quality goal	Accessible						
	Invisible to others						
	Responsive						
	Flexible						
	Fit lifestyle						
	Part of routine						
	Immediate						
	Mobile						
	Reliable						
Emotional goal	Reassured						
	Cared about						
	Safe						
	Independent						
	In touch						
	Unburdened						
	Integrated						
	In control						
Initiator	Carer/Relative						
Trigger	The carer/relative suggests the older person the use of technology-supported care.						
Condition	Step	Activity	Roles	Resources	Quality goals	Emotional goals	
Sequential	Interleaved, repeat	1	Introduction of the technology-supported care system in the older person's home.	Older Person, Carer/Relative, Service Provider, Technician	In-touch activator, Emergency call activator	N/A	Integrated, In control
		2	The older person uses the system to get in touch with the carer/relative.	Older Person, Carer/Relative, In-touch Monitor	In-touch activator	Part of routine	Reassured, Cared about, Independent, In touch, In control, Unburdened
	Optional	3	The older person calls help in case of emergency.	Older Person, Alarm Monitor	Emergency call activator	Immediate, Mobile, Reliable	Safe, Cared about, Independent, In control

**Figure 6.5:** Scenario - Provide technology-supported care

A **behaviour model** focuses on what individual agents do within the system. There are two kinds of behaviour models namely behavioural interface models and agent behaviour models. The behaviour interface model for the emergency alarm system is provided in Figure 6.6, which displays the different behavioural units (activity) and interface (trigger, pre-condition and post-condition) for each unit. The agent behaviour model describes the behaviour of an agent in terms of rules and triggering messages. The agent behaviour model for the emergency alarm system is provided in Figure 6.7 which highlights how the agents of the system behave in different situations.

Activity	Trigger	Pre-condition	Post-condition
Introduction of the emergency alarm system	The carer/relative is concerned about the wellbeing of the older person.	One service provider has been selected by the carer/relative as the most suitable for the older person.	The emergency alarm system is installed at the older person's home.
			The older person knows how to operate the system.
			Due to its personalisation, the older person feels the system is integrated in their life and under their control.
I'm in touch	It is time for the older person to get in touch with their carer/relative.	The older person has the in-touch activator within reach.	The carer/relative feels reassured that the older person is okay and unburdened.
			The older person feels in touch, cared about and unburdened.
Call help	The older person needs help.	The older person has the alarm activator within reach.	The older person receives help.
			The older person feels safe and cared about.

**Figure 6.6:** Behaviour interface model

### 6.3 Emotion-Oriented Elicitation Techniques

Software engineering provides a wide range of elicitation techniques namely brainstorming, document analysis, focus groups, interviews, surveys/questionnaire, prototyping and observation, among others (Beg et al., 2013, Pohl, 2010, Wieggers and Beatty, 2013), to suit different domains and circumstances. However, to the best of our knowledge, none of the techniques proposed so far enables us to elicit user emotional goals. In this section, we present two elicitation techniques which can be used to derive user emotional goals under two circumstances, namely *with* or *without* direct user interaction. We also describe the step by step process to convert the identified goals during the elicitation process into an emotion-oriented goal model.

These elicitation techniques were derived and refined from our findings while conducting the different case studies. Given that the other case studies namely, SMART and SleepWell, have not been described yet, we restrict the description of the elicitation techniques to the TouchFrame case study. This is mainly to help the reader better understand our proposed techniques given that TouchFrame has already been described in Chapter 5.

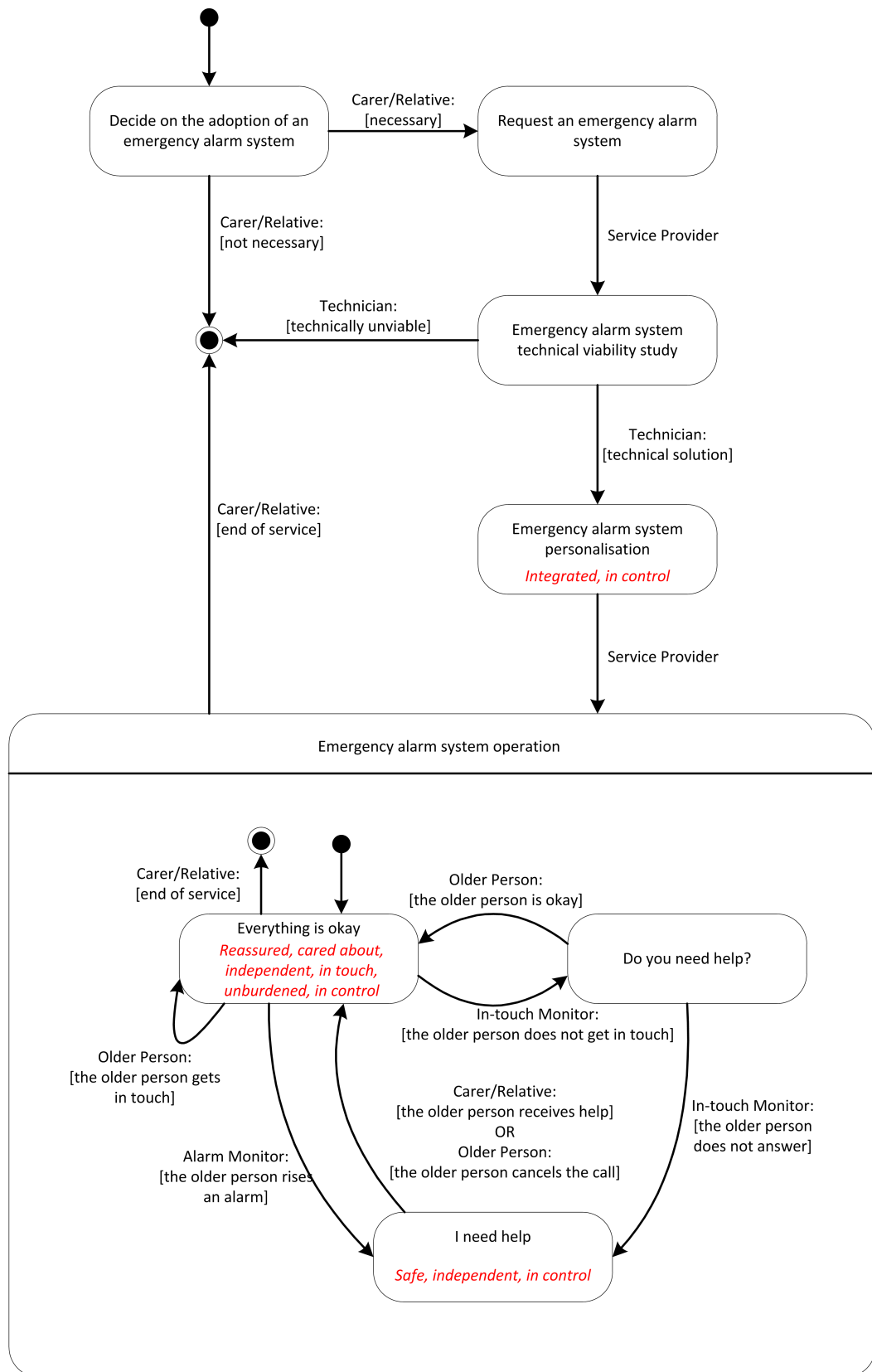


Figure 6.7: Agent behaviour model

### 6.3.1 Emotion-informed requirements elicitation technique *with direct user interaction*

The technique that we propose in this subsection is an adaptation of the brainstorming elicitation technique. Brainstorming is a problem-solving technique which allows a group of people to spontaneously contribute their ideas, thus, leading to a better problem understanding and a sense of ownership of the outcome (Paetsch et al., 2003). This technique consists of two phases, namely (1) the generation phase where all ideas are welcomed even though they are out of the box, and (2) the evaluation phase where each generated idea is discussed. Our proposed technique extends the traditional brainstorming session by encouraging participants to contribute their ideas and voice out their *emotional expectations* from the system. These ideas and emotional expectations are then discussed and validated.

The process starts with the identification of key stakeholders of the system. These stakeholders are then called to a workshop and asked to participate in a brainstorming session. Prior to the start of the brainstorming, the facilitator has to identify three separate empty areas on the wall or a board (if available) for each category of goals. Each area is labelled as *to do*, *to be* and *to feel*. A complete set of steps involved in this methodology are presented in Figure 6.8 and further described below:

- Small Post-It notes and markers are provided to stakeholders.
- Participants are asked to think about what they want the system *to do*, *to be* and how they want *to feel* when using the system.

For example, goals for the TouchFrame application are “be in touch with my relatives”, “feel cared about”, “system should be easy to use”, etc.

- As they think, they are requested to write down their expectations on the Post-It note.

Instructions are given to have only one expectation per Post-It note.

- While writing the goal, participants are encouraged to think aloud so that others can hear about the goal and thus avoid duplication of goals.
- The facilitator starts sticking the notes under the category specified by the participant.

For example, goals such as “be in touch with my relatives” and “feel cared about” will fall under emotional goal while the goal “system should be easy to use” will be placed under quality goal.

- If within the process, the facilitator feels that the ideas are running out, he/she might ask the participants to take a look at what is already on the wall.

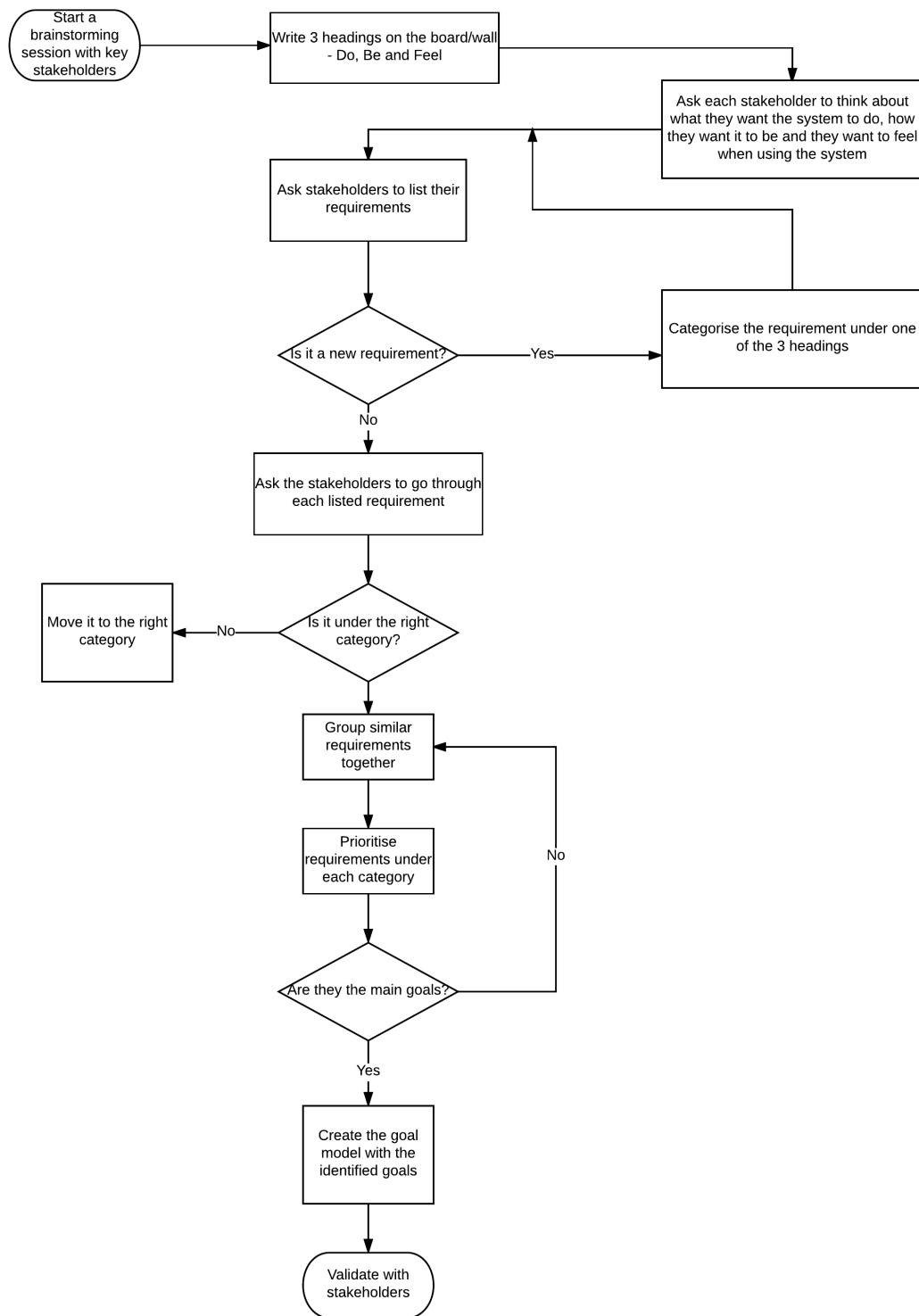
While going through the list, new ideas can emerge. This process goes on until the facilitator feels that no new ideas are coming up.

- The next step then involves going through the whole list again and checking whether all the items are under the right category.

For instance, some items might need to be moved from “to do” to “to be” or “to feel”.

- Once the participants are sure that the list is complete and each item is under the right category, they are then asked to group similar requirements together.
- The next step involves prioritising the requirements under each section starting from “to feel”, “to be” and then “to do”.
- Once this is done, they are asked to again check if these are really the main goals.

At this stage, the identified goals can be converted to a goal model which is then validated with the stakeholders at a later date. The process to convert the identified goals into a goal model is described in Subsection 6.3.3.



**Figure 6.8:** Elicitation technique with direct user interaction

### **6.3.2 Emotion-informed requirements elicitation technique *without* direct user interaction**

As mentioned in the previous Chapter, the author joined the team of researchers after the EAS field study and did not have any direct interaction with the end users of the TouchFrame app prior to its development. She therefore had to derive the requirements for the TouchFrame app from a set of interview transcripts generated from the EAS field study. Also, in case of the SMART project, the end-users, being psychosis patients, were classified as “high-risk” participants and since the author did not have a background in psychology was not granted permission to interact with them directly. Hence, the requirements for the SMART system had to be derived through the notes captured during the focus groups conducted by the psychologists within the SMART team. In both case studies, the elicitation method, that was applied to identify the users’ emotional goals, was an adaptation of existing techniques namely *content analysis* (Patton, 2002) and *Affinity Diagram*.

#### **Content Analysis**

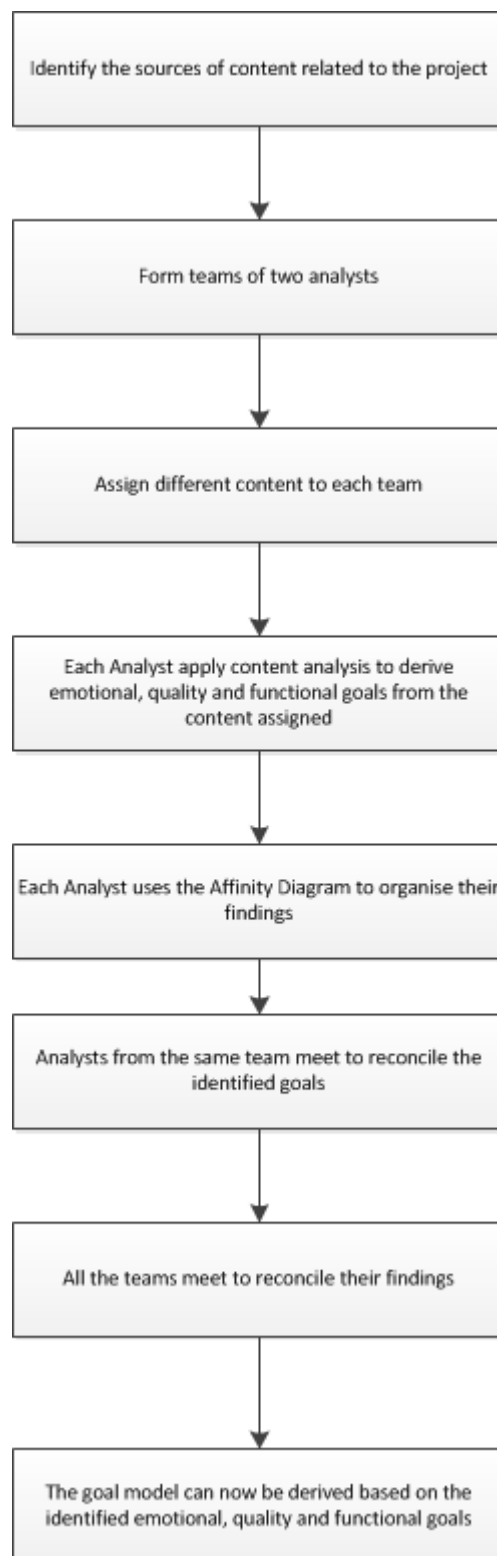
Content analysis is a technique for analysing content that may consist of words, meanings, pictures, symbols, ideas, themes, or any message that can be communicated (Patton, 2002). The format is anything written, visual or spoken that serves as a medium for communication, and includes among other things text documents, interviews, videotapes and photographs. Content analysis is usually applied to analysing text in transcriptions or documents and lets the researcher reveal their content (Weber, 1990). The text is searched for recurring words or themes to identify core consistencies and meanings. Content analysis involves identifying, coding, categorising, classifying and labelling primary patterns in the data. The coding process starts with a complete view of all the collected data. In the initial reading, the analyst can start visualising some coding categories and patterns but the actual coding occurs in the second reading. It is expected to have several readings before the complete set of indexes and codes. Codes are tags or labels used to assign meaning to a chunk of collected data. Content analysis re-

lies on the skill of the analyst in being able to recognise patterns in the data and being able to find appropriate terms to label them. These are all subjective judgements on the part of the analyst, because there are no prescriptive rules and exact guidance on how to proceed. A second researcher independently analysing the data provides some neutrality to this process, but the codes from both researchers then need to be reconciled. Coding outcomes are likely to vary from analyst to analyst with the same data, which is acceptable as long as the outcomes are viewed and discussed (Patton, 2002).

### **Affinity Diagram**

During the analysis session, an *affinity diagram* can be used to organise the identified patterns and codes into a hierarchy to draw higher-level concepts out of the data (Baxter et al., 2015, Dix, 2004). The patterns and codes are grouped together by related themes to create a story about the phenomena studied (Tufte, 1991). The affinity diagram is built bottom up. Individual ideas are grouped into common themes, suggesting categories to which they belong, using an inductive process. The ideas are written on Post-It notes. One note is studied and other related notes are identified. Two notes have an affinity if they are saying similar things about the situation being modelled or they have a similar intent, problem or issue. Deciding if notes go together involves reviewing the meanings of words on the note to understand the themes they represent. Grouping notes reveals new insights into the data. When notes are collected together they are given a group name, a succinct phrase summarising the content of the group. First-level groups are then collected into groups of groups, which are grouped into higher-order groups, which describe a whole area of concern within the collective themes. Creating the diagram is done in pairs or groups, so that people discuss their insights and use each other to check their thinking. The resulting diagram has several levels of hierarchy, which breaks the data into manageable chunks. Additionally, it presents the broad scope of outcomes from a field study in a single view (Beyer and Holtzblatt, 1998).





**Figure 6.9:** Elicitation technique without direct user interaction

### **Applying content analysis to the elicitation process**

We adapt content analysis technique and make use of the affinity diagram to derive emotional, functional and quality goals. The approach used is presented in Figure 6.9.

The process starts with the identification of the sources of content related to the project. The content identified is then divided among different teams of analysts where each team consists of two members. Each analyst within the team has to go through the content with an open mind (preferably more than twice) and complete the following set of tasks:

- highlight content which is relevant to the study, for example, words such as *“I want to be in touch with my relatives and I want to know what is happening in their lives”*
- find content relating to the emotional expectations and concerns of the user, for example, *“I feel stigmatised when I wear a pendant....it’s like a cowbell....I prefer something which is more modern”*
- find content relating to the quality goals, for example, *“it should not be too hard to use...I’m too old to learn complicated things”*
- find content relating to the functional goals
- use an affinity diagram to organise identified patterns/content under four main categories, namely emotional goals, emotional concerns, quality goals and functional goals
- group similar patterns together
- generate corresponding goals for each emotional concern identified.

In the previous chapter, we described how negative emotions can be mapped to one or a set of functional, quality and/or emotional goals in Section 5.2.1. The use of an emotion model was recommended to maintain traceability between the mapping of the goals and the negative emotion.

- name each group such that they represent either an emotional, quality or functional goal of the system to be designed

The analysts from the same team then meet to reconcile the identified goals. Once the goals are reconciled within each team, all the teams meet to reconcile their findings. At this stage, an affinity diagram is used to organise all the goals identified by the sub teams whereby similar goals are grouped together and each group is named. The analysts go through each group to ensure validity and relevance to the project. Once the goals are finalised, the goal model can now be derived. The process to convert the identified goals into a goal model is described in Subsection 6.3.3.

### **6.3.3 Converting the identified goals into an emotion-oriented goal model**

We describe the step by step process to convert the goals identified during the elicitation process into an emotion-oriented goal model. The goal model has already been described in Section 6.2.2. Even though goal models are very simple tools and present information clearly, the mapping between the brainstorming session to the goal model requires some additional steps as described below:

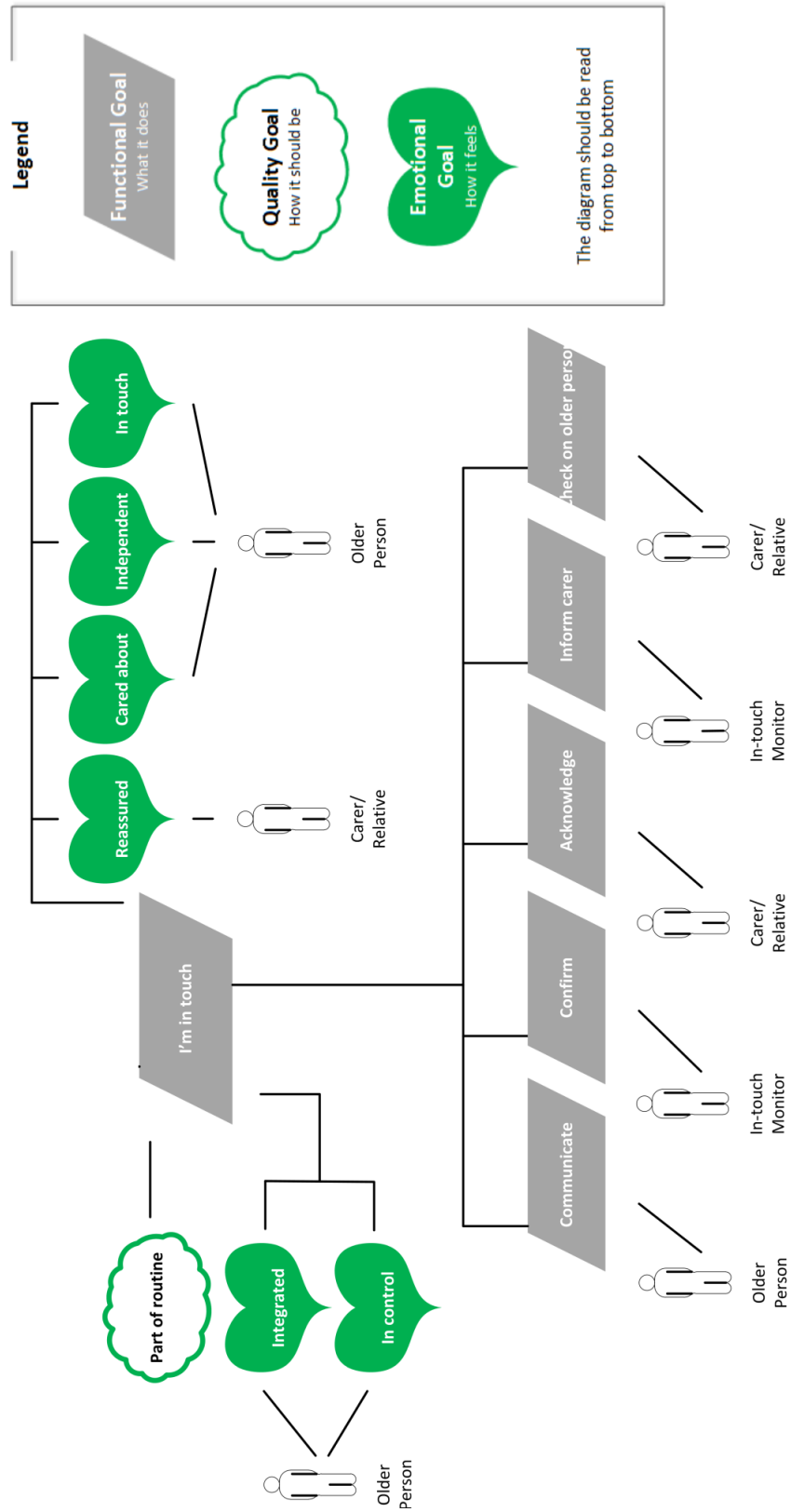
1. List the goals under their specific category as identified during the elicitation process, for example, goals such as “system should be easy to use” are treated as quality goals.
2. Highlight the main goals under each category. In other words, prioritise the goals.
3. Identify sub goals which can fall under the main goals.
4. Create goals and sub goals until all the goals have been classified. For example, the main functional goal of TouchFrame is “*I’m in touch*” and a subgoal is “*check on older person*”
5. Start working on the goal model by first identifying the primary functional goal of the system

6. Assign the main functional goals under the primary goal
7. Assign the sub functional goals to the main goals
8. Assign roles to each goal. For example, roles for TouchFrame include *older adult*, *relatives* and *carers*.
9. Assign the emotional goals. For example, the emotional goals for TouchFrame are *reassured*, *cared about*, *independent*, *in touch*, *integrated* and *in control*.
10. Assign the quality goals. The quality goal for TouchFrame is *part of routine*.
11. Go through the goal model and check if all the goals have been presented

The next step now involves validating the goals with the stakeholders. The validation process makes use of the goal model as a baseline to cross check whether key requirements have been taken on board and also whether any conflicts exist. In case of changes needed, the goal model is modified to suit the needs of the stakeholders. The goal model for TouchFrame is provided in Figure 6.10.

## 6.4 Deriving Emotion-Informed Personas

During our research, we often encountered the following comment and question from other fellow researchers: “We understand the reasons why user’s emotional expectations should be captured and incorporated within the software paradigm. You also showed how it can be captured and included within the early phases of requirements engineering. However how do you explain to software developers what they need to do to include these emotional goals in the software?” We therefore explored the use of *personas* to represent emotional goals in an attempt to bridge the gap between the requirements phase and the design phase.

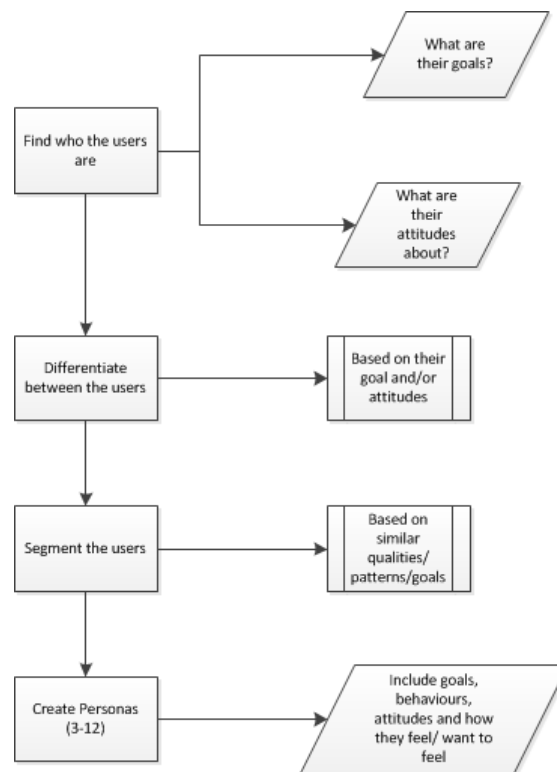


**Figure 6.10:** Example Goal Model for TouchFrame

Nielsen (2012) describes a persona as “a description of a fictitious user, who does not exist as a specific person but who is described in such a way that the reader can recognise the description and believes that the user could exist in reality”. Personas help identify the user motivations, expectations and goals for using the system. Although fictitious, personas bring users to life by giving them names, personalities and often a photo (Calabria, 2004). They are used by designers, developers, project participants, and others to get ideas for design of products, IT systems, and services (Calabria, 2004, Nielsen, 2012, Pruitt and Grudin, 2003). Personas is a widely researched topic in user-centered design and marketing.

Our approach at generating emotion-informed personas is derived from a set of existing techniques (Blomquist and Arvola, 2002, Chang et al., 2008, Cooper et al., 2014, O’Connor, 2011, Pruitt and Grudin, 2003). Our technique focuses on highlighting the users emotional goals and feelings. The process that we recommend is detailed in Figure 6.11 and further elaborated below:

- Identify who your users are and why they are using the system. The users need to be identified in terms of their goals and behaviours/attitudes.
- Differentiate the users by looking for goals and/or attitudes that are specific and relevant to the system.
- Segment the users into distinct groups based on similar goals, patterns and/or attitudes.
- Create personas by including user goals, behaviours, attitudes and how they feel or want to feel when using the system.
- Make them realistic by including names and personal backgrounds.



**Figure 6.11:** Method used to generate personas

## 6.5 Summary

In this chapter, we provided a rationale for the use of agent-oriented software engineering to represent user emotional expectations. We then briefly described how the existing agent-oriented models initially proposed by Sterling and Taveter (2009) can be extended to showcase the emotional viewpoints of stakeholders. While constructing the models for the emergency alarm system, we identified that the models lend themselves to a seamless transition between layers. The concepts used in higher abstraction layers are easily transformed into equivalent ones at lower abstraction layers, that is closer to implementation. For instance, the role model, defined in the conceptual domain modelling layer, provides basic information about the different roles involved in the system, human or otherwise, and highlights their responsibilities. The equivalent constructs one layer lower are agents, which aggregate roles according to their capabilities as concrete agent types. At this stage, the agent model still includes both human and man-made agents.

However, in the lowest level of abstraction, the platform-dependent layer, only the man-made agents are codified as software entities. It is worth noting that even though we discuss an agent-oriented approach to modelling, it is not essential to produce agent-oriented models at the platform-dependent layer, as the final product might be more suitable for other methodologies such as object-oriented. Even though Sterling and Taveter (2009) proposed a list of agent-oriented models at different layers of the viewpoint framework, software professionals have the flexibility to use only those models which best suit their project. In addition to that, the models can be further tailored as per the needs of the system. This modelling approach is applicable in any domain where emotions are relevant. Socio-technical and domestic systems are particularly suitable for it as the role of people is more prominent and their engagement with the system can influence its success. However, even traditional business systems can be affected by stakeholders' emotions as illustrated by Ramos et al. (2005) by highlighting the impact of a change in management decision on the emotions of the employees. Beyond the emergency alarm system discussed in this chapter, we have applied the same modelling approach in all of our case studies.

We then presented a set of elicitation methods to capture the user's goals, in particular the emotional goals, within a software engineering context under two circumstances namely *with* and *without* direct users interaction. We also described the process of converting the identified goals into an emotion-oriented goal model.

Finally, we provided an overview on how personas can be extended to showcase user emotions. The idea behind using emotion-informed personas was to bridge the gap between the requirements phase and design phase in an attempt to help designers understand the importance of the emotional goals.

We discuss the adequacy of the emotion-informed elicitation and modelling techniques, proposed in this chapter, later in the thesis. The next chapter presents an evaluation tool to evaluate the extent to which emotional goals have been addressed within a system.



# Chapter 7

## Emotion-Oriented Software Validation Method

A key challenge in any methodology that aims to make emotional requirements a first class citizen is in offering robust measures of emotional goals. Psychology proposes several measures of emotion such as self-report, questionnaires, observations, facial and speech recognition, heart rate, blood pressure, skin conductance and ECG among others (Clancy and Noyes, 1976, Gough, 1960, Nelis et al., 2011). The area of computer science has also investigated different techniques to measure emotion such as facial and speech recognition, blood pressure, skin conductance, interviews and questionnaires among others (Allaire et al., 2013, Colomo-Palacios et al., 2011, Lakens, 2013, Lisetti and Nasoz, 2004, Lottridge, 2008, Powers et al., 2011, Rani et al., 2006). Despite the existence of various measures, Mauss and Robinson (2009) argue that measuring a person's emotional state is one of the most complicated issues. In addition, it is unclear how the measured emotion can inform further system development or improvement.

In disciplines such as software engineering, measurement is a fundamental concept (Boehm, 1984) and it is a common practice to use metrics to measure the extent to which the requirements set at the beginning of the project were met (Wieggers, 2005). Given that user requirements are at the core of the success of a technology, it is important to

measure requirements in order to assess the success of the technology. Even though there are well established techniques, processes and metrics to measure functional and non-functional requirements (Fenton and Pfleeger, 1997), the techniques available to measure the way stakeholders feel when they use a system are limited. A recent study (Hoon et al., 2016, 2013, 2012) investigated the factors that influence the length and contents of mobile app reviews with the main objective of informing the developer about key design priorities. This study revealed that reviewers lean towards the use of sentiment words to express their views on the app they were using. The final findings from this study were published after the completion of our research and therefore could not be applied to our work.

In Section 5.2.1, we presented the rationale behind using the questionnaire as an emotional assessment tool and in Section 2.3, we highlighted that since emotions are driven by perception, our target is to measure people's perception of emotion rather than their emotions. In our work (Kissoon-Curumsing, Pedell and Vasa, 2014), we described the iterative design of an emotional assessment tool, which started with the TouchFrame study. In this chapter, we present a summary of the different iterations of the tool used during the TouchFrame study and discuss how this tool was further refined based on the findings of the TouchFrame study.

The chapter is organised as follows: Section 7.1 provides a summary of the initial versions of the validation tool that were designed for the TouchFrame case study. Section 7.2 describes the refined version of the validation tool following the findings from the pilot study of the TouchFrame case study. Section 7.3 presents the final version of the tool which was refined based on the feedback from the users of TouchFrame. Section 7.4 summarises the contents of this chapter.

## **7.1 Iterative Design of the Validation Tool**

In order to better inform our background on emotions, we consulted psychologists at the beginning of our research, to have a deeper in-

sight into the way emotion is captured and measured in psychology. We were provided with *The Profile of Mood States*, more commonly known as POMS (McNair et al., 1971). POMS is an economical and rapid assessment used to measure six active mood states namely anger, confusion, depression, fatigue, tension and vigour (McNair et al., 1971). The original questionnaire consists of 65 adjectives such as *friendly*, *tense*, *angry* and *terrified* which relate to the feelings of the participants. They are provided to participants on a 5-point Likert scale where 1 refers to *not at all* and 5 for *extremely* (McNair et al., 1971). Our first questionnaire, was therefore designed with a similar set of adjectives taken from the POMS questionnaire to represent the emotional goals for the TouchFrame Case Study. This tool was provided to the other researchers within the TouchFrame and SMART team and their feedback revealed the following shortcomings:

1. Selecting words from the POMS questionnaire to represent an emotional goal can prove to be very subjective and depends mainly on the person who is constructing the questionnaire.
2. The comparison between positive and negative feelings could prove to be challenging in cases where the ratings conflict. For example, if four out of five negative feelings have a high scale and at the same time two out of three positive feelings have a high scale, it would be difficult to comment on the extent to which the emotional goal had been fulfilled.
3. Most importantly, the POMS questionnaire was designed to cater for only six mood states and not every emotion in general. Hence, picking and choosing an adjective from this list does not guarantee that our selection actually identifies the right emotional goal.

The second and third versions of the validation tool consisted of questions and statements respectively. For this version, a 7-point Likert scale was used given that research shows that the 7-point Likert scale provides more accurate information as compared to the 5-point Likert scale (Finstad, 2010). Even though studies (Dawes, 2008) show that a higher-point Likert scale such as a 9 or 10 point scale allow for more fine

grained conception of the participants' emotions as compared to the 5 or 7-point Likert scale, we opted for a 7-point scale to maintain simplicity and ease the task of the respondent when they fill out the questionnaire. An excerpt from both versions of the questionnaires are provided in figures 7.1 and 7.2. The feedback from the other researchers within the team highlighted another set of drawbacks:

1. Even though the technique of using questions or statements instead of adjective words from POMS caters for a wider range of emotions to be considered, it does not solve the problem of subjectivity. For instance, the questions or statements that have to be set for each emotional goal again depends entirely on the person who is designing the tool.
2. The validation process might end up being confusing and misleading with different questions or statements being used for each emotional goal. For instance, if the answer for two questions or statements turns out to be positive but the answer to the third one is a strong negative, the validation of that emotional goal can prove to be challenging.

	Never	Rarely	Occasionally	Sometimes	Frequently	Usually	Every time
1. How far do you think the system supports the assisted person?	1	2	3	4	5	6	7
2. How far do you think the assisted person's life has improved?	1	2	3	4	5	6	7
3. How often do you feel the need to double check on the assisted person?	1	2	3	4	5	6	7

**Figure 7.1:** Questions Based Emotional Assessment Questionnaire

The aim of the fourth version of the validation tool was to address the main shortcomings identified in the previous versions of the questionnaire namely subjectivity and complexity. A study conducted by Davey et al. (2007) to assess anxiety among women attending a dedicated breast clinic showed that a single question with either a Likert scale

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
1. The system provides necessary support to the assisted person	1	2	3	4	5	6	7
2. The assisted person's life has improved after using the system	1	2	3	4	5	6	7
3. I feel the need to double check on the assisted person	1	2	3	4	5	6	7

**Figure 7.2:** Statements Based Emotional Assessment Questionnaire

or a visual analog scale (VAS) was an adequate predictor of the Spielberger State Trait Anxiety Inventory (STAI) score. The STAI is a 20 item long questionnaire extensively used to measure anxiety in populations (Davey et al., 2007). According to the findings of Davey et al. (2007), a single question with either a Likert scale or VAS response adequately replaces the 20 item long STAI questionnaire. This approach is useful in cases where researchers need to reduce the burden on participants of completing a lengthy questionnaire. Since our aim was to improve the emotional responses of the users with regards to the system, we decided to go for a simple validation tool and use only one item per emotional goal. Also, since we were assessing the way people view an application from an emotional perspective, it was easier to ask the participant about their opinion on the emotional goal. Even though studies show that both the Likert scale and the visual analog scale are simple and reliable assessment methods, we opted for the use of the visual analog scale to give the participants more flexibility to plot their ratings on the scale (Davey et al., 2007, Jaeschke et al., 1990, Lukacz et al., 2004). Based on studies related to the use of visual analog scale, a 10 centimeter horizontal line was used to represent the scale with two parameters at each end namely *Always* and *Never* (Hawker et al., 2011, Paul-Dauphin et al., 1999). An example is given in Figure 7.3 for the emotional goal *safe*.

The validity of this fourth version was assessed during the pilot study for TouchFrame. Details of how the questionnaire was used during the pilot study and the findings from the pilot study have already been



**Figure 7.3:** Use of Visual Analog Measure

presented in Section 5.3. In the next section, we provide a brief account of the pilot study and present the findings from the pilot study to lay out the foundation for the next version of the emotional assessment tool.

## 7.2 Version 5: Refined Emotional Goals Based Design of Questionnaire

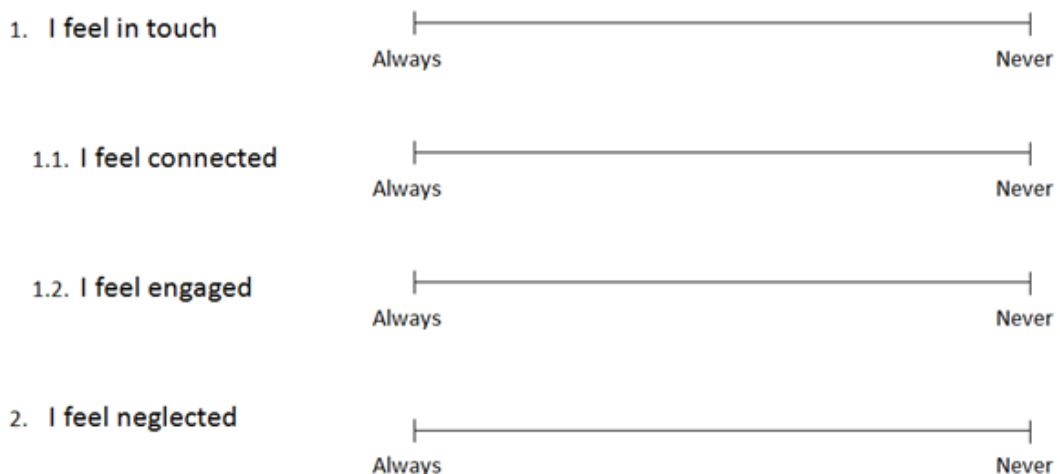
The pilot study was carried out over a period of two weeks with nine older adults mostly living alone in their homes. Some of these adults were previous users of the emergency alarm pendants. They were requested to use a digital photoframe on an iPad to interact with their loved ones. The objectives of this pilot study were to assess the validity of our case study design, in particular our data gathering tools and also the prototype. At the end of the two weeks, the participants were interviewed and requested to fill the questionnaire (version 4). The findings from this process are summarised below:

1. Participants had difficulty interpreting the terms used for the emotional goals. For instance, when it came to rate the emotional goal *independent*, a participant questioned the validity of this goal by mentioning that he never had any issues with his independence so how does this relate him.
2. Technical issues with the app had a major impact on the way the participant viewed the application from an emotional perspective.

This fifth version of the emotional assessment tool was therefore designed after taking into consideration the findings from the TouchFrame pilot study as discussed in Section 5.3.3. Based on the findings of the

pilot study, some participants were confused regarding the interpretation of an emotional goal, we therefore decided to provide a brief description for each word used in the questionnaire to ensure that users have a clear understanding of the goal. The description would be given to the participant by the interviewer at the time the participant was filling the questionnaire.

An interesting finding from the interviews that preceded the filling in of the questionnaire was that different words were used to refer to the same emotional goal. For example, people were using the words *connected*, *in touch* and *engaged* which all had similar connotations. We therefore decided to create sub categories of the emotional goals. That is, all emotional goals contributing towards a more general goal can be classified under a main heading, thus leading to the concept of an emotional goal having a number of sub emotional goals. For instance, *connected* and *engaged* will appear under the emotional goal *in touch*. These sub goals were included along with the main emotional goal in the refined questionnaire with the intention of understanding the link that exists between the sub goals and the main emotional goal. The new questionnaire therefore consisted of the main emotional goals followed by their sub emotional goals and threats as shown in Figure 7.4.



**Figure 7.4:** Refined Emotional Goals Based Design of Questionnaire

To minimise the impact that functional and quality goals had over the emotional goals, we first of all suggested eliminating usability problems

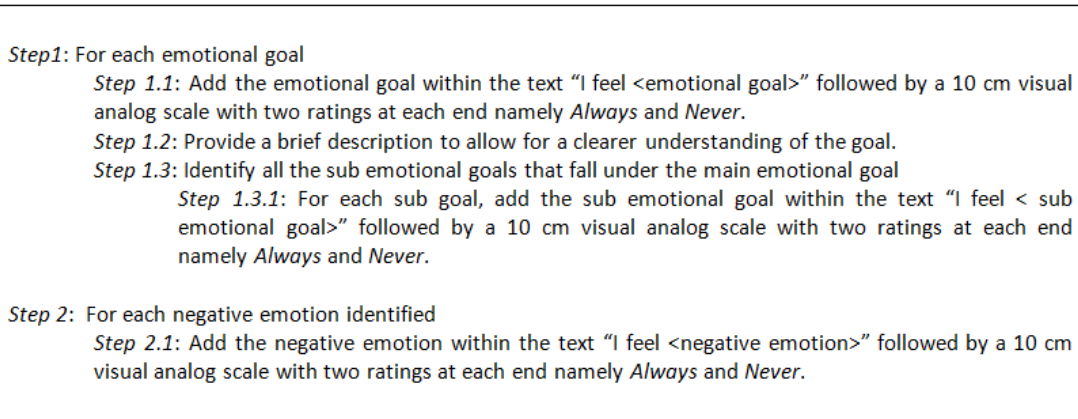
and ensuring high system performance. We considered these criteria to be the preconditions to test emotional goals. We also included negative emotions along with the positive emotional goals in the questionnaire. In their paper Miller et al. (2015) and Lopez-Lorca, Miller, Pedell, Mendoza, Keirnan and Sterling (2014) talk about how people have a tendency to relate to what they do not want rather than what they want. The findings from the study conducted by Pedell et al. (2013) revealed more negative feelings compared to positive feelings. Lopez-Lorca, Miller, Pedell, Mendoza, Keirnan and Sterling (2014) further mention that since a system should portray what it can achieve, system models should reflect the emotional goals rather than the negative emotions. They, however, use these negative emotions to derive corresponding positive emotional goals which can neutralise them. The process through which positive emotions are derived from the negative emotions have already been discussed in Section 5.2.1. Hence, by including the negative emotions, we expect to have a clearer picture of whether the emotional goal has indeed been able to neutralise the concerns of the users.

The design of the new questionnaire consisted of a set of steps which is presented in Figure 7.5. Since the main inputs of the tool consist of the list of positive and negative emotional goals, it is important to identify all the negative and positive emotions prior to the construction of the questionnaire. Once the complete set of emotions is identified, the next step involves categorising the emotional goals under sub categories. That is, emotions which relate to a general category can be grouped under the same heading. Two sets of questionnaires designed for the TouchFrame study are available in appendix A.

### **7.2.1 Validity of the Tool**

This fifth version of the questionnaire was trialled during the main study of the TouchFrame case study. The findings from this case study turned out to be contrary to what we expected. A detailed description of the findings has already been provided in Section 5.7. In this section, we present a summary of the findings.





**Figure 7.5:** Steps to construct the Emotional Goal Based Questionnaire

1. The questionnaire consisted of three pages and was therefore cumbersome to complete. Many participants stopped half way through.
2. The terms used in the questionnaire, such as *nostalgic*, turned out to be hard to explain to participants whose first language was not English.
3. The emotional assessment tool was not easily quantifiable. It turned out that the data we collected could not be represented in a clear format thus making analysis hard.

The questionnaire failed to serve its purpose which forced us to reconsider the whole design process.

### 7.3 Version 6: Feedback Based Design of Questionnaire

Before proposing a new version of the tool, we revisited all the previous versions of the emotional assessment tool taking into account the shortcomings and the features that worked. This activity revealed a key message:

Users prefer a *short* questionnaire with *simple statements* which are *easily understood*.

We conducted another experiment with another set of researchers who were working on implementing a Smart Home Technology system for elderly people. It is important to inform the reader that Ethics Approval was obtained for this project (refer to Appendix B) and the author had the authorisation to interact with the users of this project. Due to some unforeseen circumstances, the project was stopped and that is why we do not describe this project within this thesis. We only refer to this project in general to explain how we came up with a refined version of the questionnaire.

The main objective of this smart home technology was centered around ensuring high user satisfaction. A literature review in this area revealed that users of smart home technologies are very often concerned about their privacy, independence, safety and being monitored. We designed a similar questionnaire for this project as the one designed for the pilot study of the TouchFrame case study (version 4) and asked the researchers to comment on the questionnaire design, statements and scale used.

The findings from this experiment are summarised below:

1. Even though the researchers were working in the same field as us, they had difficulty understanding the terms used to represent the emotional goals. For instance, terms such as “I feel independent” turned out to be confusing. They were unsure whether the independence here related to their freedom to move around, free to make decisions or their being monitored.
  - (a) The suggestion was to use common terms which are easily understood by common man. For instance, instead of using terms such as “*I feel that the system is integrated in my life*”, we can use short statements like “*I feel that the system runs smoothly*”.
2. The participants had mixed views regarding the VAS scale used. Much of the feedback suggested that the scales have to be changed to facilitate analysis.

3. Another set of feedback guided us to the use of existing emotion-oriented tools to measure user satisfaction.

A research in literature on existing emotion-oriented tools to measure user satisfaction led us to the *Attrakdiff questionnaire* (Hassenzahl, 2007). The *Attrakdiff questionnaire* was originally designed in German and later in English to assess the user's feelings about the system through a questionnaire (Hassenzahl, 2007). The questionnaire consists of 28 items whose poles are opposite adjectives, for instance, "confusing - clear", "ugly - attractive", "good - bad". A scale of 7 steps is used between each set of opposite adjectives. *Attrakdiff* is an evaluation method that records the perceived pragmatic quality, the hedonic quality and the attractiveness of an interactive product. The pragmatic quality refers to the *usefulness* and *usability* of the system while the hedonic quality refers to the *motivation*, *stimulation* and *challenge* for the user to use the system. The theoretical work model of *Attrakdiff* shows how the pragmatic and hedonic qualities influence the subjective perception of attractiveness giving rise to consequent behaviour and emotions. For example, the pragmatic quality *controllable* and the hedonic quality *innovative* of a system makes it *likeable* to the user thus leading to *increased use* which is a behavioural consequence and *joy* which is an emotional consequence.

Even though the *Attrakdiff questionnaire* is widely used to assess user's feelings about the system, it does not meet our objectives. Our objective is to measure the extent to which user's emotional goals have been successfully taken into consideration during the system design. Emotional goals include terms such as *in control*, *independent*, *confident* and *cared about* which are not directly mapped to an emotion or a classification of emotion (refer to Section 2.1.3). Additionally, they cannot be directly derived from a quality or functional goal. They mainly relate to users' perception of the system's functionalities and importance in their lives.

We therefore applied the *Attrakdiff* approach to our validation tool by using corresponding emotional threats for each emotional goal, which we place at different poles within the questionnaire. A Likert scale of 7 points was used instead of the analog scale to facilitate the analysis of

results. Additionally, taking the feedback into consideration, the wordings for the emotional goals and emotional threats were simplified so that they are easily understood by common people. The simplification process was done through a brainstorming session where researchers had to come up with common terms which best described the emotional goals and its corresponding emotional threats.

The step by step process used to design the validation tool is summarised in Figure 7.6. The process starts by identifying the emotional goals and threats for the system to be developed by using any appropriate elicitation method. For example, our proposed brainstorming technique can be applied in cases where direct user interaction is feasible or the content analysis technique can be applied in situations where requirements have to be derived from interview transcripts. Step 2 consists of running a brainstorming session with the other members of the team to associate emotional threats with their corresponding emotional goals. During this step, team members can also identify common terms to describe the emotional goals and threats. The final step in this process consists of including statements for each emotional goal and its corresponding emotional threat within the questionnaire. We applied this process to design another questionnaire for the TouchFrame system. An excerpt of this refined questionnaire is provided in Figure 7.7.

Step 1: Identify the emotional goals and emotional threats using an appropriate elicitation method

Step 2: Run a brainstorming session to:

Step 2.1 Identify the corresponding emotional threat for each emotional goal identified and vice-versa until all the emotional goals and emotional threats have been addressed

Step 2.2 Identify common terms to describe the emotional goals and emotional threats

Step 3: For each emotional goal/threat,

Step 3.1 Create a phrase which begins with I feel and include the common term identified for the emotional goal. E.g. *I feel confident about using the system*

Step 3.2 Create a phrase which begins with I feel and include the common term identified for the emotional threat. E.g. *I feel scared about using the system*

Step 3.3 Add the two phrases from steps 3.1 and 3.2 at opposite ends of the scale

**Figure 7.6:** Steps to construct the refined Questionnaire

**Questionnaire to evaluate the impact that the TouchFrame application has in your life**

I feel worried about using TouchFrame	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	I feel excited about using TouchFrame
I feel scared about using TouchFrame	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	I feel confident about using TouchFrame
I feel neglected with TouchFrame	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	I feel that TouchFrame connects me to my loved ones
I feel that I am being controlled with TouchFrame	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	I feel that I am in control with TouchFrame
I feel that I am a burden on my loved ones	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	I feel that my loved ones care for me
I feel anxious about being monitored with TouchFrame	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	I feel comfortable about being monitored with TouchFrame
I feel that TouchFrame gets in my way	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	I feel that TouchFrame improves my day to day life
I feel that TouchFrame is a complicated system	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	I feel that TouchFrame runs smoothly

**Figure 7.7:** Refined Version of TouchFrame Questionnaire

### 7.3.1 Validity of the Tool

At the time when this refined questionnaire was developed, the Touch-Frame study was already completed and we could not run this new version with the TouchFrame participants. We, however, applied the same principle to design the emotional assessment tool for the Smart Home Technology system and we trialled the questionnaire with five participants of this project. The feedback obtained from the trial were positive and are summarised below:

1. The participants did not have any difficulty understanding the terms used in the questionnaire. They could clearly understand what was being asked of them and completed the questionnaire without asking any questions.
2. The length of the questionnaire was reasonable and most of the participants filled it out within five minutes. This time, none of them were distracted. We had comments like “Oh well, this was a quick one.....I wish that all questionnaires were this long.....it’s boring to go through several pages...”
3. The statements placed at the different extremes of the scale were of interest to the participants and helped them in deciding the exact location where they wanted to put the dot on the scale. Some comments received were “I like the idea of having the two extremes in the questionnaire.....I don’t have to scratch my head to think of what is on the other end...”, “The statements on both ends are very interesting.....I am always curious to know what’s on the other end...”

## 7.4 Summary

In this chapter, we presented different iterations of an emotional assessment tool namely, the *questionnaire* which has been designed to validate the extent to which user emotional goals have been integrated within the system. The assessment process is based on users’ perspectives

and therefore subjective to a large extent. However, given that emotion in general is subjective, it is hard to devise a simple measure which can objectively evaluate emotional goals. We therefore propose the use of a simple questionnaire which is an adaptation of the Attrakdiff questionnaire. This assessment tool, described in Section 7.3, is of reasonable length and consists of statements which are easily understood by common people. This questionnaire was trialled by five participants and the feedback obtained from the trial was positive and therefore guarantees its success as an emotional assessment tool.

Given its simplicity, we expect that this tool can be used to evaluate any technology where emotional goals are of major importance to the acceptance of the technology. It can also be used to evaluate emotional goals for existing systems. For instance, if an organisation wants to conduct a validation of a particular system to assess whether user emotional goals have been met, they only need to (1) identify the emotional goals using one of our proposed requirement elicitation techniques described earlier in Section 6.3; (2) construct a questionnaire using the steps described in Figure 7.6 and; (3) get the users of the system to fill out the questionnaire.

It is important to note that this tool attempts to assess the inclusion of emotional goals within the system from a user's perspective. Given that users' perspectives and opinions are subjective, it is highly recommended to supplement this validation technique with other well established qualitative assessment tool such as interviews to capture qualitative data which can then be used to cross validate the findings from the questionnaire.

The next chapters provide a detailed description of the remaining two case studies namely, SMART and SleepWell, and the way the emotion-oriented methods were applied within these case studies.

# Chapter 8

## Case Study 2: SMART

In this chapter, we present the second case study which involved the development of a website, which we called *SMART*, to promote self-management and recovery in people suffering from psychosis with the aim of making the patients feel hopeful, engaged, empowered and safe. Part of the research consisted of applying our proposed emotion-oriented techniques to identify and represent the required emotional, functional and quality goals. Key research questions related to the emotional needs and barriers preventing the take-up of assistive technology by people suffering from serious mental conditions such as psychosis. We explored these aspects via focus groups and interviews with the intended end-users. This case study was designed to explore the first two research questions in this thesis:

**RQ1** Why should user emotional expectations be captured?

**RQ2** How can user emotional expectations be captured?

The key findings from this case study show that when it comes to designing technology for people suffering from psychosis, many factors other than these people's feelings come into play. These factors include policy and compliance considerations, the motivation of these people to learn new technology and the support mechanisms used. Additionally, given the lightweight nature of our proposed emotion-oriented



techniques, they were easy to adapt within this particular domain and served their purpose in identifying and representing the different goals of the SMART system. Detailed information on the findings of the case study is provided at a later stage in this chapter.

This chapter is organised as follows: Section 8.1 highlights the key contributions of the author within this case study. Section 8.2 presents the rationale and objectives of the case study, highlighting the logic behind selecting this case study for our research. Section 8.3 provides detailed information on the way the case study was designed and highlights how the research questions were addressed by this case study. Section 8.4 gives an account of how the study was conducted and the interactions with the software development team highlighting the way the emotion-oriented techniques were used to capture and represent emotional, functional and quality goals. Section 8.5 provides an overview of the contents of the SMART website followed by a description of how the emotional goals were represented within the website. Section 8.6 presents the findings and discussions which provide evidence of the importance of capturing emotional goals in a systematic way. Section 8.7 presents an assessment of the validity of this case study by highlighting any threats to internal, construct and external validity. Section 8.8 provides a summary of the chapter.

## **8.1 Research Contributions in this Case Study**

As mentioned in the introductory part of this thesis, the research conducted in this thesis was done in collaboration with a team of researchers at the Swinburne University Center for Computing and Engineering Software Systems (SUCCESS). In this particular case study, 4 researchers from the SUCCESS team were involved but the case study was mainly designed and trialled by the author of this thesis. Throughout the running of this case study, the SUCCESS team interacted with a team of 2 researchers from the psychology department at Swinburne University (the SMART team) and a group of 4 software professionals (development team) who designed and developed the SMART system.

The author's contributions in this project consisted of:

1. applying the brainstorming elicitation technique with the SMART team to identify potential emotional, quality and functional goals for the SMART system;
2. applying the content analysis elicitation technique to identify the key emotional, quality and functional goals from the transcripts generated from the focus groups which involved the intended end-users of the SMART system;
3. representing the identified goals through agent-oriented models and personas;
4. Using content analysis to analyse the data obtained from the feedback of a SMART user.

## **8.2 Rationale and objectives of the Case Study**

In this section, we present the rationale and objectives of conducting the SMART case study. The SMART project consisted of the development of a website designed to promote self-management and recovery in people with a history of persisting mental illness by providing a series of educational modules containing textual information, exercises, audio, and video clips. This project, named as “Self-Management and Recovery Technology (SMART)”, is part of a broader program which was funded by the Victorian Department of Health Mental Illness Research Fund (MIRF33). The overall research program is examining the therapeutic potential of using online (Internet based) educational and multimedia resources in mental health services. The past decade has witnessed a prevalence of online resources to facilitate communication and deliver therapeutic interventions in mental health. Australia is one of the leading countries in this area, providing stakeholders with a number of websites for online mental health intervention (Thomas et al., 2015) such as *mentalhealthonline.org.au*, *mindspot.org.au* and *moodgym.anu.edu.au*. Most of these websites have been designed to help people with mild-to-moderate mental health problems and do not fully address people

suffering from serious mental illness. In order to address this shortcoming, the Swinburne SMART Research team investigated ways to develop online resources for specialist mental health services.

Given that the targeted audience of this tool was people suffering from a serious mental health illness, one of the main objectives of the SMART team was to provide a website which was not only appealing in terms of its look and contents but which also made its users feel hopeful and engaged. The team was concerned that users would be reluctant to accept online technology as a medium to provide treatment. Therefore, the focus of this project was to develop an online tool to promote mental health self-management among people suffering from psychosis with the goal of making the users feel *hopeful, engaged, empowered* and *safe*.

The terms *hopeful, engaged, empowered* and *safe* relate to users' emotional expectations rather than functional or quality goals of the system. Since our research was in line with part of the research conducted by the SMART team, that is, the consideration of user emotional expectations during the design of a technology, we collaborated with the SMART team to assist them in identifying the emotional, functional and quality goals of the system. Our collaboration also consisted of interactions with the development team where emotion-oriented models and personas were used to emphasise the users' emotional expectations.

The main objectives of this case study consisted of:

- Identifying the emotional needs of the intended users of the SMART system
- Identifying the barriers preventing the take-up of assistive technology by people suffering from serious mental health illness.
- Representing the emotional expectations of users through the use of emotion-oriented models and personas.

## 8.3 Case Study Design

Given that the stakeholders involved in this project included people suffering from psychosis, we were not allowed to interact directly with any of the participants. We however planned the study and prepared the questions which were used by the SMART team to elicit responses. In this section, we describe the design plan for the study.

### 8.3.1 Research Questions

This case study was designed to answer the first two research as described below:

#### **RQ1 Why should user emotional expectations be captured?**

The focus of the SMART project was to provide an online tool to people suffering from psychosis with the aim of making the users feel *hopeful, engaged, empowered* and *safe*. The terms *hopeful, engaged, empowered* and *safe* do not relate to a functional or quality goal of a system. They refer to the emotional expectations of users. Given that these emotional expectations are critical to the adoption of technology, they cannot be ignored and have to be somehow represented within the requirement documents. These identified terms refer to non-functional requirements rather than functional requirements. In Chapter 4, we discussed the limitations of the existing taxonomies of non-functional requirements to cater for emotional goals. In that same chapter, we argued the need to represent emotional goals as a separate category of goals under non-functional requirements. In this chapter, we reiterate our argument that emotional goals are a key component to the success of a system and should be represented as a separate category of goals under non-functional goals.

## **RQ2 How can user emotional expectations be captured?**

In order to capture user emotional expectations, we used our emotion-informed requirements modelling and elicitation techniques. These techniques have already been described in Section 6.2 and Section 6.3, respectively. In this chapter, we describe how these elicitation techniques were applied within this case study. Further details are provided in Section 8.4.

### **8.3.2 Participants**

The key stakeholders of the SMART system, were patients suffering from psychosis, and were thus very sensitive participants. Given that we did not have any psychological background on how to deal with these people, we were not granted ethics clearance to interact with them directly. The participants for the SMART project were therefore recruited by the SMART team and consisted of three sets of users, namely:

- people who had experienced psychosis earlier,
- families of people suffering from psychosis, and
- mental health workers who were working with/caring for someone who was experiencing psychosis.

### **8.3.3 Ethics**

This project was a component of a broader research program referred to as “Self-Management and Recovery Technology (SMART): Use of online technology to promote self-management and recovery in people with psychosis”, which has been funded by the Victorian Department of Health Mental Illness Research Fund (MIRF33). The project has received ethics approval at Swinburne (SUHREC Project 2013/253 Self-Management and Recovery Technology (SMART)). A copy of the full Ethics application is available in the Appendix C. According to the ethics requirements, no person would be identifiable from the results.

### **8.3.4 Data gathering techniques**

The data gathering technique used to collect data from potential users of SMART was focus group. Different focus groups were planned with different stakeholders namely, (1) mental health workers, (2) families of people suffering from psychosis and (3) people suffering from psychosis.

The questions used during the focus group were designed to find out about (1) their feelings when dealing with clients/family members, (2) current technology usage and (3) how can technology help them?. A complete set of the questions used are available in Appendix C.

## **8.4 Capturing and Modelling User Emotional Expectations**

In this section, we describe how the emotion-informed elicitation techniques and the emotion-oriented models were used to identify and represent the emotional, functional and quality goals for the SMART website. Prior to our joining the team, the SMART team within the psychology department at Swinburne University of Technology, had already come up with a requirements document and a set of wireframes for each screen to highlight the contents that they wanted to have within the SMART website. Given our background, we were asked to review the requirements document and wireframes to check whether they were in line with their main objective, which was “providing an online technology to promote self-management among people suffering from psychosis”.

During our analysis, we identified that many of the SMART system intended requirements were confusing and conflicting. Also, the wireframes were very complicated and did not achieve the main objective of the SMART team. Furthermore, emotional goals were not given enough consideration even though one of the key objective of the whole project was to “empower” patients suffering from psychosis. Further details on the requirements analysis process are available in Appendix C. We

therefore decided to adjust the requirements engineering process using our proposed emotion-informed elicitation methods. A series of 7 focus groups were conducted, each consisting of either a group of five to ten patients or mental health workers. Prior to the focus groups, we conducted a brainstorming session with the SMART researchers to identify the key functional, quality and emotional goals. We then devised a set of questions which was used by the SMART researchers during the different focus groups.

The rest of this section describes how the elicitation processes were carried out to identify the key goals for the SMART system and how these goals were represented through the emotion-oriented models and personas.

#### **8.4.1 Elicitation technique involving stakeholders - Brainstorming session**

In this subsection, we describe how one of our elicitation techniques was applied to this case study to identify the emotional, functional and quality goals for the SMART website. The technique, namely *Emotion-informed requirements elicitation technique with stakeholders*, that we applied, has already been described in a previous chapter in Section 6.3.1.

A brainstorming session was held which consisted of two key researchers from the SMART team and three people from our SUCCESS team. One person from our team acted as the facilitator for the whole process while the others assisted the facilitator by taking notes, photos and handing out Post-It notes, etc. The process started by briefly highlighting the purpose of the session which was to identify the key goals of the system. The researchers were asked to think from the perspective of the users given that they had had several interactions with them. The wall was separated into three sections namely “to do”, “to be” and “to feel”, which represented *functional*, *quality* and *emotional* goals.

These categories were briefly explained to the two SMART researchers, following which they were provided with Post-It notes and markers.

They were then asked to write whatever came to their minds which they thought should be a goal of the system. They were encouraged to think aloud such that the other person knew about the goal that is being proposed. This step was mainly to avoid duplicacy of goals and applied mostly in sessions with many stakeholders.

Each new goal was written on a fresh Post-It note and, while handing them out, the researchers were required to specify the category under which they came. It was interesting to note that the number of post it notes grew very quickly under each category and when the goals started repeating themselves, we stopped this process. At this stage, the SMART researchers were requested to go through each Post-It note to check whether:

- the goal identified was valid
- the goal identified was not a duplicate, in which case it was merged with the corresponding note
- the goal identified was in the right category, that is functional, quality or emotional
- the goal identified could be merged with another existing goal

The researchers took approximately half an hour to go through all the Post-It notes as they were discussing and questioning the validity and importance of each goal with regards to the SMART website. The notes were rearranged several times based on their discussions and some goals such as *hopeful* and *promising* were merged together.

The next process involved prioritising the goals starting from the emotional goals, moving to the quality goals and then the functional goals. Even though the whole elicitation process took us around two hours to complete, it turned out to be very productive. The key functional, quality and emotional goals were identified for the system. We then used these identified goals to create our first goal model for the system. At this stage we could not finalise the goal model as the inputs from the patients and mental health workers were yet to come.



### 8.4.2 Elicitation technique without stakeholders - Content analysis

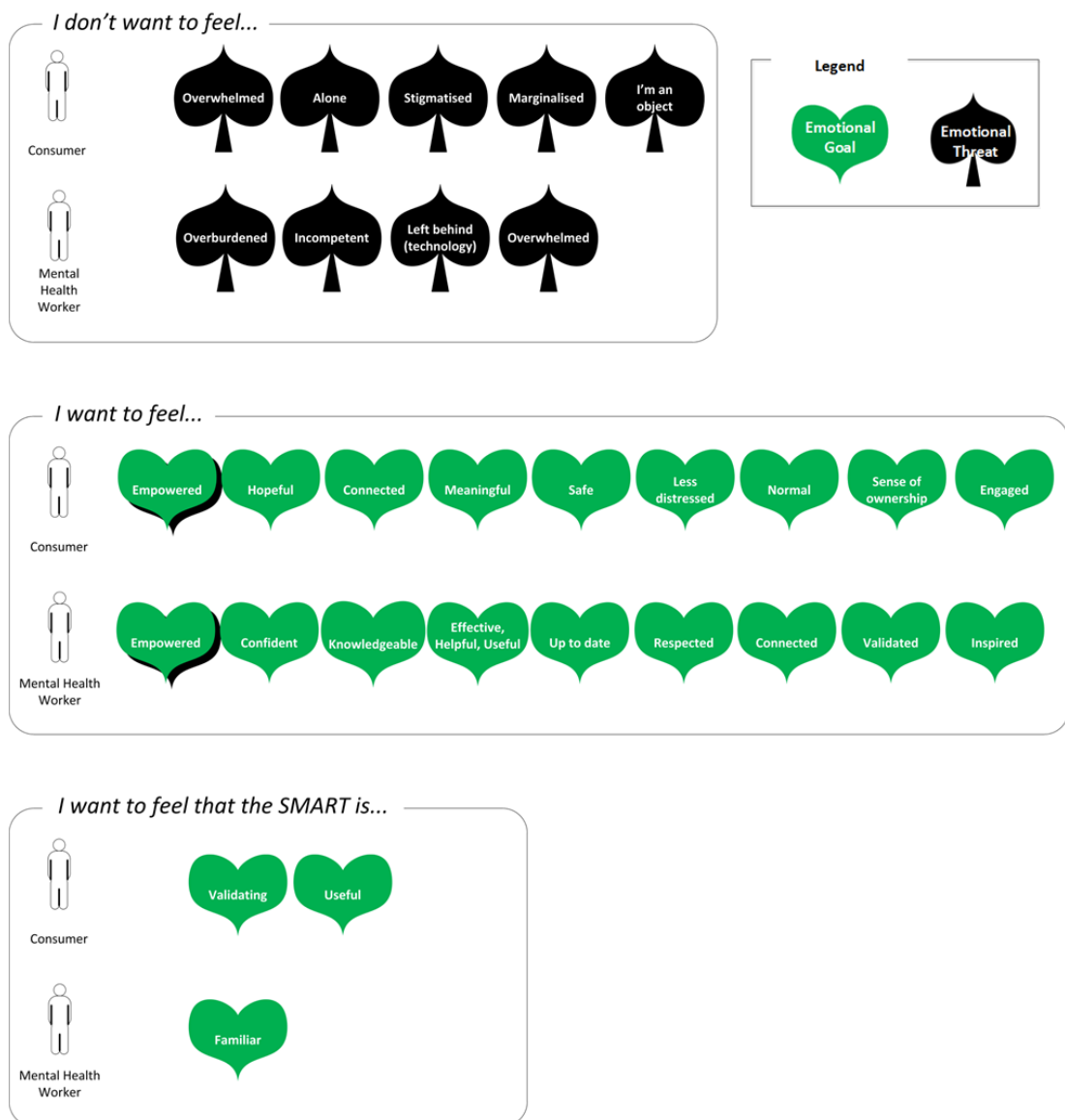
As mentioned earlier, we did not participate in the focus groups and could not interact with the participants directly. We therefore prepared some interview questions using the word ‘feel’ in the questions to elicit emotional goals from the participants. For instance, one of the questions was “how do you want to feel when using the website?” A complete list of questions is available in Appendix C. The SMART researchers conducted the focus groups and provided us with the transcribed notes that they took from the sessions. We then applied content analysis technique (described in Section 6.3.2) to the data from the focus groups with the objective to identify the key functional, quality and emotional goals. The results from the content analysis are available in Appendix C.

During our analysis, we found out that stakeholders mostly use *negative emotions* to explain what they want to feel when using the system. For instance, one comment was “I definitely don’t want to feel *demoralised*”. We therefore compiled a list of negative emotions which we refer to as emotional threats, along with any positive emotion which we termed as emotional goal, that came up within the text. We then came up with corresponding emotional goals for each emotional threat. Two notations, namely the heart and the spade, were used to represent emotional goals and emotional threats as shown in Figure 8.1.

The new list of goals were then compared with those identified during the brainstorming session with the SMART researchers. The goal model was adjusted to cater for any new goals and validated with the SMART researchers prior to the meeting with the software developers. The dimension of the entire SMART goal model being too large to fit on a normal page, we only provide an excerpt of the diagram in Figure 8.2. The complete diagram is available in Appendix C.

The functional goals of the system are represented through parallelograms, quality goals are represented through the cloud symbol while emotional goals are portrayed using the heart shape. In the goal model, the key functional goal is *to deliver intervention* which is linked to the

mental health worker. This key functional goal is linked to the goal “empower” which is associated with the consumers. In this system, the consumers refers to the patients suffering from psychosis. The emotional goals linked to the mental health worker are *up to date, connected, empowered, inspired, respected, engaged, knowledgeable, effective, helpful, useful, confident* and *validated*. The emotional goals linked to the consumers are *sense of ownership, less distressed, hopeful, normal, engaged, connected, empowered, meaningful* and *normal*. The way these goals were included in the system are discussed in Section 8.5.



**Figure 8.1:** Examples of some SMART system emotional goals and emotional threats

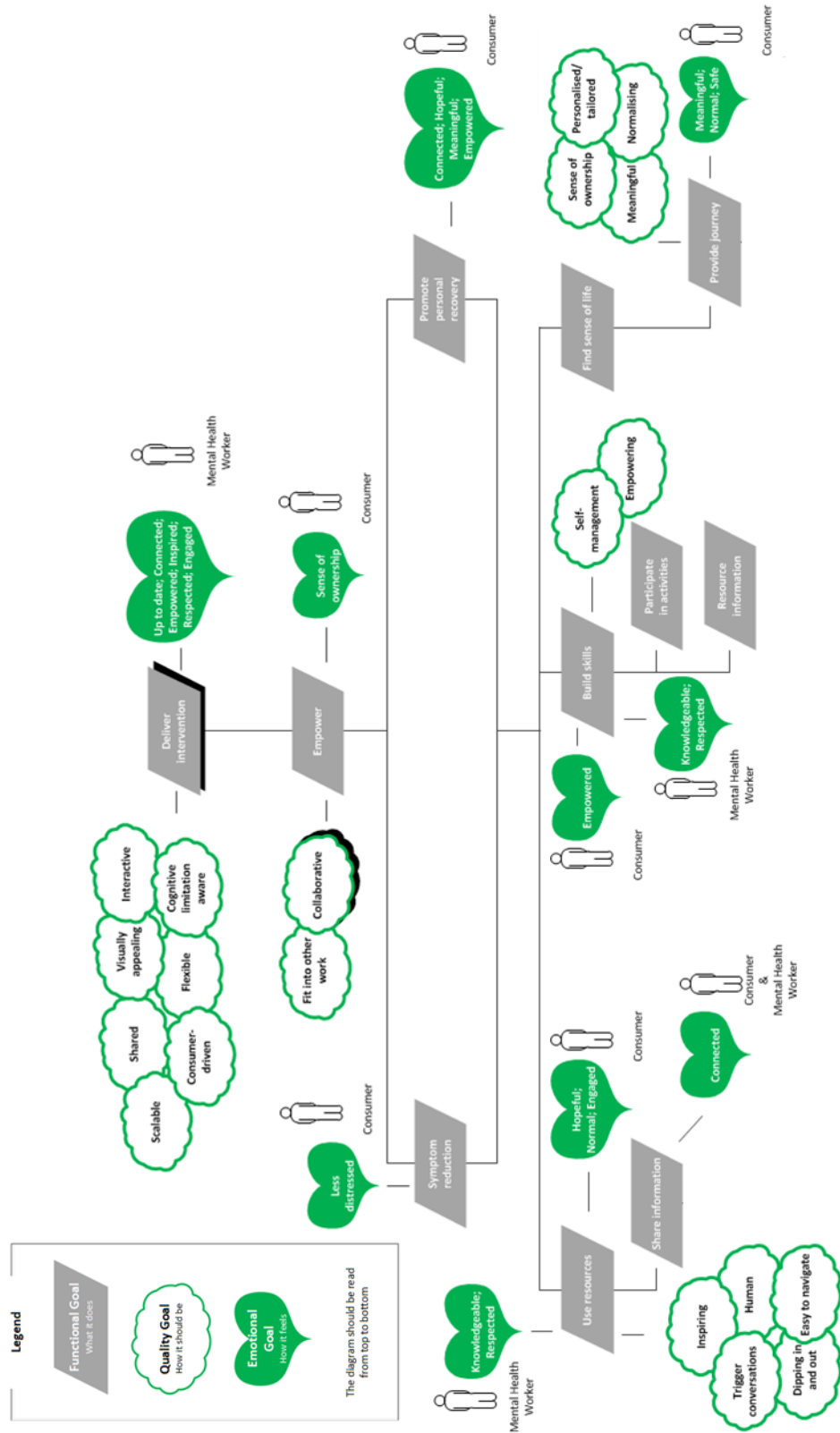


Figure 8.2: Excerpt of the SMART Goal Model

### **8.4.3 Interactions with the Software Development Team**

The meeting with the software developers consisted mainly of discussing the requirements of the system based on the data gathered from the interaction with the mental health workers and consumers during the focus group. We used our goal model as part of the discussions. The software developers found the goal model to be an easy and simple tool to represent the key goals. It served as a baseline to identify additional goals and discuss the contents of the website. They also agreed that the concept of emotional goals is a key determinant to the success of such a system. They however had no guidelines as to how these emotional goals could be represented within the software. One of the developers mentioned “it is very interesting to have identified all these emotional goals but how can we prove that the design that we come up with has actually met these goals”. We spent some time discussing ways to bridge the gap between the requirements phase and the design phase. In the end we agreed that if some additional agent-oriented models were provided to them along with some personas, it would help them understand what we actually need from them. We therefore started working on emotion-informed personas and some interaction models to emphasise on the emotional goals.

### **8.4.4 Emotion-Informed Personas**

Following the request of the software developers, emotion-informed personas were derived from the feedback and comments obtained during the focus groups. Two set of personas are provided in this section to represent the potential consumer (person suffering from psychosis) and the mental health worker. The process that was followed to come up with these personas has already been described in Chapter 6 in Section 6.4.

#### **Consumers Persona 1: Peter**

Peter is the only child of a well off family. He was a top student through primary school and most of secondary school. During year 10, his

results started to get worse to the extent that he just managed to pass that year. He spent all summer at home barely having contact with his friends. His parents believed that Peter's behaviour was all due to him entering puberty and thought that things would get better when he was back at school. However, when year 11 started, Peter's attitude was very apathetic and he did not interact with teachers or students. He did not do his homework and he failed his exams. One raining morning in April, Peter attempted suicide. His mother found him and managed to take him to the hospital before it was too late. Eventually he recovered from his injuries. Peter was diagnosed with a schizoaffective disorder and put under psychiatric treatment. He told his psychiatrist that, for over a year, he had been hearing voices that kept on telling him that he was a failure as a student and that he should give it up. The voices had been sinking in until he could not take it any longer. When he returned to school, the rumour of his illness had spread. Most teachers chose to ignore him and his old friends bullied him.

Peter is now 18 years old. His medication manages to silence the voices most of the time, but its side-effects make focusing on studying very hard, so his performance is poor. He meets his mental health worker every week, but the progress is very slow. He has not felt this lonely and isolated in all his life. Now, nobody talks to him unless it is to pick on the "crazy kid". He feels depressed and he thinks that his life is over. Why bother living when it is such a torment?

### **Consumers Persona 2: Sarah**

Sarah is married to Chris, a farmer who manages a large property in rural Australia. Their closest neighbour lives two hours away. The farm is mostly self-sufficient but every fortnight Chris drives five hours to the closest town to buy some basics and sell his produce. Sarah and Chris have two baby twins. One day, six months after the birth of the twins, Chris heard shooting when he arrived home after going shopping. From the distance he saw that someone was shooting from inside the house. Scared, he ran in through the back door to find Sarah shooting his shotgun through the window. The twins were crying in their cots.

She explained to him that she had been defending the house for hours, because there were people outside trying to take the children. Chris tried to calm her and finally managed to make her put the shotgun away.

It has been 12 years since Sarah was diagnosed with schizophrenia and she has come to terms with her illness. Chris and their children are completely involved in her process, they understand what she is going through and they have been a major support for Sarah. Her medication keeps the illness mostly under control, having only minor episodes every two or three years. During the relapses she hears voices, but they are not threatening anymore and she has learnt to deal with them. Sarah still finds it useful to meet with her mental health worker, but due to the distance, she can only visit him once a month. They complement the visits with occasional phone calls. Sarah knows that there are valuable resources available on the Internet, but she has never been very technology literate and finds it hard to make sense of “all that computer jibber jabber”.

### **Consumers Persona 3: Michael**

Michael is a senior consultant in a high profile consulting company. He is very good at his job and leads consulting teams that deal with the most complicated projects. He is under a lot of pressure at work; weeks of 70 hours are not uncommon. However, for a long time the lack of sleep and hard work did not seem to affect Michael at all - he was full of energy. It has always been a bit difficult to work with him. Once he had an idea, he would not change his mind and would react angrily to critical comments no matter how reasonable they were. A few months ago, Michael started feeling a bit down and did not find his projects as exciting as they were before. In fact, he felt that he had lost “his touch”. The decisions that he made were no longer as good as they used to be. He struggled to get out of bed every morning and started skipping most meals. People in the office noticed how much weight he had lost and suggested he should visit his GP and take better care of his health. He ignored the suggestions and kept on working. A few weeks after, in a

regular company check-up, a doctor diagnosed him with depression and referred him to a psychologist. After two sessions with the psychologist, Michael's diagnosis changed from depression to bipolar disorder.

Michael has been taking medication and seeing a mental health worker on a weekly basis for the last 5 months. He is still struggling with the idea that he is one of those "dangerous wackos". He has not told anyone about his diagnosis yet. He is single, his parents passed away a few years ago, but he has lunch with a sister every now and then. When they were children, they grew up in a very traditional family that did not approve of anything not "normal". He knows that his sister will not understand what is going on with him, so he prefers to hide it from her and pretend that everything is okay.

The situation at work is even worse, he climbed high in the company by fighting colleagues for promotions and working long hours. He knows if anyone in the company knew about his situation, they would make him feel worse and his career would be ruined. This thought is making him extremely anxious. When he is at work he worries all the time that people will discover about his illness. The medication does not help in that sense either, because as a side-effect he is putting on a lot of weight. He hears people gossiping behind his back about these drastic changes of weight. He has been reading about bipolar disorder online and he has been reading many contradictory opinions, making him confused about all this information. Michael's mental health worker finds it very hard to help him, because Michael hates that he is no longer in control of his own life, and reacts badly to a traditional passive treatment.

### **Mental Health Worker Persona 1: Sam**

Sam has been working as a mental health worker in the same hospital for the last 35 years. In his long career, he has seen everything and he has developed an instinct to know how to best approach different cases. Other mental health workers often come to him for advice in complex cases. He is always helpful and his comments always useful.

His co-workers do not quite understand the obscure logic behind his advice, but they cannot deny that it works. Being the most experienced mental health worker on the payroll means that many of the hard cases end up on his hands. He tends to have one on one sessions with consumers back to back many days and he also organises group sessions frequently. Sam is a bit set in his ways. He believes that there is a right way of doing things. After all, he has managed to help hundreds of people for the last three and a half decades. There is no reason to change his methods now. Sam, will tell anyone interested in listening that new approaches are “useless junk put together by people who have too much time on their hands and not enough real problems”. He is not particularly at home with new technologies. He does not have a computer and still handwrites the reports about his consumers. Years ago, the hospital introduced an electronic HR system, but Sam still walks to the HR office and asks his friends there to sort out annual leave applications or any other administrative issues.

### **Mental Health Worker Persona 2: Jenny**

Jenny always knew that she wanted to help people. Since she was a little girl she has been very empathetic and a good listener. Her mum’s brother, her favourite uncle, suffers from a severe case of schizophrenia. Her mum is his carer so Jenny grew up in very close contact with the illness. When she finished high school, she enrolled in a university degree to specialise in mental health care. She graduated two years ago as the number one in her course and started working in a hospital straight away. She was quite disappointed when she realised that many of the theories and techniques that she studied and that fascinated her, were not really used in the real world. When she talked to her colleagues about them, they agreed that things could be done better, but unfortunately, they did not have the resources to change things. Jenny is a good mental health worker and manages to help her consumers, but every day she leaves work frustrated. She knows that she could achieve so much more if she had the means to help people help themselves.



### 8.4.5 Interaction model

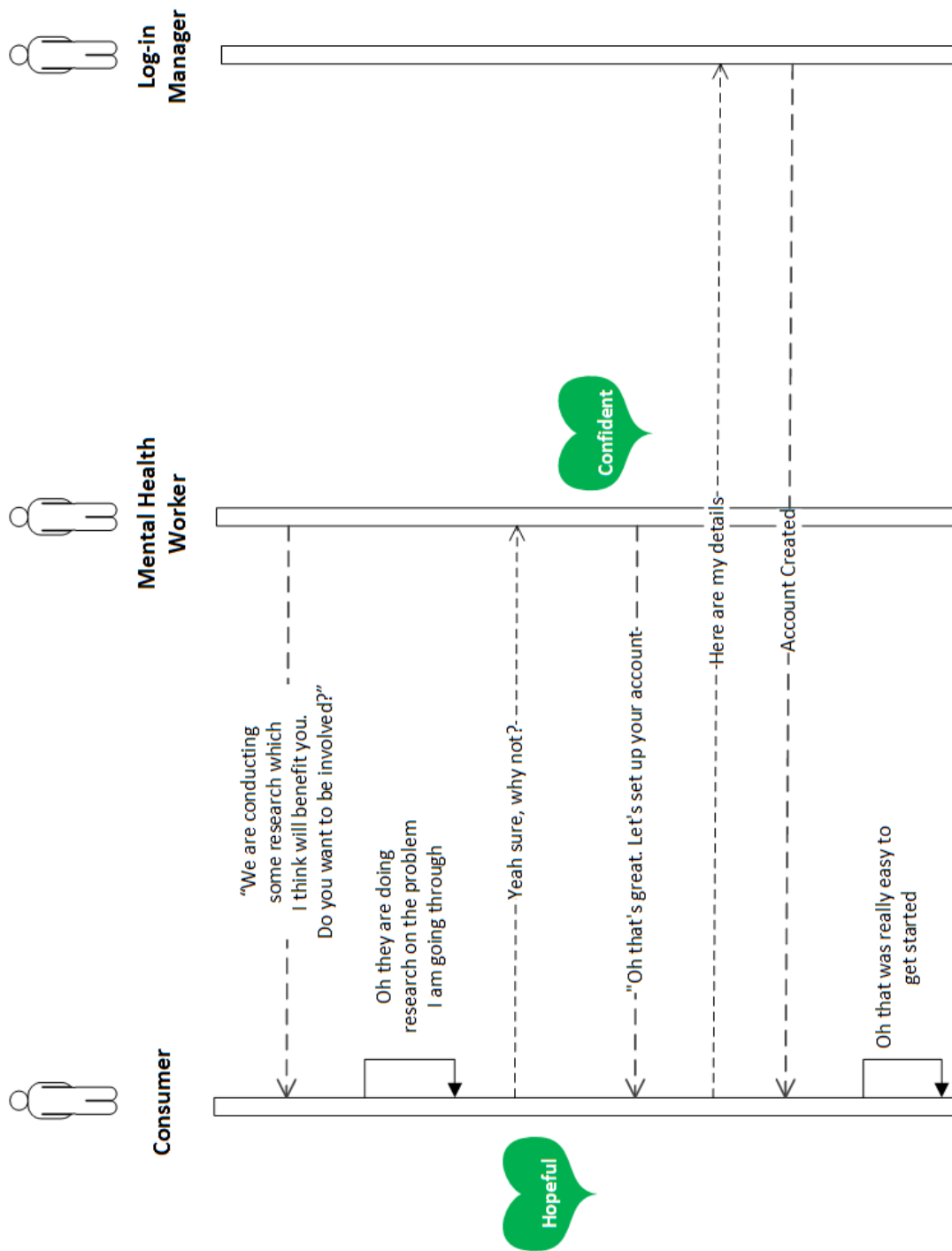
In addition to the personas, we also derived some interaction models to reflect how the interaction with the system can trigger emotional goals. Interaction models, as described earlier in Section 6.2.3, are effective tools to represent a set of interactions that exist between the different agents within a system. It also allows software practitioners to easily identify how the emotional goals associated with each agent can be achieved. A complete set of the interaction models for the SMART project are provided in Appendix C. In this section, we demonstrate the first interaction that the consumers have with the SMART system in the interaction model shown in Figure 8.3.

In this particular interaction model, the consumer attends their session with the mental health worker where they learn about the SMART system. Feeling *hopeful* that research is being conducted to help them come out from their health problem, they decide to sign up for an account. Their positive response builds the *confidence* of the mental health worker who then proceeds to create an account for the consumer.

The emotional goals are represented through the usual heart shape and human icons are used to depict the agents. The pointed arrows show the interactions between the agents within the system. The functional goals associated with the interaction diagram consist of delivering intervention and matching with consumer need.

## 8.5 The SMART Website

In this section, we provide a brief overview of the features of the website and also describe how each emotional goal was represented through these features. After several interactions between the key stakeholders and the software development team, the website was developed and an attempt was made to include all the key functional, quality and emotional goals.



**Figure 8.3:** Interaction between the consumer and the system

The targeted users of the SMART website are primarily

- people who have experiences of psychosis,

- mental health workers who are working with psychosis patients, and
- family members who are supporting people who have experiences of psychosis.

The SMART website provides content related to psychosis and promotes communication to support its users in living a satisfying life with mental health problems. It focuses on providing users with different pathways to choose from rather than giving a single solution or one-size fits all approach. There are three ways to use the website:

- Working together with mental health workers
- Working together with carers
- Using the system independently

The rest of this section describes the features of the SMART website and how the user emotional goals have been addressed through the website design.

### **8.5.1 Features of the SMART website**

The contents of the website consisted primarily of different modules which were designed to address different areas within the recovery process of the consumer. A brief description of each module is presented in Table 8.1.

Each module consisted of a combination of written content, video recorded expert material and exercises, which were further divided into subtopics. The video recordings consisted primarily of other patients of psychosis discussing the themes in question. The idea behind using peer videos was *“to promote a higher level message that there is diversity in how people approach recovery, whilst inspiring the user with ideas about how to consider their own recovery”* (Thomas et al., 2015). In addition to

<b>Module Name</b>	<b>Content Description</b>
Module 1: Introduction	Overview of recovery, experiences of mental health problems and living beyond them.
Module 2: Stress and Coping	Recognise signs of stress, the effects of stress and how to cope under stress
Module 3: Looking after your mental health	Making the most of the mental health services, medication, promote discussion with peers
Module 4: Me	Considering the impact of mental illness on identity, and how people have evolved their experience of who they are
Module 5: Relationships	The impact that mental illness has on one's relationship, how to feel and become more connected with others
Module 6: Life	Consideration of personal values, identifying ways of dealing with barriers to engaging in work and having a good life

**Table 8.1:** SMART Content Framework

the modules, the consumers were provided with a personal page which listed out their names, the activities that they had gone through, their progress and the items that they had selected as “favourites”. They could also connect to their peers through the use of a forum.

### **8.5.2 Realisation of Emotional Goals in the SMART website**

In this section, we provide an account of how each emotional goal was addressed. We start by looking at the emotional goals identified for the consumers (Table 8.2) followed by those identified by the worker (Table 8.3).

<b>Emotional Goals</b>	<b>Design Considerations</b>
Sense of ownership	The consumer has a personal page that welcomes them by their name and contains the activities that they have done and the things that they have “liked”.
Less distressed	This should come through the experience of using the complete system over a period of time.
Hopeful	Conveyed through the content of the videos.
Normal	The feeling of being normal is conveyed through the content of the videos, as they see peers going through the same stages as them. They are also using technologies that everyone uses - Internet and iPads.
Engaged	It is an attractive and interactive website that keeps on prompting the consumer to do (or re-do) things. The social component should also encourage the engagement.
Connected	The consumer can exchange messages with their contacts via direct email or forum.
Empowered	The consumer can choose who do they want to add as contact or whose requests to accept. They choose what they share with others and when to make public comments to resources. They have a range of tools that they can use when they consider.
Meaningful	As the consumers keep on working on their own recovery and feel that, indeed, they are improving, they realise that all actions that they are doing are meaningful.
Safe	The website is backed by universities and hospitals, they know that the contents that they are consuming are reputable and trustworthy. They also feel safe in the forums as they are moderated.

**Table 8.2:** Design Considerations of Consumer’s Emotional Goals

<b>Emotional Goals</b>	<b>Design Considerations</b>
Up to date	The worker uses modern technology. The contents, in form and essence, are modern, as videos and research material.
Connected	The worker feels connected to their consumers through the direct messaging and forum mechanisms supported by the website.
Empowered	The worker has the flexibility to use the system in the most convenient way to guide the recovery of the consumer.
Inspired	Through the use of the system the consumer advances in the path of recovery. This inspires the worker to keep up working.
Respected	The worker's opinions and advice are backed by the peers' videos and recovery results. As a result, the consumer respects them better.
Engaged	The website provides useful resources for consumers and the videos are good to spark conversations. The worker uses it as a regular support during the consultation times.
Knowledgeable	Achieved through the contents of the website.
Effective	Achieved as the consumer recovers using the resources.
Helpful	Achieved as the consumer recovers using the resources.
Useful	Achieved as the consumer recovers using the resources.
Validated	Achieved as the consumer recovers using the resources.
Confident	The worker feels confident that the technical resources will be there when needed. The iPad is self-sufficient in terms of Internet connectivity and access to all resources. The website is simply designed and the contents logically structured so the worker knows how everything works and where every resource is.

**Table 8.3:** Design Considerations of Worker's Emotional Goals

## 8.6 Findings and Discussion

Our collaboration with the SMART team focused primarily on improving the requirements phase which was early in the lifecycle. The SMART project has a 5 year horizon and since it is still an active project and undergoing improvements, we focused on an informal interview with some of the mental health workers to gauge the effectiveness of the work in progress. The feedback from the mental health workers were transcribed and used to analyse the success of the project in terms of the inclusion of emotional goals. In this section, we present our findings and discussions based on the feedback obtained from different stakeholders of the system at different stages of the project.

### 8.6.1 Emotion-Informed Elicitation techniques

In this case study, we applied both of our emotion-informed elicitation techniques to identify the functional, quality and emotional goals for the SMART website. The first set of goals were derived through a brainstorming session where two key researchers from the SMART team came up with a list of goals. Basic instructions were provided to these participants and even though the participants had no IT background, they successfully followed the instructions given to them. At the end of the process, they came up with a list of functional, quality and emotional goals which, according to them, was in line with what they actually wanted from the system. They were not only satisfied with the outcomes of the brainstorming session but also with the way the process was conducted. Some of the comments from the participants were *“I cannot believe that a simple process can yield such good results”*, *“I have dealt with IT people before for previous projects but we never came up with a list of emotions...”*, *“...this is exactly what we want our users to feel.....how do we convey them to the IT guys?”*

The second set of goals were derived through a content analysis process where interview transcripts from potential users of the SMART system were used. We generated a list of emotional threats and goals along with functional and quality goals of the system. These emotional threats

were then mapped to emotional, functional or quality goals using an emotion model. This process helped us identify some additional goals for the SMART system.

Based on our findings, we reiterate our earlier claim that our proposed emotion-informed elicitation techniques are simple and straightforward to use. They can be applied within multiple domains and used with any stakeholder irrespective of their background. Given their simplistic approach, they can be easily incorporated within any existing software engineering framework.

### **8.6.2 Emotion-Oriented Models and Personas**

The identified goals for the SMART system were represented through a goal model which was used during the discussions with the software development team. The software developers found the goal model to be an easy and simple tool to represent the key goals. It served as a baseline to identify additional goals and discuss the contents of the website. While the software developers acknowledged the importance of emotional goals, they could not understand how to incorporate these emotional goals within the software. Interaction models and a set of emotion-informed personas were therefore derived in an attempt to bridge the gap between the requirements and design phases.

One of the major findings from the interviews with the mental health workers showed that the contents and design of the website did address most of the emotional goals. For instance, the forums and lived experiences videos made users feel *connected* to their peers. We are, however, unable to confirm whether our models and personas were used by the software professionals during the design and implementation phases of the SMART website.

We therefore conclude that our emotion-oriented models and personas are valuable tools to capture and represent emotional, functional and quality goals. Given their simplistic nature, they can be used as a baseline during negotiations with stakeholders to discuss the core function-



alities of the system and identify further goals.

### **8.6.3 Representation of Emotional Goals within the SMART website**

According to the feedback obtained from the mental health workers, most of the emotional goals were addressed by the SMART website. The system failed to address some of the identified emotional goals such as *normal* and *engaging*. Even though emotional goals were identified for each potential group of users, the way that they should be represented within a particular system is not clear. How can we in the area of technology, propose a design which actually make the users feel *confident*, *empowered* or *normal*? One of the main findings of the study reinforced the point that designing a technology to engage people is not an easy task. Despite all the efforts of ensuring that the contents of the website is *engaging*, the general comments from the mental health workers were that many consumers were not engaging with the system outside the sessions.

During our meeting with the software development team, one of the designers asked us “*How can we ensure that our design reflects the emotional goals identified for each user of the system?*”. The personas and models provided to them were helpful in coming up with a design for the website but they cannot be used as a guideline to design or develop a system. Designers and software developers have to abide by existing policies and development processes to execute the task assigned to them.

### **8.6.4 Acceptance and Adoption of Technology**

As identified in the previous case study described in Chapter 5, when it comes to accepting a technology, many factors other than the users’ feelings come into play, such as the motivation factor, support mechanism and background of the users. The **motivation factor** plays a major role in the acceptance and adoption of technology. For instance, the

system failed to engage many consumers even though the contents of the website were designed to be engaging. The issue lay mainly with the determination of the consumer to come out of their mental health problem. The mental health workers referred to consumers who were engaging with the SMART system as being generally *“enthusiastic, research-oriented and self-motivated”*. According to them, *“the system would fail to engage people otherwise”*. The motivation factor was also linked to the stage in the mental health problem that the consumer found themselves. People at different stages of the recovery process have different needs. For instance, people just being diagnosed, struggle just to get out of bed, they do not have the priority or capacity to check their email (if they had it), much less to go online and do exercises. A comment from a mental health worker pointed out that *“Consumers that are better in terms of recovery, tend to be more engaged and tend to use SMART between sessions. However, the consumers that are not self-motivated to start with, will not engage with SMART in between sessions. The system unfortunately fails to engage those who are at the initial stages of psychosis.”* Promoting SMART amongst the newly diagnosed patients remains an outstanding dilemma.

The support mechanism provided to the consumers also plays a determining role in the adoption and acceptance of the technology. The way SMART was promoted and recommended to be used influenced the usage of the program. Given that the mental health workers were using the program during their sessions with the consumers inspired a sense of confidence among the consumers rendering the tool to be trustworthy. Also, the videos being stories related by peers made the consumers feel more connected to the contents as compared to other videos by professional mental health workers.

Another finding reinforced the point that users' technical backgrounds play a critical role in the acceptance of technology. According to the mental health workers, the SMART website was mainly used by consumers who are by nature tech savvy and who rely on the web for most of their solutions. These consumers were better in terms of recovery, more engaging and used SMART between sessions. The interactions during the treatment sessions with their mental health workers were

more fruitful as compared to those who did not use the website. In comparison, those consumers who are not used to technology were reluctant to use the SMART website. They preferred to rely on face-to-face human intervention rather than use an online tool as a solution to their problem.

## 8.7 Threats to Validity

In this section, we assess the validity of the study by conducting four tests which are common to all social science method (Yin, 2013) namely:

- Construct Validity
- Internal Validity
- External Validity
- Reliability

### 8.7.1 Construct Validity

Based on our findings, the data collection instruments namely the brainstorming session with the SMART researchers, the interviews and focus groups with the participants and mental health workers provided us with significant data which was used to formalise our proposed methods. This finding strengthens our construct validity.

### 8.7.2 Internal Validity

Our research proposition states that “user emotional expectations play a critical role in the acceptance of a technology”. While our findings show that user emotional expectations are a critical determinant of the success of a technology, we cannot ignore the other factors that can influence the success or failure of the SMART application. These factors, namely user’s motivation, the support mechanism and the technological background of the users, are *threats to internal validity*. Even

though the application was designed taking into account users' emotional expectations, these above mentioned factors highly influenced the acceptance of the technology.

### **8.7.3 External Validity**

This study is currently being extended to several people suffering from psychosis and all the participants involved in our case study are reflective of the population of people suffering from psychosis. At this stage, we cannot comment on the external validity of this case study as more studies with a larger number of participants are required to validate our findings.

### **8.7.4 Reliability**

Even though user emotional expectations is a subjective concept, the data analysis process was conducted objectively using the process of content analysis to eliminate subjectivity to a maximum. Each interview script was analysed by 2 researchers and the compilation of the synthesised notes was conducted by a group of 4 researchers. Hence, in terms of reliability, we can say that the findings of this study are not dependent on any specific researcher. This study can be conducted by any other group of researchers and similar outcomes can be anticipated.

## **8.8 Summary**

In this chapter, we presented a case study which involved the use of online technology to promote self-management and recovery in people suffering from psychosis. This case study was designed to answer the first two research questions namely: (1) Why should user emotional expectations be captured? and (2) How can user emotional expectations be captured?

In Section 8.2, we identified that the main objectives of SMART system consisted of making the users feel *hopeful, engaged, empowered* and *safe*. These identified goals relate to neither functional requirements nor do they fall under any of the existing taxonomies of non-functional requirements. However, given their importance to the success of the project as highlighted in Section 8.3.1, they cannot be ignored and have to be somehow represented within the requirement documents. In Chapter 4, we referred to these terms as being the *emotional goals* of the users and argued that these emotional expectations refer to non-functional requirements rather than functional requirements. Given the limitations of the existing taxonomies of non-functional requirements to cater for emotional goals as discussed, we reiterate our argument that emotional goals are a key component to the success of a system and should be represented as a separate category of goals under non-functional goals.

Having established the importance of why user emotional expectations should be captured, we then addressed the second research question in Section 8.4 where we described how the emotion-informed elicitation techniques were used to identify the goals for the SMART system. In this case study, we applied both of our elicitation techniques starting with a brainstorming session with two researchers from the SMART team to identify the key functional, quality and emotional goals of the system. Given that the participants of the SMART project are people suffering from psychosis and are, thus, very sensitive people, we were unable to have direct access to them. We therefore had to apply our second elicitation approach, namely, content analysis to identify the key functional, quality and emotional goals from the interview transcripts gathered from a focus group which was facilitated by the SMART researchers. The goals identified from both elicitation processes were represented using emotion-oriented models, namely the goal model and the interaction model. Following the request of the software development team, we also derived emotion-informed personas to better guide the designers in their task.

Given that our collaboration with the SMART team focused primarily on improving the requirements phase which was early in the life-

cycle and the SMART project being an active one and still undergoing improvements, we were unable to conduct a proper validation of the project to assess the validity of our proposed techniques. Based on the feedback obtained from the software development team and the SMART researchers, we reiterate our earlier claim that our proposed emotion-informed elicitation techniques, emotion-informed models and personas are simple and straightforward to use. They can be applied within any domain and used with any stakeholder irrespective of their background. Given their simplistic approach, they can be incorporated within some of the existing software engineering frameworks.

From an informal interview with one of the mental health workers, we found that when it comes to designing technology for people suffering from psychosis, many factors other than the patients' feelings come into play. These factors include policy and compliance consideration, the motivation of the patient to use the technology, the support mechanism and the patient's personal background. It is interesting to note that similar findings were derived from the TouchFrame case study described in Chapter 5.

The design process of the SMART case study and its findings were used to formalise the emotion-oriented elicitation techniques which we described in Chapter 6. These methods were further applied and refined in the SleepWell case study, which we describe in Chapter 9.

## **Chapter 9**

### **Case Study 3: Supportive Technology for Monitoring Sleeping Difficulties (SleepWell)**

As part of our research, we conducted another case study namely SleepWell with the main objectives of:

- refining our proposed emotion-oriented techniques;
- assessing their validity within different domains; and
- their acceptability among different stakeholders.

The research approach and emotion-oriented techniques used in this case study were similar to the previous SMART case study, described in Chapter 8. In order to avoid repetition, we refrain from providing a complete description of how the emotion-oriented techniques were applied within this study. In this chapter, we present a brief overview of how the case study was conducted followed by a discussion of the main findings from the study.

The “Supportive Technology for Monitoring Sleeping Difficulties: Developing a Mobile Application for Addressing User’s Needs” project, which

we refer to as the *SleepWell project* consisted of the development of a mobile app with the aim of making sleep-deprived people feel *calm, relaxed* and minimise physical arousal around bedtime. This project was funded by the Barbara Dicker Brain Sciences Foundation (BDBSF) Grants<sup>1</sup> and was closely linked to another previously BDBSF funded project named as “*Sleep-e*”. *Sleep-e* is a website which was developed by researchers at Swinburne University of Technology and consists of six online modules treatment for insomnia that focuses on mood/cognition, lifestyle factors and the personal experience of sleep quality. The overall research program was examining the potential of using technology to improve the life quality of people with sleep disorders. *SleepWell* involved the development of a mobile application by adapting content on relaxation exercises from the *Sleep-e* program taking into account the needs and preferences of people who experience sleep difficulties. Relaxation exercises are a common component of psychological treatment for sleeping difficulties such as insomnia (Currie, 2008, Gustafson, 1992, Morawetz, 1989, Morin et al., 2009, van Straten et al., 2009) and considered highly beneficial for people encountering sleep difficulties (Gustafson, 1992, Means et al., 2000, Woolfolk and McNulty, 1983).

Since our research was in line with part of the research conducted by the *SleepWell* team, that is, the consideration of user emotional expectations during the design of a technology, we collaborated with the *SleepWell* team to assist them in identifying the emotional, functional and quality goals of the system. Our team consisted of four researchers but the case study was mainly designed and trialled by the author. Our involvement started at the very initial stages of the requirements gathering process. We applied the same research approach and elicitation process used in the previous SMART case study, described in Chapter 8, to capture the key functional, quality and emotional goals of the system. These identified goals were converted into agent-oriented models and emotion-informed personas, which were used by the software developers during the development of the mobile app. Once the mobile app was developed, eight participants were recruited for a trial. Prior to the trial, the participants were interviewed whereby they were asked

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<sup>1</sup><http://www.swinburne.edu.au/lss/bpsyc/barbaradicker/>



about their opinion on the design of the app and whether they felt that the contents would make them feel relaxed and calm. The mobile app was then trialled with the 8 participants for a period of four weeks. A complete set of the emotion-informed personas and supporting documents related to the trial, including ethics application are available in Appendix D.

Most of the findings from this case study were in line with those observed during the previous case study, described in Chapter 8. A new finding that came up from the interactions with the designers and developers of this mobile app revealed that little consideration has been given to emotional goals within software engineering as compared to areas such as human computer interaction and game design. Detailed information on the interactions with the development team and their feedback are provided in the next section.

The rest of this chapter describes the interactions with the development team (Section 9.1), the features of the mobile app (Section 9.2), the trial with the participants (Section 9.3), in particular, their feedback gathered during the interview followed by a brief discussion of the findings from this case study (Section 9.4) and a summary in Section 9.5.

## **9.1 Interactions with the Development Team**

The development team consisted of two developers. The first interaction with the team consisted of providing them with a background on the project and the potential users of the app while highlighting the key emotional goals identified for the system. The goal model, presented in Figure 9.1, was used as part of the discussion to give them an overview of the system.

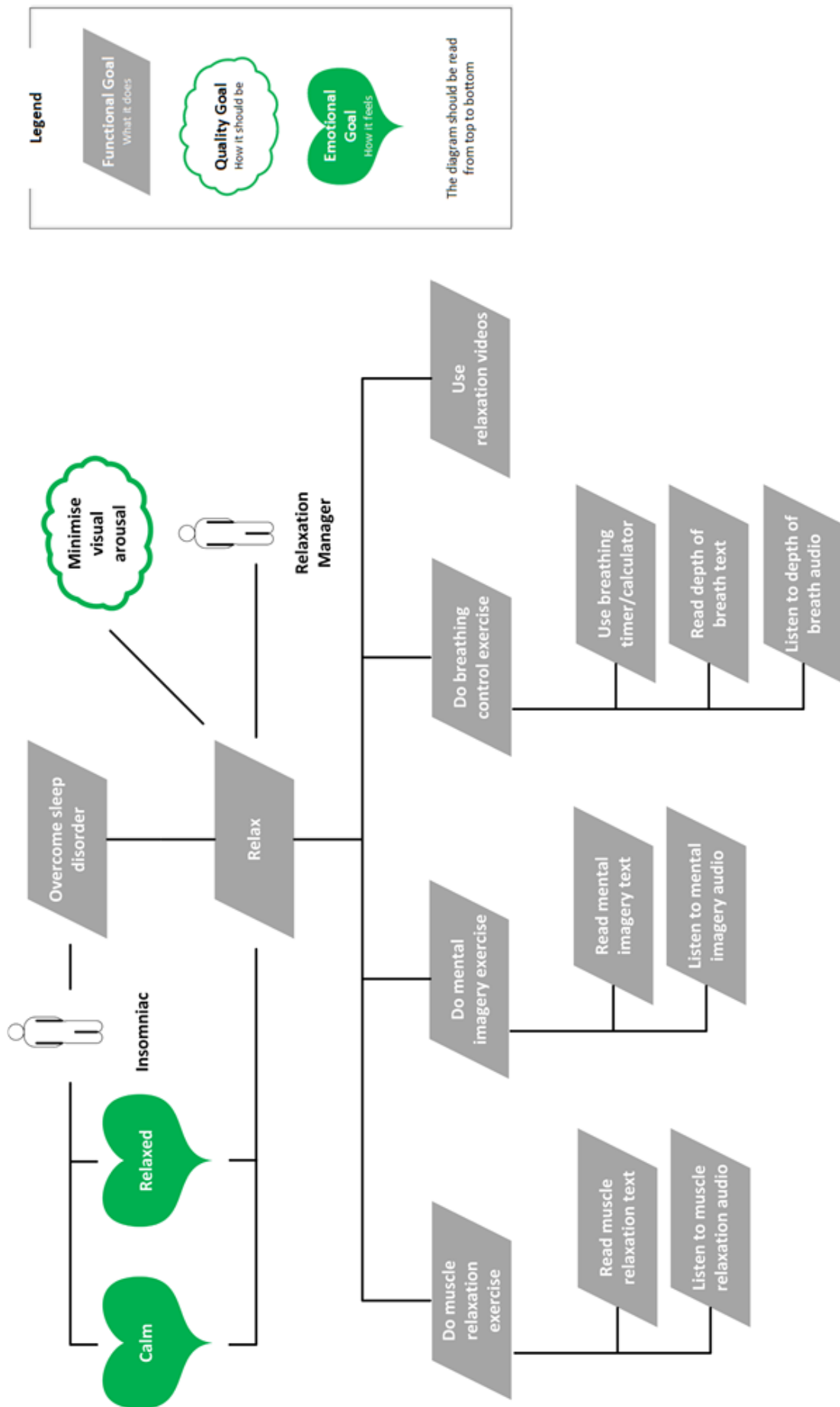


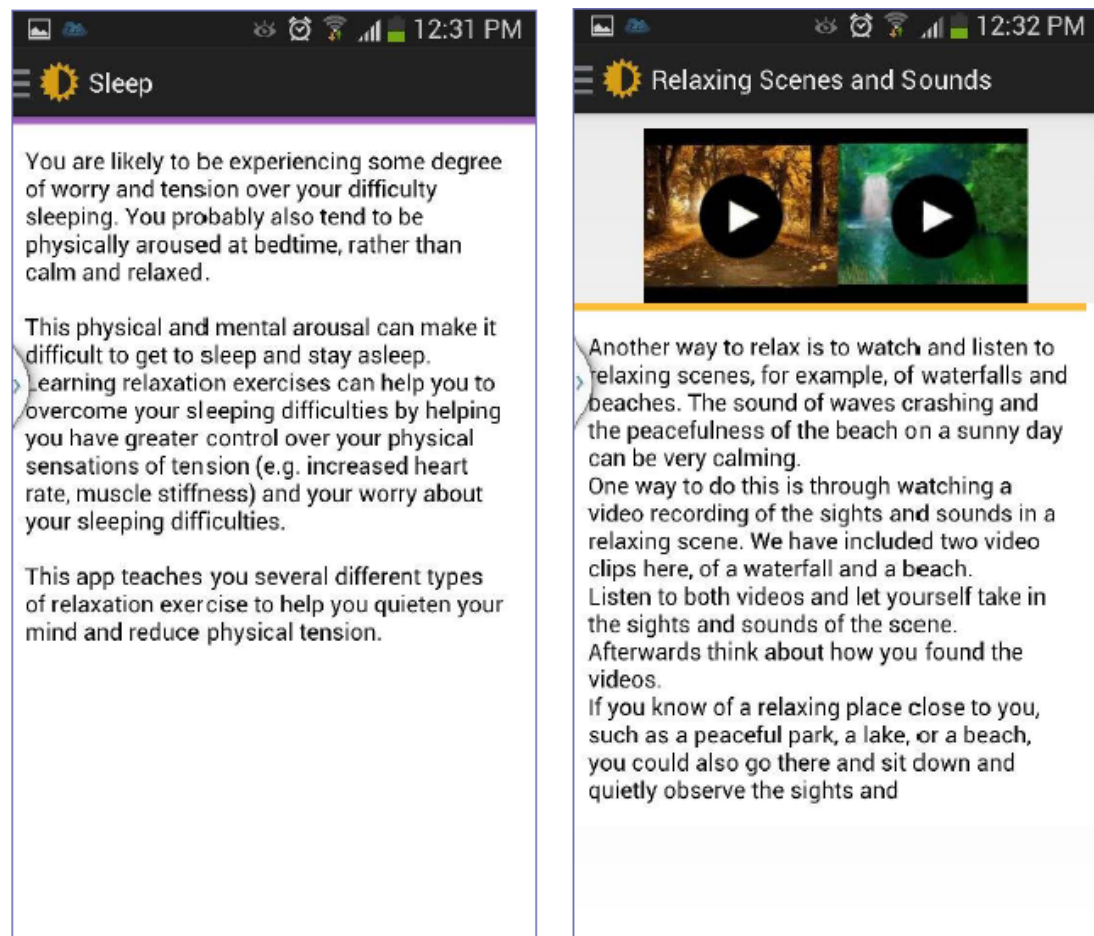
Figure 9.1: Goal Model for SleepWell

Given the simplicity of the goal model, the development team had no difficulty in understanding the core functional and quality requirements of the system. They were also able to identify the emotional goals and agreed on their importance with regards to the acceptance of the technology. They were, however, unsure about how to include such goals within their design and implementation phases.

Emotional goal was a new concept for them and they had never worked on any such goal before. Hence, their concerns were legitimate when they asked “are there any guidelines or methods to help us in our task? How do we ensure that our design is actually reflecting the said emotional goal?” Given that we were still at the initial stages of introducing emotional goals within the software development life cycle, we were unable to provide them with any such guidelines or methods. We therefore provided them with the emotion-informed personas in an attempt to help them bridge the gap between the requirements and design phases. The developers seemed more convinced and agreed to come up with a draft design for the prototype.

During our second meeting, we were presented with a set of screenshots for the mobile app. Two of the screenshots are provided in Figure 9.2. The general consensus from our team of researchers was that the screenshots, even though they addressed the key functional and quality goals, did not address the emotional goals. Each screen consisted of a large amount of text which made the relaxation tasks tiring and cumbersome. The aim was to make users feel calm and relaxed. When presented with the screenshots, the SleepWell team shared our concerns and they suggested the use of sounds rather than text.

Given that the developers were having difficulty designing the app with the emotional goals, we approached a group of three students who were from a computer design background and doing an internship with one of our researchers. They easily understood the requirements of the system from the goal model and personas provided to them. These students came up with a set of screenshots taking into account the potential users of the system and their emotional goals. The colour scheme, icons and font selection were made in accordance with the



**Figure 9.2:** First set of screenshots for the SleepWell mobile app

emotional goals. Further details on these screenshots are provided in Section 9.2. These screenshots were provided to the developers who then implemented the mobile app.

During one of the post implementation meetings with the designers and developers, we queried the validity of our proposed goal model and emotion-informed personas. Both the designers and the developers agreed that the goal model was easy to understand and served as a baseline during our negotiations. The developers also admitted using the goal model during the implementation process to cross check whether all the functional and quality goals have been addressed. They, however, raised concerns regarding the implementation of emotional goals. Even though they fully understood the importance of the emotional goals with regards to the project, they could not map those emotional goals to the design. The personas were helpful but not enough

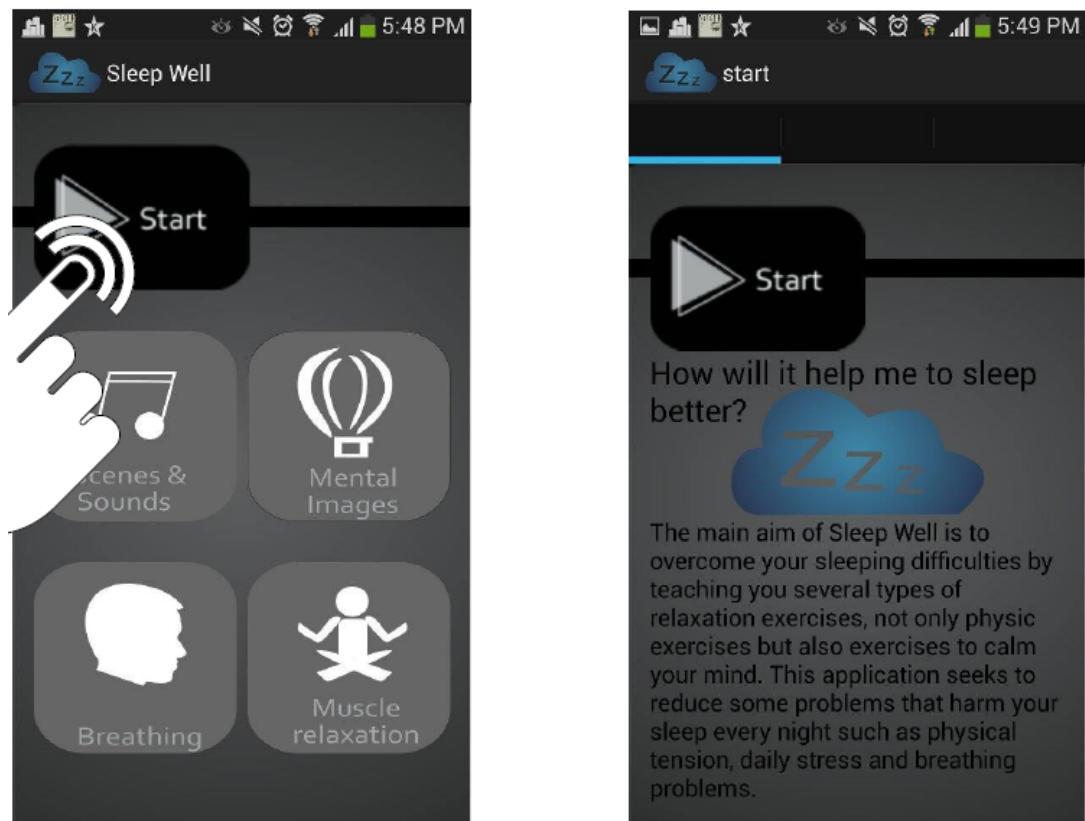
to help them in their task. These developers were from a software engineering background and were trained to apply a set of software engineering practices when developing software. As discussed in Section 2.2, even though there is some early progress on integrating emotions in software solutions, to the best of our knowledge, none of the software engineering practices fully address the concept of user emotional expectations. Without proper guidance on how to incorporate user emotional expectations within the software development life cycle, software engineers tend to ignore these goals as the project progresses to the next phase. Based on these observations, we all agreed that there was a gap between the requirements and design phases.

The designers, on the other hand, were in a better position to understand the concept of emotional goals. Having designed computer games where “having fun” was the primary goal, designing a system with goals such as “feeling calm and relaxed” was easier for them as compared to the software engineers. The designers agreed that even though the goal model clearly depicted all the goals, the emotion-informed personas further helped them in understanding the potential users and their emotional expectations. They came up with a set of screenshots, as described in Section 9.2, taking into account the user’s emotional expectations depicted in the goal model and personas.

## **9.2 Description of SleepWell Mobile App**

The contents and the features of the SleepWell app was designed based on (1) the existing content of the Sleep-e project; (2) the goal model and (3) the emotion-informed personas. The colour scheme, screen design and the font sizes used within the app have been chosen in accordance with the requirements of the users. Given that this app will be used mostly at night, either when having difficulty falling asleep or going back to sleep, sober colours have been used throughout the app to avoid further physical arousal.

The first screen in the app, as shown in the screenshot on the left in Figure 9.3, allows the user to access the contents of the app which

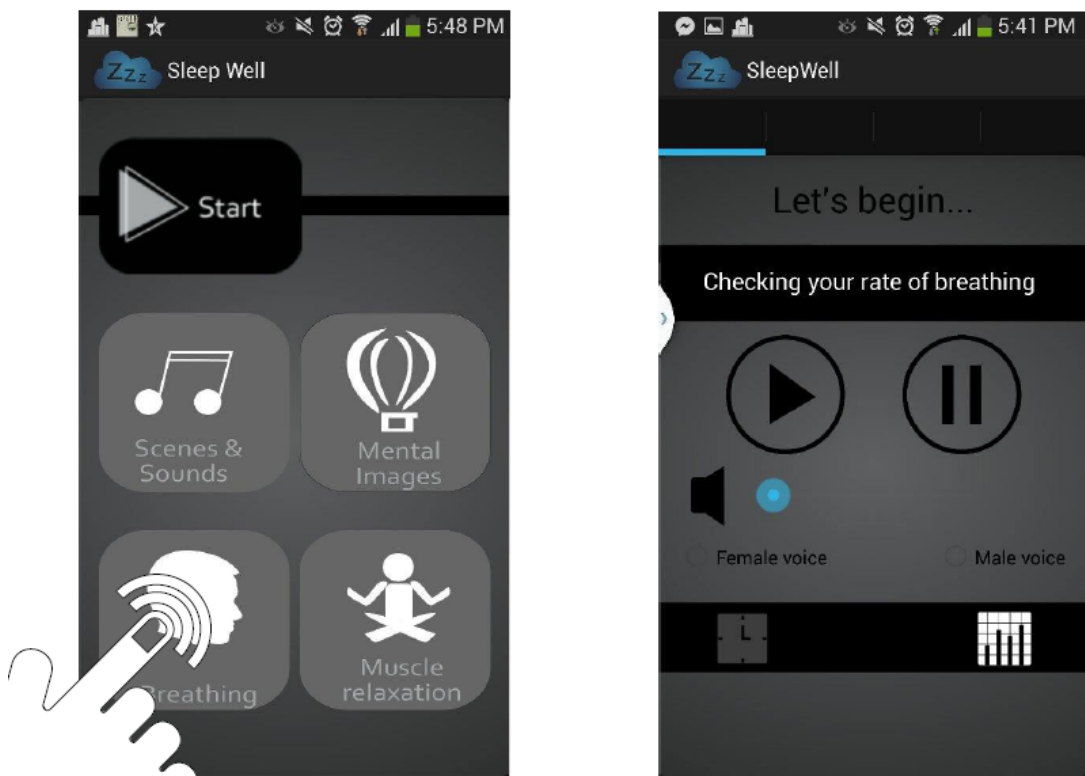


**Figure 9.3:** SleepWell mobile app

consists of four main categories namely:

1. Muscle Relaxation Exercises,
2. Mental Images,
3. Breathing Control Exercises, and
4. Relaxation Videos.

The contents of the *Muscle Relaxation Exercises* and *Breathing Control Exercises* consist of audio files whereby a soothing voice guides the user through a set of exercises. The *Relaxation Videos* provide the user with a short video consisting of peaceful sceneries and a soothing voice guiding the user through a set of steps such as “settle yourself in a comfortable position and let go...relax....imagine your body relaxing....your eyebrows relaxing...”. The *Mental Images* consists of a soothing voice

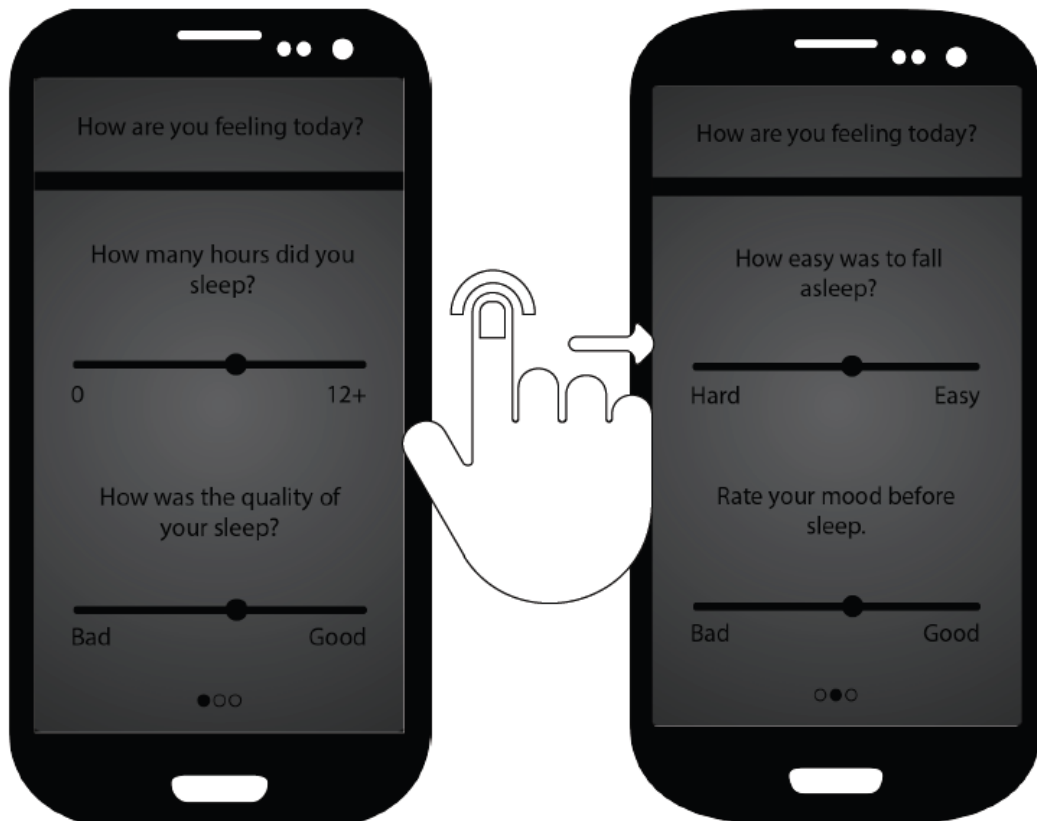


**Figure 9.4:** SleepWell Breathing Exercises

asking the user to imagine themselves in a peaceful place such as the beach followed by the soothing sounds from that specific place. For instance, if the user selects the beach option, sounds of waves are heard. The key objective of these contents are to make the user feel calm and relaxed such that they can fall asleep. A screenshot of the Breathing Control Exercises is presented in Figure 9.4.

In addition to these exercises and videos, the app also consists of:

1. A help functionality in the form of small tips on how to use the different components of the app as shown in Figure 9.3.
2. A feedback tool which the user can use to record their daily sleep pattern as shown in Figure 9.5.
3. A sleep tracker tool allowing the user to track their sleep over a specific period of time. The screenshot for this tool is available in Figure 9.6.



**Figure 9.5:** SleepWell Feedback Tool

### 9.3 Trial with participants

In this section, we provide a description of some of the participants who trialled the SleepWell app and also provide an account of the pre-trial interviews conducted with these participants. The pre-trial interview was designed to understand the general background of the participants, general technology use, their sleep problems and any current techniques used to combat sleep difficulties. Prior to the interview, the participants were sent a set of screenshots via email and, during the interview, they were asked about their thoughts on the design of the app in terms of colour scheme, layouts and whether the design and contents would make them feel relaxed and calm. A key objective of conducting the pre-trial interviews was to informally assess whether the emotional goals identified for this system had been addressed by the design of the prototype. Feedback obtained from this process was then used to refine the app prior to starting the trial.





**Figure 9.6:** Sleep Tracker

The trial started with the recruitment of 12 participants who expressed their interest to participate in the trial. The criteria for recruiting participants consisted of anyone:

- who was 18 years or above;
- who had been having difficulties getting to sleep or staying asleep on 3 nights or more per week for at least 3 months;
- whose sleeping difficulties caused them distress or made it difficult for them to do everyday activities

Informed consent forms and details of the project were sent to all the twelve participants. Given that the duration of the trial was set at four weeks, during which the participants had to use the mobile app on a regular basis, three participants could not start the trial straight away because they had to travel during that period. Another four participants

did not respond back after receiving the informed consent forms. We therefore started the trial with the remaining five participants who were interviewed and requested to use the mobile app over a period of four weeks. The three participants who had earlier postponed the trial due to their travel plans, were interviewed at a later stage. We provide a brief overview of the first five participants in this section. In order to maintain confidentiality, the participants' names and addresses have not been disclosed. We give them the following fictitious names Jenny, Paul, Serena, Jinny and Tom.

### **9.3.1 Participant 1: Jenny**

Jenny was 68 years old and had previously worked as a secretary at a local hospital. She was retired but had a very active social life. She enjoyed gardening and sports. Unfortunately, after her menopause in her early fifties, she started having sleeping problems. Initially, she did not realise that she was having a problem as she had a busy work life. "It does not feel good to be awake during the night because you have to wake up at 6-7 am". As she neared her sixties, she realised that she was having a serious problem regarding her sleep. "I realised that I cannot sleep even when I keep lying in bed. It worries me because I know it will have a long term effect on my health". She tried some sleeping tablets based on the recommendation of her doctor and it worked for some time. However, she is worried about the side effects of the sleeping tablets. She tried other techniques such as herbal tea, reducing TV time, doing some physical activity but they are not always effective.

When asked about how it feels on the mornings when she did happen to sleep throughout the night, Jenny responded "it feels lovely but that does not happen very often". Jenny was keen to try the SleepWell app given that its contents have been moderated by a team of psychologists. She was also desperately looking for some natural remedies to her sleep problems rather than relying on the sleep tablets. Jenny did not use computers regularly but owns a smartphone.

#### **Jenny's comments regarding the SleepWell app and emotional goals**

Jenny mentioned that “well it’s good to have many options but I am an old lady and I like routines, too many options become hard to remember”. She indicated that she might consider using one option at a time until she decides which one works best for her. Additionally, she mentioned that “I like the idea of being able to try things on my own and monitor my own progress rather than being told by someone else....I hate it when my partner always tells me you should do this and that”. Jenny valued her freedom.

Regarding the screen design, she mentioned that “from what I can see on the document, the images appear to be soothing...nothing bright which is good”. She also added that “it’s hard to comment on whether the app will be able to calm or relax me at this stage. I need to try the app for some time to comment on that”.

### **9.3.2 Participant 2: Paul**

Paul was 41 years old and a management consultant who ran his own business. He spent his days driving around and meeting with clients. “I have to move around with my job but I am not physically active...I don’t have time to do sports”. His daily activities consisted of getting the kids organised for school, driving out to his work and meeting clients, bringing the kids back home, and when his wife came home, they prepared dinner together. He normally went to bed at 9:30 pm. During the day, he was mostly on the phone or using his tablet for his work. His sleeping problems started some 15 years ago and he tried different techniques to overcome his sleeping difficulties such as medication and exercises. Nothing worked for him. He was considering changing his lifestyle and managing his work balance. “Work is always stressing and I feel very stressful when I wake up in the middle of the night because I know how unproductive I am going to be at work and how I am going to fall behind”. Occasionally when he did have a good sleep, he felt “..I do feel energetic and I can be productive...it has a massive impact on me”. However, on most days when he was unable to get proper sleep, his energy and motivation were lower and he was grumpy with the children which stressed his wife.

Paul was keen to try out new techniques to combat his sleeping problems. He wanted to have a normal life again and hated to see his family suffer because of him. He was therefore more than willing to participate in the SleepWell study.

#### **Paul's comments regarding the SleepWell app and emotional goals**

Paul mentioned that "it is all looking good on paper...I need to try it out to see how good it really is". While going through the different options, Paul was concerned about being able to imagine being at different places. His comment was "it's too hard for me to concentrate when I cannot sleep... how can I imagine being at the beach?".

### **9.3.3 Participant 3: Serena**

Serena was a 23 year old business administration student who had just finished her exams. She stayed at home during her university vacation and sometimes met her friends. She had a history of bad sleep for a very long time. She woke up several times during the night and sometimes just kept lying in bed for a long time until she finally gave up and got out of bed. She sometimes went for a jog in the middle of night. The jogging helped her feel relaxed enabling her to sleep for a few hours but it was not always effective. She had tried several techniques such as jogging, pilates, reading and working for long hours so that she is exhausted. Unfortunately, while some techniques were helpful on some days, they had not been able to eradicate her sleep problems completely. Serena was interested in participating in the study mainly because she hoped to find something useful which could help solve her problems.

#### **Serena's comments regarding the SleepWell app and emotional goals**

Serena mentioned that the features were very restrictive and also added "after some time, I will get bored doing the same thing...you should consider updating the contents of the app regularly". She was also concerned that the contents of the app were too simple to have a long term calming or relaxing effect on her.

### **9.3.4 Participant 4: Jinny**

Jinny was 35 years old and worked as a student administrator at a University on a part time basis. She was physically very active and went to the gym at least 4 times per week. Jinny had sleep difficulties all her life. Her mum had them and one of her sisters had them as well. However, another sister slept without any difficulty. It took her a long time to fall asleep and she would wake up soon after she fell asleep. In the morning she felt tired and found it hard to concentrate during the day. She felt groggy and needed coffee to keep her going. When she woke up in the middle of the night she cursed a lot, and wondered how she was going to fall asleep. Occasionally she got up and read or watched TV. She found that these fired up her brain and then she would stay awake throughout the night. She had tried medication, listening to relaxation music for as long as two hours and even yoga exercises to relax. About 40% of the times that she woke up, none of these techniques helped her go back to sleep. She felt very annoyed when she could not sleep.

Three years ago, Jinny went through a tough time and had to take sleeping medication. She did not like it because, although it worked, it made her groggy all day. She therefore dropped them. She did not have any particular expectations of the trial. She was willing to try anything to find a way to cope with the sleep difficulties. She was very happy to give it a go, but was very sceptical. She was quite doubtful that technology would be the solution.

#### **Jinny's comments regarding the SleepWell app and emotional goals**

Jinny preferred listening to music rather than reading a whole lot of text. Her comment was "when I wake up in the middle of the night, I would not like to read a whole lot of text but I prefer to listen to some relaxing music, so the music works for me." She liked the idea of having different options to try but mentioned that the list currently provided was restrictive. She said "I want to be able to find different resources suitable for different situations".

Jinny also mentioned that she was doubtful that technology was the solution to her problems and “I would be more confident if my progress was monitored by a professional in the area”.

### **9.3.5 Participant 5: Tom**

Tom was a student of 33 years and physically disabled. He had a car accident 3 years ago. “I ended up with damage in my neck and leg”. Due to his condition, he was unable to work and therefore had some money problems. Tom had been having sleep problems since his accident. “I can’t get back my sleep”. For him a decent sleep was anything more than three hours - “ I still feel better though I am tired constantly and irritated”. Most days when he cannot sleep, Tom said “not being able to sleep makes me feel annoyed and frustrated. I am so tired and grumpy all the time”. When he woke up in the middle of the night he makes himself a cup of tea and puts on the TV. “Trying to get back to sleep is a waste of time”. His concentration was very low and he felt that the lack of sleep was affecting his memory.

Tom was more than willing to try out anything that could help him get his sleep back - “anything that can help me get some sleep and make me feel relaxed is worth a try”.

#### **Tom’s comments regarding the SleepWell app and emotional goals**

Tom liked the idea of visualising different scenes and images. He mentioned “I love the idea of imagining that I am at the beach....given my circumstances it is not often that I can afford to go to the beach.” He liked the design and was willing to try the app.

The feedback obtained from the participants are discussed within the next section.

## 9.4 Findings and Discussions

The main findings from this Sleepwell case study revealed that:

- **Our emotion-informed elicitation technique, which consisted of a brainstorming session, was successful in identifying key functional, quality and emotional goals for the Sleepwell system.**

The researchers from the Sleepwell team were not only satisfied with the outcomes of the brainstorming session but also with the speed, ease and way the process was conducted. Some of their comments were *“When you were talking about user’s emotional requirements, I had no idea what it meant but here we are with a list of user emotions”, “...I cannot believe that you guys have come up with a model so quickly”, “...this is exactly what we need from the app...what’s the next step?”*.

- **Our emotion-oriented models and personas were considered as valuable tools to represent emotional, functional and quality goals.**

Both the developers and designers acknowledged the usefulness of the models and personas in representing the key goals of the system. They were used during negotiations and the developers even admitted using the goal model throughout the implementation process to cross check whether the key functional and quality goals were being addressed.

- **There is a gap between the requirements and design phases.**

Even though the goal model successfully represented the emotional goals, it was hard for the developers to map those goals within their design. On the other hand, designers had no difficulty mapping the emotional goals to their design. Given that the developers were from a software engineering background and the designers from the design background, we reiterate our claim that little consideration has been given to emotional goals within software engineering as compared to areas such as human computer

interaction and game design. Introducing the concept of emotional goals at the requirements elicitation phase is not enough. The gap between requirement and design phases need to be addressed.

- **Users have different personal expectations from the system.**

The major finding from the feedback obtained from the initial interviews with the participants is that each user had their own set of preferences and, therefore, the contents of the app did not necessarily suit everybody. For instance, Jinny mentioned that “when I wake up in the middle of the night, I would not like to read a whole lot of text but I prefer to listen to some relaxing music, so the music works for me.” Tom, on the other hand, prefers to visualise different scenes and images. He mentioned “I love the idea of imagining that I am at the beach....given my circumstances it is not often that I can afford to go to the beach.” But then Paul found it too hard to be able to imagine being at different places.

Another key finding was that some users preferred to have some guidance and assistance from experts rather than just read some text or listen to music or conduct some exercises. Even though they agreed that all these activities could be helpful, they still expected to have a follow up with a professional to discuss their progress or relapse. For instance, Jinny clearly mentioned that she is doubtful that technology is the solution to her problems and “I would be more confident if my progress was monitored by a professional in the area”. But then Jenny contradicted Jinny by saying “I like the idea of being able to try things on my own and monitor my own progress rather than being told by someone else....I hate it when my partner always tell me you should do this and that”.

Two users commented that the contents seemed to be very restrictive. For example, Serena mentioned that “after some time, I will get bored doing the same thing...you should consider updating the contents of the app regularly”. Jinny also agreed with this comment and further stated “I want to be able to find different resources suitable for different situations”. On the other hand, Jenny mentioned that the contents seemed to be sufficient for her



- “well I am an old lady and I like routines, too many options become hard to remember”.

Even though emotional goals were easily identified using our proposed techniques, the way that they should be represented within a particular system is still unclear. From these findings, it can be clearly seen that users have different expectations from the system and what is satisfactory for one does not necessarily satisfy another. For instance, not everybody feels relaxed by listening to music. This concern was also raised by the developers who found it hard to mirror the emotional goals through the design and implementation phases. They were also unsure about how to assess whether the design of the prototype reflected end-users’ emotional expectations. How do we in the area of technology propose a design which meets the emotional goals of every user while abiding by existing policies and development processes?

- **Motivation and support mechanism are driving factors to the acceptance of technology.**

Even though we did not interact with the participants during the post interviews, it was clear from the initial interview that the motivation factor played a major role in the acceptance and adoption of technology. For instance, most of the users were keen to use the app because the contents were prepared by professionals in the area and above all it was free. Additionally, they were desperate to find a solution to their sleep problems and any technique was worth trying.

The support mechanism provided to the participants also played a determining role in the adoption and acceptance of the technology. The way SleepWell was promoted and recommended to be used influenced the usage of the program. Given that the contents were prepared by psychologists, they inspired a sense of confidence among the participants rendering the tool to be trustworthy.

## 9.5 Summary

In this chapter, we presented a case study which involved the use of a mobile app to help people suffering from sleep difficulties. Given that the design of the case study and the research approach adopted were similar to the previous SMART case study, described in Chapter 8, we refrained from providing a complete description of how the case study was designed to avoid duplication.

Our involvement in this project was only until the launch of the mobile app. We managed to interview some of the users prior to the start of the trial but could not conduct a formal validation of the app to assess the extent to which the emotional goals had been addressed by the app. We, however, applied our emotion-oriented techniques to some part of the software development life cycle. Based on the feedback obtained from the SleepWell researchers and the development team, we reiterate our claim that our proposed emotion-informed elicitation techniques, emotion-informed models and personas are simple and straightforward to use. They can be applied within multiple domains and used with different stakeholders. A key finding obtained from the development team is that little consideration has been given to emotional goals within software engineering as compared to other areas such as HCI and game design.

The feedback from the interviews revealed similar findings as identified in the previous case studies. The findings showed that when it comes to accepting a technology, many factors other than the users' feelings come into play, such as the motivation factor and support mechanism used. Even in the case of the SleepWell project, even though we did not have the post usage feedback, it was clear that the motivation to use the app and the support mechanism provided throughout the duration of the case study highly influenced the acceptance of the technology.

# Chapter 10

## Discussion

In previous chapters, we addressed the research questions that motivated this study. In this chapter, we discuss how our findings could potentially provide support to some of the software development processes and stakeholders. More precisely, in Section 10.1, we discuss the value that our observations could add to some of the processes within the software development life cycle, and in Section 10.2, we discuss about how useful these findings could be to different stakeholders. In Section 10.3, we highlight some of the adoption challenges identified during our study. Lastly, we summarise the contents of this chapter in Section 10.4.

### **10.1 Implications on the Software Development Processes**

One of the major causes of software project failure is linked to the poor identification of requirements (Hofmann and Lehner, 2001, Kotonya and Sommerville, 1998, Miller et al., 2015, Pfleeger and Atlee, 2010, Wieggers, 2005). Incomplete set of requirements can have a domino effect on the whole software development life cycle leading to poor design of the user interface, lower team productivity, poor quality of end-product and costly reworks (Baxter and Sommerville, 2011, Pfleeger

and Atlee, 2010, Sommerville, 2010). In this section, we discuss how the work, presented in this thesis, could potentially be applied and extended to identify the key requirements of the system, improve the productivity of team members and enhance the quality of the software at different levels of the software development life cycle.

### **10.1.1 Requirements Elicitation**

Requirements elicitation processes focus on systematic and rationale capturing and analysis of requirements (Baxter and Sommerville, 2011, Ramos et al., 2005, Sommerville, 2010). In most cases, they do not fully acknowledge and capture users' emotional concerns, which are critical to the success of a project (Proynova et al., 2011, Ramos et al., 2005, Sutcliffe, 2011, Sutcliffe and Thew, 2010, Thew and Sutcliffe, 2008). The emotion-oriented elicitation techniques, presented in this thesis, were applied within three different case studies, namely TouchFrame, SleepWell and SMART. The feedback obtained from the researchers of the SMART and SleepWell project consisted of comments such as "*I cannot believe that a simple process can yield such good results*". Our findings show that these elicitation techniques have the potential to identify the key functional, quality and emotional goals of the system.

Given their simplicity, these elicitation techniques could be integrated within existing requirements engineering processes, and could thus add value to the overall set of requirements. Furthermore, they could be applied and extended to other projects with a user-centered focus, within different domains. For instance, in the introduction of this thesis, we used one of the case studies from Ramos and Berry (2005), as an example, to demonstrate how computer based systems can fail when they conflict with the emotions, beliefs and values of stakeholders. This case study referred to an application designed to store information about mistakes and details about the person who was responsible for the mistakes. Users felt so stressed with this feature that it had to be removed.

Applying our elicitation techniques within such systems, could help in

identifying potential concerns and desires related to the way users feel about the system at the very early stages of the development process. This process could hence contribute towards the completeness of the set of requirements, improving the quality of the software and reducing the redesign costs and development time, as project managers and engineers have a clearer picture of what end-users want. Knowing what users want could also help in improving the productivity of the development team as they do not have to guess or imagine what would satisfy the users.

### **10.1.2 Requirements Modelling**

Traditional project scoping exercises capture use cases, user stories and potentially personas as well. However, no further work has been done in terms of explicit modelling of emotions beyond simple words (Miller et al., 2012). Our findings revealed that the emotion-oriented models and personas helped in representing the emotional goals and were used during negotiations with key stakeholders.

Project managers and requirement analysts could potentially use these models, in particular, the goal model, to develop an additional layer to identify how well emotional goals have been captured and to uncover any hidden requirement. For instance, the developers of the SMART project agreed that the goal model represented the key goals of the system and was a useful tool in identifying new goals.

The emotion-informed personas could provide the designers and software developers with a better insight into who the users are and what are their needs. They could engage the empathy of the software development team, thus enabling the development of better quality software which is more in line with the needs of the users. Again, this could contribute towards improving the productivity of the development team and reducing the development time and redevelopment costs.

### **10.1.3 Design and Implementation**

The feedback obtained from the development teams of the SMART and SleepWell projects revealed that even though the personas provided them with a clearer picture of the end-users and their needs, they were insufficient in guiding them throughout the design and implementation processes. Interestingly, in the area of game design, designers are adept at developing games which are meant to be 'fun', 'interactive' and 'engaging'. These designers use design patterns and follow design guidelines to create games (Bjork and Holopainen, 2004). Unfortunately, this wealth of knowledge has not fully permeated in the software engineering field.

The emotion-informed models and personas, presented in this thesis, could be applied and further extended to create a set of design guidelines and heuristics to guide designers in their task. Similarly, a set of software development guidelines or checklist could be created such that developers could potentially be provided with specific guidance to ensure that emotional aspects are considered/implemented.

### **10.1.4 Software Verification and Validation**

Based on our observations during the TouchFrame case study, our proposed emotion-informed questionnaire could be used to validate solutions where emotional goals are important. It is worth noting that emotion being subjective and complex, the proposed tool might not provide adequate information regarding the extent to which emotional goals have been achieved. It is, however, simple to use and provide a quick insight into the extent to which emotional goals have been achieved. Our recommendation is to use this emotional assessment tool along with some other existing qualitative data gathering tool such as interviews.

A key observation at this level revealed a shortage of tools available to help the test teams in assessing the inclusion of emotional goals within the proposed solution prior to user acceptance testing. The assessment tool, presented in this thesis, could be applied and extended to create a

checklist, along with a measurement framework, to verify and validate the proposed solution with respect to emotional goals. That is, software engineers could use this checklist to validate how well emotional goals have been addressed by the solution and test teams can check for these along with traditional usability testing methods.

## **10.2 Benefits to Stakeholders**

When deciding whether to adopt a set of techniques or not, most stakeholders ask the question "what is in it for me?". In this section, we highlight the value that our study and findings bring to different stakeholders. We classify the stakeholders in four categories namely, *end-users*, *project sponsors*, *project managers* and *engineers*.

### **10.2.1 End-Users**

One of the major problems encountered during requirements elicitation is that stakeholders are often unaware of what they want from a system or they find it difficult to articulate their needs. Our observations during the brainstorming sessions, interviews and focus groups showed that the end-users had the flexibility to express their needs in their own words and were using terms *regarding what they did not want* to express *what they actually wanted* from the system. For instance, terms such as "*I don't want to be a burden on others*" were used to describe how they wanted to feel when using the TouchFrame system.

By applying our elicitation techniques during the requirements elicitation process, users could have more control, more choices and more flexibility to decide and propose what they want. As a result, they could benefit from having a product which addresses their functional and *emotional* needs.

Furthermore, early user involvement could result in several benefits including higher chances of the solution being accepted (Kujala, 2003). By involving users and taking into account their emotional expecta-

tions, users could feel a sense of ownership towards the product and feel included in the development process.

### **10.2.2 Project Sponsors**

Project sponsors invest with an intent to recover, or gain from the adoption of the technology. Unfortunately, despite using well established software development methodologies and practices, not all software projects are successful in generating profits and some lead to massive losses (Hassenzahl, 2008, Lorence and Park, 2006, Meuter et al., 2005). Software failure has tremendous implications for the continuity of the organisation and it is important to mitigate the risk of failure (Charette, 2005).

Based on our findings, we argue that if user emotional expectations are included within the different stages of the software development life cycle, the chances could be higher for the software to be adopted by the end-users. Hence, organisations can benefit from a higher success rate and return on investment.

Moreover, by adopting a user centric strategy where users' needs are given high importance, the products developed could drive user engagement. Organisations could thus earn a good reputation as being a provider of a good service or product, who cares for its customers. This could further guarantee continuity within the market, repeat business, customer loyalty, improved credibility and profits.

### **10.2.3 Project Managers**

One of the major responsibilities of project managers is to ensure that the project is delivered within the set deadline and does not exceed its cost. Adding new processes, involving users and capturing a new set of requirements could be very costly and time consuming, especially if deadlines and budget are tight (Abrás et al., 2004). Management may therefore question the importance of this new set of requirements.



Based on our observations, we could argue that by applying our elicitation techniques, the set of requirements generated at the beginning of the project life cycle could be more reflective of what users actually want from the system and hence the end products could have higher chances of being adopted by the end-users. Furthermore, this process could reduce the redesign costs and hence the development time as the key requirements are captured at a very early stage and address the key needs of the users.

Since users are involved from the beginning of the development process, they could feel a sense of ownership and could be more likely to accept and adopt the product. As a direct consequence, this could reduce the amount of reworks required to adapt the product to the needs of the users and could consequently reduce maintenance costs.

#### **10.2.4 Engineers**

Engineers, which includes requirements analysts, designers, software developers and testers, invest a lot of time and effort in developing software products and the impact of a software failure affects them, mainly, in terms of productivity (Linberg, 1999). In most cases, software professionals follow well-defined methodologies and software practices throughout the development process (Pressman, 2015) and yet users refuse to use the product. One of the major problems is linked to the set of requirements, provided to them, which fails to address the needs of the user.

Our observations show that by applying our proposed techniques, in particular the emotion-informed models and personas, software professionals could have a clearer understanding of the users, their needs, what motivates and engages them. The collaboration with the users could enable the engineers to generate more creative design solutions to address the needs of the users, hence potentially improving their productivity and reducing the development time and cost.

By embracing the needs of the user, the chances of the project being

successful could be higher and this could have a direct impact on the motivation of the engineers. It could encourage them to be innovative and inspired (Linberg, 1999).

### **10.3 Technology Adoption Challenges**

According to some researchers, the acceptance and adoption of a technology depend mainly on the technology's benefits, cost and relative advantage over other alternatives as well as the complexity of use (Davis, 1989, Karahanna et al., 1999, Venkatesh, 2000, Venkatesh et al., 2003). Others identify user emotional expectations as a critical determinant for the adoption and acceptance of a technology (Demiris et al., 2004, Miller et al., 2015, Pedell et al., 2013, Ramos et al., 2005). Our findings show that when it comes to adopting and accepting a technology, many factors other than the above mentioned factors come into play, such as the motivation factor, support mechanism and background of the users.

For instance, the SMART system failed to engage many psychosis patients even though the contents of the website were designed to be engaging. The issue lay mainly with the determination of the consumer to come out of their mental health problem. In the case of the TouchFrame application, the idea of being connected to their loved ones rendered the application appealing to most of the older adults leading to its quick adoption. Similarly, during the SleepWell project, most of the participants were desperate to try any technique to come out of their miserable situation and this motivation encouraged them to trial the SleepWell app.

The support mechanism provided to the participants also played a determining role in the adoption and acceptance of the technology. During the TouchFrame case study, we noticed that the support mechanism which consisted of a user manual and phone conversations did not support some of the participants as the user manual was written in English and English was not the first language for many people. On the other hand, the way SMART was promoted and recommended to be used influenced the usage of the program. Given that the men-

tal health workers were using the program during their sessions with the consumers, it inspired a sense of confidence among the consumers rendering the tool to be trustworthy. Similarly, in case of the SleepWell app, participants were keen to use the app given that the contents were prepared by psychologists.

Another finding in some of the case studies reinforced the point that users' technical backgrounds play a critical role in the acceptance of technology. According to the mental health workers, the SMART website was mainly used by consumers who are by nature tech savvy and who rely on the web for most of their solutions. Similar findings were observed during the TouchFrame study.

These above mentioned factors highly influenced the adoption and acceptance of the technology within our case studies. Emotional goals, even though important to the acceptance of the technology, were not the only component that guaranteed the success of the technology and it is therefore important to consider all these factors, given that they are critical to the acceptance of the technology.

## **10.4 Summary**

User emotional expectations are a critical determinant to the success of a project and should, therefore, be integrated within software development processes. Based on our observations, the work presented in this thesis could be applied and further extended to incorporate user emotional goals at different stages of the software development life cycle. Our techniques could contribute towards identifying the key requirements of the system, improving the productivity of team members and enhancing the quality of the software.

Furthermore, our findings show that stakeholders could also stand to gain from our study. In particular, end-users could have a technology which caters for most of their needs, including their emotional needs, while project sponsors could enjoy continuity within the market, repeat business, customer loyalty, improved credibility and profits. Project

managers could benefit in terms of reduced development time and cost. Engineers could have a clearer understanding of what users want and, hence, could generate creative designs which have higher chances of being accepted by the user.

Based on our findings, even though emotional goals are critical to the success of a technology, there are several technology adoption challenges such as motivation and user's background. Given their importance with regards to the acceptance and adoption of the technology, we recommend that these factors should be considered along with the users' emotional goals when designing a system.

# Chapter 11

## Conclusions

User emotional expectation is a critical determinant for the acceptance of technology, however, there has been little research into incorporating user emotional expectations within the software development life cycle. In our study, we addressed this existing gap by proposing methods to capture, model and evaluate user emotional expectations. These methods were trialled within three real life case studies to assess their validity.

### 11.1 Contributions

The key contributions of this research:

- We investigated the need to represent user emotional goals **as a separate category of goals under non-functional goals**. As described in Chapter 4, emotional goals are non-functional goals which describes the users' feelings, perceptions and emotions generated from their experience with the technology. However, emotional goals do not relate to any of the existing taxonomies of non-functional requirements. Given the importance of user emotional goals with regard to the acceptance of a technology, these goals cannot be ignored and have to be represented within the requirements documents. Hence, we recommend that a new set of goals

be created under the taxonomies of the non-functional requirements to represent user emotional expectations.

- We presented **two new methods to elicit user emotional goals** along with functional and quality goals at the early stages of the software development life cycle. These methods have been used within our case studies to identify key functional, quality and emotional goals. Our experience and analysis showed that these techniques were successful in eliciting key user requirements and, given their lightweight nature, could be applied to other domains where user emotional goals are of paramount importance.
- We extended **a set of emotion-informed agent oriented models** at different levels of the viewpoint framework. These models, especially the goal model, have proved to be a helpful tool during discussions with different stakeholders. Even though we provide a list of models, software professionals have the flexibility to choose the models that best suit their situation and they can further adapt them to suit their needs.
- We presented **a technique to generate emotion-informed personas**. These personas were designed in an attempt to bridge the gap between the requirements phase and the design phase. Our analysis showed that these personas were helpful to convey the key emotional goals to the designers.
- We provided **a validation tool to assess the extent to which user emotional goals were addressed by the technology**. This tool, namely the questionnaire, was designed after several iterations and the final version proved to be a successful emotion assessment tool. However, given that this tool assesses emotional goals only from the user's perspective, it is highly recommended that this tool is accompanied by other well established evaluation tools.
- We **applied our emotion-oriented techniques to real world case studies** in different domains, namely, health care and technologies for the elderly.

- We contributed ***techniques to capture, model and evaluate user emotional expectations, which could further be enhanced or adapted to cater for different situations.***

## **11.2 Emotional Goal as a First-Class Citizen**

Throughout this thesis, we have argued about the need to consider emotional goals within the software development life cycle. We also argued that user emotions, a key determinant for the success of a technology, should be given equal importance as functional goals. Given their importance, emotional goals could have been represented as a third class of goals, separate from functional and quality goals. In Chapter 4, we talked about how in the area of game design, Marshall (2012) created a third class of goal, namely, emotional goals, to represent users' emotional expectations given that emotional goals such as "having fun" fit neither under functional nor quality goals. In the same chapter, we later mentioned that even though emotional goals are crucial to the success of a technology, they cannot be specified as software requirements, given their abstract and subjective nature. Emotional goals cannot be implemented directly as they relate to the property of the user but the system can be designed to support these goals. Additionally, there is no way to measure emotional goals other than asking the users directly about how they feel when they use the system. However, even though emotional goals cannot be specified as software requirements, they cannot be ignored.

Given that emotional goals relate to users' feelings, perceptions and emotions generated from their experience with the technology, we categorise emotional goals under non-functional goals but argue that emotional goals are not quality goals and they should be treated as a first-class citizen within the software engineering methodology.

## **11.3 Limitations of our Research and Future Work**

In this section, we highlight the limitations of our study and present some possibilities for future research in the area of user emotional goals to overcome these limitations.

### **11.3.1 Eliciting Emotional Goals in other Domains**

We proposed two elicitation methods which can be used under two circumstances, namely with and without stakeholders' involvement. These methods have been applied and refined during the execution of the three case studies. Our analysis and experience showed that these methods have successfully identified key emotional goals.

However, it is important to note that these case studies involved users who had a specific need and correspond to a particular group. For instance, elderly people, people having sleep difficulties and people suffering from psychosis. Also, emotional goals were of paramount importance within these case studies.

A question that arises is whether these techniques will generate similar results if applied to the development of generic software whereby the users come from a vast background. Also, it would be interesting to see whether these techniques will be adopted within the existing software development life cycle of such systems.

### **11.3.2 Bridging the Gap between the Requirements and the Design phases of Software Development**

In our study, we focused on identifying user emotional goals and representing them through agent-oriented models. During our study, we interacted with software professionals at different stages of the software development life cycle and one of the main concerns of these professionals was with regard to the representation of emotional goals through



the design and implementation phases. How do we map the emotional goals to the design phase? Even though the emotion-informed personas enhanced the designers' understanding of what users want from the system, they are still inadequate as a formal method. Bridging the gap between the requirements and the design phases is an area of future work which we intend to explore. We seek to conduct experiments to verify if it is possible to apply the game design process to incorporate user emotional goals within the design phase. We also intend to explore the possibility of creating a set of heuristics as a design guideline.

### **11.3.3 Validating Emotional Goals**

A key shortcoming in our research was to find a validation tool to validate the extent to which user emotional goals were addressed by the software. Even though we proposed an emotion-informed validation tool during our study, we recommend that the data captured from this tool has to be backed by other validation tools. This is an area which requires further investigation. The validation tool requires further testing and potentially refinement.

Additionally, during our study, we were often confronted with the question "How can we validate that our software does include the identified emotional goal?". When designing and implementing software, software professionals have a set of well established processes that they generally follow. Given that emotional goal is a new concept to these software professionals, they are sceptical about including this concept within their well established processes, especially since the process of incorporating emotional goals has not been formalised at every stages of the software development life cycle, in particular the implementation and testing phases.

Another future work that we intend to explore is to find an emotion-informed validation technique from the developer's perspective. One avenue of research which could be investigated is the validation of the system against a set of heuristics.

## **11.4 Concluding Remarks**

Software engineering literature provides us with a set of well established techniques and methods on how to develop software. However, even though software professionals follow these techniques and methods, statistics show that many systems fail. One of the major reasons for this failure is because user emotional expectations have been ignored or given little consideration. The findings from our research show that user emotional expectations are a critical determinant to the success of a technology. By providing techniques to capture, model and validate emotional goals, this thesis contributes towards bridging this gap and promotes further research in this area.

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# Appendix A

## Supporting Documents for Case Study 1: TouchFrame

The supporting documents for the motivating case study TouchFrame, referred to in Chapter 5, are described in Table A.1, and located in the directory `1TouchFrame/SupportingDocuments` on the CD.

The data collected from each participant during the pilot study are located in the directory `1TouchFrame/PilotStudyData`. This dataset consists of a set of transcribed interviews conducted during the setup of the prototype and after the trial of the prototype. The directory also contains the file `PilotStudyQuestionnaires` which includes the questionnaires filled by the participants of the pilot study.

The data collected from the participants during the main study are located in different folders within the directory `1TouchFrame/MainStudyData`. Each folder consists of a set of transcribed interviews and/or audio versions of the interviews conducted during the setup of the prototype and after the trial of the prototype, along with any interactions that took place between the researchers and the participants throughout the duration of the project. The directory also contains the files `Questionnaires` and `NikoNikoCalendars` which contain the questionnaires and Niko Niko calendars filled in by the participants of the main study.

<b>File Name</b>	<b>Description</b>
00EthicsAmendment.pdf	Contains details about the ethics application and the amendments made to include new project personnel
01Ethics.pdf	Email approving the modifications requested on the ethics application.
02CallForParticipants.pdf	The statement used to advertise for participants.
03PIS.pdf	Contains the project information statement
04ConsentForm.pdf	The consent form provided to participants of the TouchFrame case study
05Interview.pdf	Contains a complete set of interview questions used during different stages of the trial with both the older adults and their relatives
06QuestionnaireOP.pdf	Contains the questionnaire given to the older adults following the trial of TouchFrame
07QuestionnaireRelative.pdf	Contains the questionnaire given to the older adults' relatives following the trial of TouchFrame
08HelpManual.pdf	Contains the help manual provided to the older adults during the trial of TouchFrame

**Table A.1:** Supporting Documents for TouchFrame



## **Appendix B**

# **Ethics Approval for Smart Home Technology project**

The ethics approval document and a set of preliminary questionnaires obtained from the participants of the Smart Home Technology project, referred to in Chapter 7, are located in the folder `SmartHomeTechnologies` on the CD.

## **Appendix C**

### **Supporting Documents for Case Study 2: SMART**

The supporting documents for the case study SMART, referred to in Chapter 8, are described in Table C.1, and located in the folder 2<sup>SMART</sup> on the CD.

<b>File Name</b>	<b>Description</b>
00SMARTEthics.pdf	Email approving the modifications requested on the ethics application.
01RequirementsAnalysis	Describes the research process applied to analyse the first set of requirements provided to us by the SMART team of researchers. It also provides a complete analysis of the set of requirements
02SMARTFocusQuestion.pdf	Contains the list of questions used during the focus group sessions
03ContentAnalysisResults.xlsx	Provides a list of functional, quality and emotional goals identified from the transcribed notes obtained from the focus group sessions
04SMARTInteractionModel.pdf	Contains a complete set of interaction models provided to the development team of the SMART website
05EGInDesign.pdf	Describes how each emotional goal identified during the early stages of the project were addressed through the different features of the SMART website
06PostInterviewMHWorker.pdf	Contains the post usage feedback obtained from mental health worker
07SMARTGoalModel.png	Contains the goal model for the SMART website

**Table C.1:** Supporting Documents for SMART

The data collected from each focus group is available in the directory 2SMART/FocusGroupData. This dataset consists of a set of transcribed notes collected during the focus group sessions held in the early stages of the project with the mental health workers and patients suffering from psychosis.

## **Appendix D**

# **Supporting Documents for Case Study 3: SleepWell**

A complete set of the emotion-informed personas for the SleepWell case study, referred to in Chapter 9, are described in Section D.1. The supporting documents for the case study SleepWell, referred to in Chapter 9, are described in Table D.1, and located in the folder `3SleepWell` on the CD.

The interview data collected from each participant is available in the directory `3SleepWell/FocusGroupData`. This dataset consists of a set of audio files recorded during the interview sessions held prior to the trial.

### **D.1 Emotion-Informed Personas**

In this subsection we present four emotion-informed personas which were designed by me with an attempt to help the system designers better understand the user's emotional expectations related to the SleepWell app.

These personas were generated based on the description of the potential users of the SleepWell app. The process that was used to come up with these personas has already been described in Section 6.4.

### **D.1.1 Persona 1: Kyle**

Kyle has recently joined a Bachelors degree in Computer Science at a prestigious Australian University. He spends a lot of his free time playing video games, computer games and cell phone games. He enjoys connecting with his friends through Facebook and is always using his mobile phone to be in touch with them. However, Kyle is anxious regarding his studies and as the semester is coming to an end, he finds it hard to sleep at night given the number of assignments he has to submit within a tight deadline. Kyle wants to have a good sleep at night such that when he wakes up in the morning he feels fresh and relaxed.

### **D.1.2 Persona 2: Betty**

Betty is an accountant who has recently started working with a big company. Due to work pressure, Betty is always stressed and has trouble sleeping at night. Whenever she wakes up during the night, she reaches for her phone to check her work mails. This lack of sleep makes Betty feel tired and sleepy throughout the day. It is very hard for her to concentrate in her work. She wants to feel more calm and relaxed and enjoy a good night's sleep.

### **D.1.3 Persona 3: Matt**

Matt was forced to leave his job last year as his company was making losses. Even though Matt is 60 years old, he had not planned to retire for another 5 years. Finding himself without a job and being idle most of the time resulted into Matt waking up several times during the night. As the problem persisted over several months, Matt's wife forced him to see a psychologist. Being a stubborn man, Matt refused to follow the guidance from the psychologist and started to explore ways of treating himself on the internet on his mobile phone. He came across some breathing and relaxation exercises which he decided to try. The exercises make him feel relaxed and allow him to sleep better.

### **D.1.4 Persona 4: Rita**

Rita is a stay at home mum. She has three young children under the age of four and they keep her very busy all the time. Even after a very tiring day looking after the kids and taking care of the household chores, Rita finds it hard to sleep throughout the night. She is always stressed

about how to manage the kids and the house, and start planning the following day. The lack of sleep makes Rita feel very tired and she is always shouting at her kids. There is always a lot of tension around the house and Rita realises that it is mainly because she cannot relax. Rita wants to try out some simple techniques to fall asleep and enjoy a good night sleep.

<b>File Name</b>	<b>Description</b>
00EthicsModification.pdf	Contains details about the ethics application and the amendments made to include new project personnel.
01SleepWellEthics.pdf	Email approving the modifications requested on the ethics application
02SMARTFocusQuestion.pdf	Contains the list of questions used during the focus group sessions
03ContentInformationStatement.pdf	Provides information about the project and the trial, highlighting the commitment required from the participants and any risks associated with the project
04ConsentForm.pdf	The consent form provided to the participants of the SleepWell project
05InterviewQuestions.pdf	Provides a complete set of interview questions used during the interview sessions
06InsomniaQuestionnaire.pdf	The insomnia questionnaire provided to users at the beginning of the trial

**Table D.1:** Supporting Documents for SleepWell