Motivational Modelling in Software for Homelessness: Lessons from an Industrial Study

Rachel Burrows*‡, Antonio A. Lopez-Lorca†, Leon Sterling‡§, Tim Miller‡ Antonette Mendoza‡ and Sonja Pedell§
*PsyLab Ltd, Cambridge Science Park, UK
Email: rburrows@psylab.co.uk
†Semantic Web Company, Vienna, Austria
Email: alexi.lopez-lorca@semantic-web.com
‡ School of Computing and Information Systems, University of Melbourne, Australia
Email: tmiller,mendozaa@unimelb.edu.au
§ School of Design, Swinburne University of Technology, Australia
Email: lsterling,spedell@swin.edu.au

***Abstract*—Requirements engineering involves the elicitation, representation and communication of diverse stakeholder needs. However, this can be particularly challenging when developing technology embedded within complex social systems. So-called socially-oriented requirements can be abstract, ambiguous and driven by the organisational, cultural and political contexts of the stakeholders involved. Motivational models are one solution which supports project-wide understanding of the key goals of stakeholders. Yet, there is still a lack of understanding about the role they can play in larger industrial projects. We present our use of motivational modelling in an Australia-wide project that develops new technology to assist people who are homeless in accessing service providers. We interviewed 100 stakeholders and utilised motivational models to advocate for the needs of key stakeholder groups. We discuss the benefits, challenges and lessons learned.**

I. Introduction

The socio-technical gap has been described as "the divide between what we know we must support socially and what we can support technically" [1]. In fact, software is often rejected if it does not address the socially-oriented requirements of stakeholders [2], [3], [4]. These requirements pose challenges as they are often abstract, ambiguous and difficult to translate into design. For instance, such requirements may relate to organisational, cultural or political contexts of the socio-technical system they are designed for.

Consequently, requirements engineers often create shared artifacts that can be used to help communicate the goals, desires and needs of software users. In industry, the fast pace of software projects and constrained resources can result in teams opting for lightweight requirements engineering artifacts [5], [6], [7], [8]. Such artifacts include use cases, personas and scenarios. However, these alone are still not sufficient when designing for technology embedded within complex social situations [4]. For this reason, recent research now specifically focuses on incorporating the social and emotional goals of the users [9], [10], [11], [12].

Motivational Modelling is an approach that aims to support teams address socially-oriented goals [13], [14], [15]. It is an emotion-led approach as, uniquely, it represents emotional goals alongside the functional and quality goals of a system. Existing work has reported how information about emotional experiences is useful to discover and define requirements [9], [10], [11], [16]. Unfortunately, there is a lack of understanding about the role of motivational models in larger industrial projects.

In this paper we report our use of motivational modelling to help develop a system called Ask Izzy. Ask Izzy aims to assist homeless Australians find information about the services that they need. It was launched in 2016 and is currently attracting over 10,000 users each month who are seeking help. Examples of services the homeless need are food, housing, legal advice, and counselling. As part of the requirements engineering, we interviewed 100 stakeholders who were government service providers, charities, and those who were homeless or ex-homeless. Information from these interviews was used to construct and evolve the motivational model during all phases of the software development process.

Consequently, the research objective is: *'What is the role of motivational models in socially-oriented requirements engineering?'*.

This experience report contributes to the literature in three ways. Firstly, we demonstrate how motivational models contribute to requirements activities in an industrial project. Secondly, we reflect on our experience using motivational models and describe the key lessons learned. More specifically, we describe how motivational models are able to assist teams to (i) maintain project-level awareness, (ii) navigate ambiguity and (iii) support conversations and sensemaking amongst the software development team. Finally, the analysis provides insights into the needs of a unique and poorly understood user group: those experiencing homelessness. We believe that this research may be useful for others who need to incorporate socially-oriented requirements into the design of software. It is also useful to those developing systems with diverse stakeholders or vulnerable users.

The remainder of this paper is structured as follows. We

outline relevant literature on socially-oriented requirements, shared artifacts and motivational modelling. We then describe our project and approach to incorporating motivational models in our requirements activities. Results present a representative sample of shared artifacts and an overview of their impact on requirements elicitation and evaluation. We reflect on lessons learned from the past four years of this project. We finally conclude.

II. Background

A. Socially-Oriented Requirements

Socially-oriented requirements [12], [17], [18], [19], [20], [21] often relate to the organisational, cultural and political needs that are difficult to capture, understand and address in a final design. In fact, they are frequently reported as a cause of software failure [2], [3], [4].

Despite the importance of these goals, many software teams still struggle to successfully support them in their software design. This is partly because it is not always common nature for engineers to prioritise these requirements, or even discuss 'soft' goals with stakeholders in the first place [22], [23]. The inherent ambiguity of socially-oriented requirements can pose a risk as there is often great uncertainty about how to address them [22], [24]. Paay et. al. [22] argue that ambiguity is an inherent property of many non-functional goals and unavoidable in socially-oriented requirements. While there is a recognition that ambiguity plays an important role in the requirements process, there is currently no consensus about how we deal with them and ensure they are given suitable attention [15], [22], [23], [24].

The challenge of addressing socially-oriented requirements becomes greater with increasing numbers of stakeholders [23]. Existing work has investigated the use of shared artifacts for improving the communication and collaboration between people within a software project [22], [23]. Yet, it is also necessary to maintain this communication amongst stakeholders who often contribute significantly to design. Diversity of input from stakeholders is beneficial. However, greater diversity in viewpoints causes an increased likelihood of disagreement. Subsequently it makes it difficult to agree upon goals and to negotiate a solution. As a result, existing work now argues that increased efforts are necessary to maintain a shared understanding [25], [23].

B. Shared Artifacts

There are a variety of artifacts that have been created to improve our ability to capture requirements and incorporate them into design. The use of shared artifacts (or boundary objects) are frequently used in product development where knowledge from design also needs to be translated into development of requirements [23], [21].

Effective shared artifacts have some key features that make them useful for joint problem solving. Firstly they establish a shared syntax or language for individuals to represent their knowledge. Secondly, they provide a concrete means for individuals to specify and learn about their differences and dependencies across a given boundary. Most importantly, they must facilitate a process of sensemaking where individuals can jointly transform their knowledge. In other words, people on the project must be able to manipulate and evolve the shared artifact [26]. Shared artifacts are appropriate to use when designing software to solve societal challenges. Maiden [27] explains how shared artifacts are a tool for creativity, and therefore need to be assessed in terms of their effectiveness for solution finding in realistic settings. In fact, a recent article explains how new competencies for technology development are needed. Often, problems are not "given" but rather "emerge from an interwoven process of problem solving and problem framing that requires a special way of thinking" [28].

Lightweight shared artifacts [5], [6], [7], [8] are favoured in industry settings as projects are always resource constrained. The variety of available modelling techniques are still under utilised in industry because they are seen as high cost in terms of time and resources. It is often unclear how the techniques will be used pragmatically, by whom, how, and when [29].

Recently, there has been an increasing body of work that uses information about the emotional goals of stakeholders to inform the design of software, because people will reject software if it does not appeal to their emotional needs [30], [31], [16], [20], [9], [10], [32]. Emotional goals reflect the way usrs wish to feel as a consequence of using the technology in question. For instance, users may wish to feel in control, connected, hopeful, cared for, or empowered [9], [20], [33].

Numerous papers have argued why emotional goals are distinct and need to be treated differently to other non-functional goals. Miller et al. [15] argue that they are a property of a person and not the software; making them different to traditional non-functional requirements. They are also inherently ambiguous, subjective and difficult to translate into actionable requirements. Emotion-led requirements engineering approaches therefore recognise and address these differences in their models and processes. Due to the sensitive nature of our application domain — support for homeless people in Australia — we used an emotion-led approach in the requirements engineering process.

C. Motivational Modelling

Motivational modelling [13], [14], [15] is a lightweight emotion-led modelling approach for socio-technical systems. It has been successfully used in a number of projects including technology for healthcare, and more recently in teaching requirements engineering [34]. It shares similarities with other lightweight modelling artifacts as it comprises a hierarchical model of the goals and roles of a system to help progress towards system design. Differently from other goal modelling methods, it distinguishes emotional goals from quality and functional goals.

The core elements of motivational models are shown in Figure 1. The stakeholder (or "role") shape represents any individual or organisation that is involved in the socio-technical system. The functional goals are represented by a parallelogram, quality goals are represented by a cloud. These

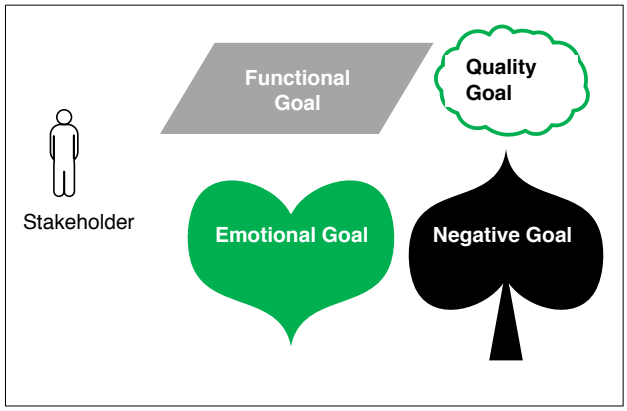

Fig. 1: Elements of the Motivational Model

two goals correspond to the traditional functional and quality requirements as widely used in existing modelling languages. Emotional goals are represented by a green heart and provide information about how a stakeholder would like to feel. The black spade is a negative goal and represents a concern or emotional pain point of a stakeholder, and is an optional addition to the basic set of elements as described in [15].

III. Our Project

In this section we describe our motivation, project brief and the overarching requirements engineering process, including how we incorporated motivational modelling into the existing practices.

A. The Problem

The objective of the project was to create a web-based system that would help people who are homeless or at risk of becoming homeless find help that they needed. The system would contain information on over 350,000 services that were available across Australia. The aim was to provide a range of support from help with health issues, food, shelter through to legal and financial advice.

According to the Australian Bureau of Statistics [35], the number of people experiencing homelessness is up 14% in the last five years. The development of new technical solutions has great potential to improve access to service providers. Despite these potential benefits, any solution needs to take into account the complex social requirements that exist.

The Australian Bureau of Statistics defines homelessness [35] as,

...in a dwelling that is inadequate; or has no tenure, or if their initial tenure is short and not extendable; or does not allow them to have control of, and access to space for social relations.

There is uncertainty about the capability of technical solutions to mitigate complex societal problems. In our project, this uncertainty arises from those who are homeless, their care workers or government service providers and even technology developers themselves. For instance, work by Hersberger [36] explains how those who are homeless are probably already overwhelmed by information provided by services, and would not have the connectivity to access information online. Additionally, service providers often resist making their service information public as they believe face-to-face communication is the easiest way to be in control of personalised advice [37], [36]. If requirements engineers fail to account these social complexities there is a chance of unintended consequences after deployment [38], [39]. As prior work in this area has already identified a number of important socially-oriented requirements, it was appropriate to adopt motivational modelling in our project.

B. Double Diamond Process

Our software development approach is based on the double diamond process [40]. We adapt this process to our purposes and illustrate key parts in Figure 2. The double diamond model was initially created by the British Council as a tool to facilitate product development and has been adapted for software development processes [41].

There are four phases: Discover, Define, Develop and Deliver as shown in Figure 2. The first diamond on the left represents activities or research that work towards understanding the problem domain. The discover phase represents the beginning of the software development process where the stakeholders and their goals are gathered. This is a divergent activity as new information and knowledge is created. This unstructured data and information is then used as input to the motivational model. The define phase scopes this information. This phase is convergent as information is synthesised to organise the key system objectives and user goals that will be pursued.

The second diamond represents activities that create a solution. The develop phase utilises outputs from the define phase. This is a divergent activity as new ideas and solutions are being generated. The develop phase also involves building and testing prototypes. Feedback is often used to evolve the motivational model. Finally, the deliver phase represents convergent activities leading to the final stage of software development where a solution is completed.

Movement through these phases is cyclical in that new information that is acquired at one phase may cause the development process to return back to previous phases. The separation between divergent and convergent activities is beneficial as it prevents constraining the creative or lateral thinking that is important to allow novel ideas to emerge.

1) Constructing the Motivational Model: In our project a motivational model was created during the initial phases as it was critical to address the socially-oriented requirements in the system design. The model was also used during the evaluation of the system to see if needs were effectively met.

Two main activities are required to create a motivational model. The first was to elicit information about the stakeholders and their goals as detailed in the next section III-B2. The second activity is to construct the model. Detailed guides on the model building activities can be found in other work [15], [34] and we provide an overview of this activity in this section.

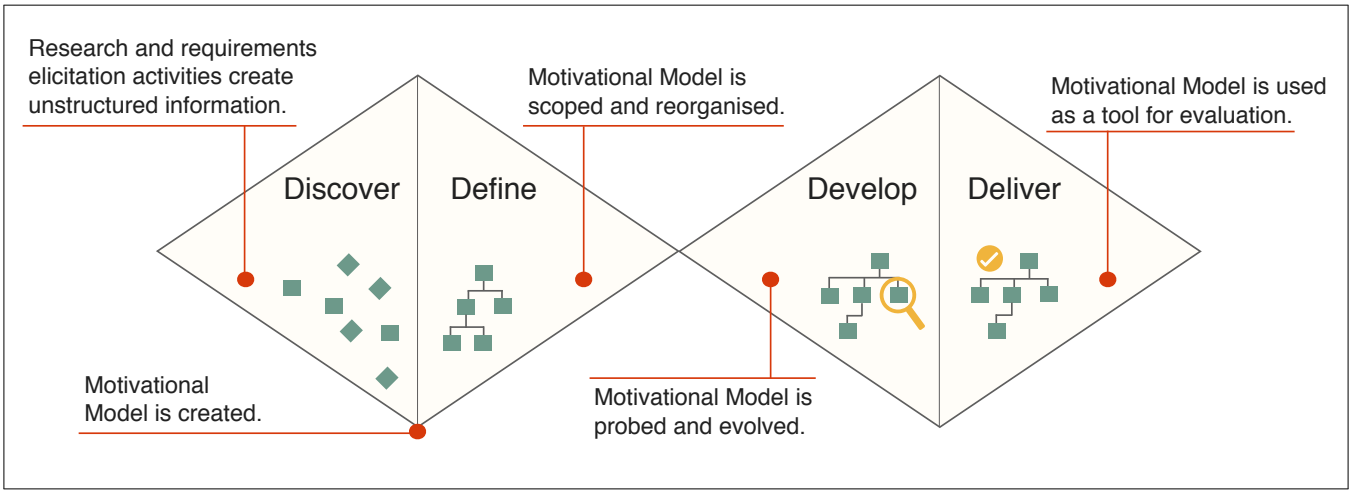

Fig. 2: The Double Diamond Process

The model construction is an iterative activity where the project team work together with the requirement engineers to make sense and bring structure project goals. In our case, the contributions to the model came from those conducting the interviews and those team members who read the transcripts. It is important to realise that many additional people working on the project had valuable experiences and understanding about the socio-technical system and consequently were able to advise and give feedback during the construction process. In our experience, the process is just as important as the finished project to bring a project-level understanding.

During model construction, the requirements engineer works alongside the team to (i) Review the data collected from elicitation activity (see section III-B2) (ii) Cluster related elements together (iii) Establish a hierarchy of functional goals (iv) Portray quality goals, emotional goals, negative goals, and stakeholder roles, and (v) Review the model with the stakeholder representatives. Model construction is comparable to a traditional brainstorming activity. The process of building the motivational model itself is intended to be a collaborative activity to improve the understanding of the problem domain. In future phases, the motivational model is scoped in the *define* phase, and evolved and evaluated during subsequent phases of development.

2) Interviews for Initial Elicitation and Evaluation: The key objectives of the requirements elicitation and evaluation interviews were to understand what would lead to or prevent long-term engagement with Ask Izzy. This required a qualitative understanding of individual experiences, perceptions towards specific design features, as well as understanding how Ask Izzy could be supported and promoted by service providers.

Table 1 outlines the participant groups that were interviewed and the number of participants within each group. Participants included those who were homeless, ex-homeless, service providers, and a representative from the software company. In all cases, we conducted a series of semi-structured, one-hour interviews. We took care to ensure the recruitment procedures and interview locations were appropriate; participants were recruited via existing service providers who were also able to provide a familiar environment for the discussion to take place. Some interviews were individual, other times it was a group-based session with people who were homeless alongside their case workers.

TABLE I: Interview Participants

Participant Group	Elicitation	Evaluation
Homeless and Ex-Homeless	30	14
Service Providers	40	15
Software Owner	0	1

Requirements elicitation interviews were conducted in the discover phase; information captured during ethnography activities, interviews, and workshops is sufficient here to build a motivational model. In our case, we conducted 70 semi-structured interviews in order to gain an understanding about the technology needs of potential users. Questions varied according to the participant. For instance, for those who had experienced homelessness we aimed to gain insights into their needs and help-seeking behaviour. For those who were service providers we were able to gain an understanding about what they perceived as the most beneficial way to help people who are homeless.

Requirements evaluation interviews were conducted 6 months after the system was deployed. Information from these interviews allowed us to evaluate the impact of the built system and reflect on the effectiveness of using motivational modelling to inform requirements. We asked what they liked, disliked, and what they would change in the system. We also asked how using Ask Izzy made them feel. We discussed interactions and experiences outside of the application including

TABLE II: Overview of the Motivational Model

Item	Count
Functional Goals	107
Emotional Goals	68
Negative Goals	47
Roles	9

how they heard about Ask Izzy and if they had recommended it or supported others in using it. We also asked what they thought were the barriers to uptake. If they chose not to use or support Ask Izzy, we asked for the reason. The two people conducting the evaluation interviews were different from those conducting the elicitation interviews. The transcripts were analysed by two authors following a thematic data analysis process [42] and then results were compared to the original motivational model. Existing work using the evaluation data has been published recently [43], [44]; this work discusses the system design and contrasts perspectives of stakeholders. Differently, this paper is about how motivational models were used alongside a variety of additional shared artifacts.

Anonymous usage data was also collected over a period of two years after the system was deployed; the purpose was to complement the qualitative interviews and monitor seasonal trends. Four time windows were selected in order to capture data that was representative of the normal use while spanning enough time to account for seasonal variations (e.g. increase in demand for services occurs over the New Year, which is also the Australian Summer). A key concern for this system was that the people would cease to continue to use it in the long term and this may reduce the awareness and momentum of use. For both these reasons it was important to track longer-term seasonal trends. User engagement data was collected over a period of two years. Version 1 data collection spanned May 2016 - April 2017; and is sampled in Time Windows 1 and 2 in Figure 8. Version 2 data collection spanned May 2017 to April 2018 and is sampled in Time Window 2 and 3 in Figure 8. We measure user engagement over the 12 months of Version 1 and compare with the 12 months of Version 2.

IV. Results

In this section, we present a range of illustrative examples to show the motivational model itself and other related artifacts that were used in our project. We then give an overview of the final system that was deployed and key requirements decisions.

A. Summary of Motivational Models

Overall, the motivational model contained over 200 goals, as outlined in Table II. The negative, emotional and quality goals are not all unique as some are duplicated across multiple functional goals; that is, the same emotional goal can be associated with multiple functional goals in different contexts.

An extract of the motivational model can be seen in Figure 4. The top-level functional goal was *Find Services*, as this is the goal for all users coming into the system. From here, every other goal contributes to fulfilling this service.

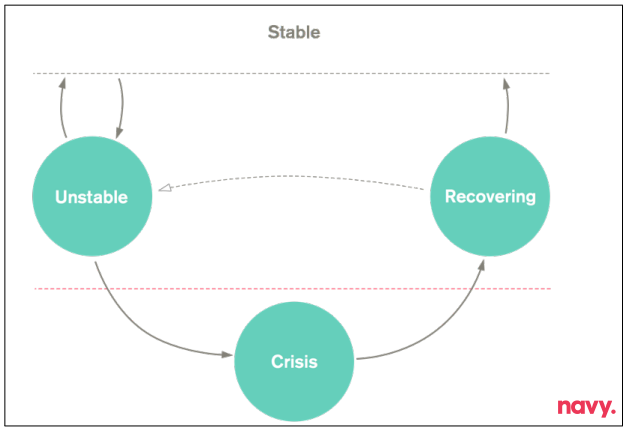

Fig. 3: Design artifact explaining different situation states. Created by project designers (Navy Design)

In total, nine roles that would interact with the application from some perspective were identified: peak bodies, families, carers, case workers, government, homeless person, person at risk of homelessness, service providers, and sector workers.

The evaluation interviews revealed a number of themes that represented aspects of design that were important to consider. These themes were: *Empowerment and Control*, *Assurance*, *Cared For*, *Identity and Belonging*, *Clarity*, *Unashamed / Without Stigma and Hopeful*. We were able to map the themes back to the original goal model to gain insights on which goals impacted user perceptions. This was a practical approach to gain insights into salient positive and negative aspects of the system from the perspective of multiple stakeholders. We were also able to see how individual goals were interpreted by different user segments. For instance, version 1 of the system did not appeal to Aboriginal and Torres Strait Islander communities as it reminded them of traditional government websites causing them to loose trust in the information contained. Additionally, they also said that it lacked colour and cultural representations, without these they did not feel that the system had been created with their needs in mind. It can be seen that these comments were related to a goal labelled *Lack of Belonging* in Figure 4. Consequently, subsequent iterations of the website contained a number of cultural representations and language changes that were co-created with this user segment (as detailed in section IV-D).

B. Selection of shared artifacts

We analysed information collected from the interviews and followed the process of constructing the motivational model. Due to space limitations it is not possible to present all the shared artifacts that we used in the project, but we present a selection to illustrate their use.

Figure 3 shows a model created by the project design team, illustrating the different situation states that people can be in and transition between. Most people are in a stable state and

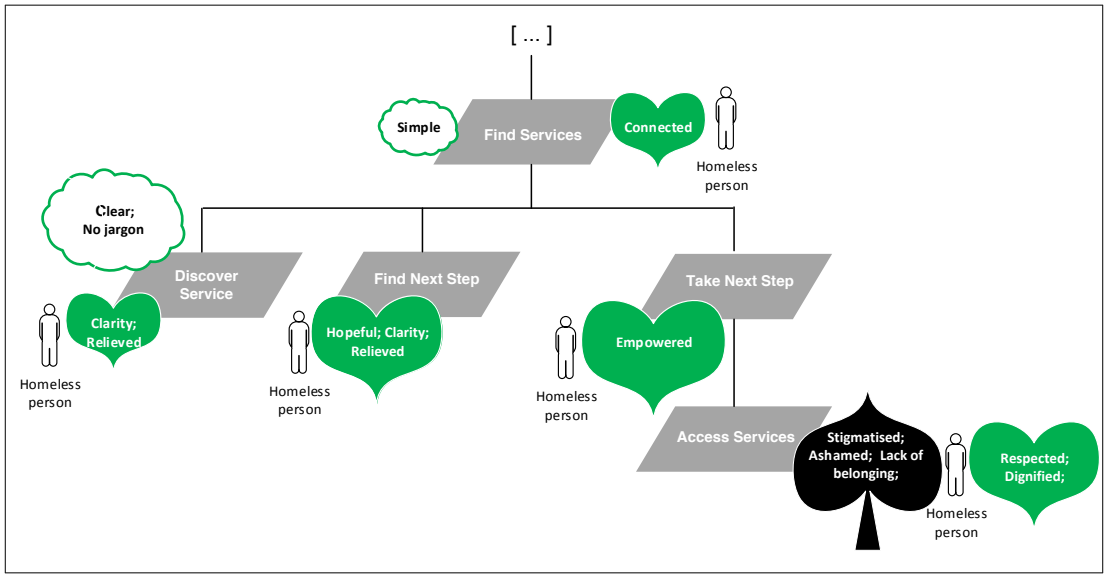

Fig. 4: Extract of the Motivational Model

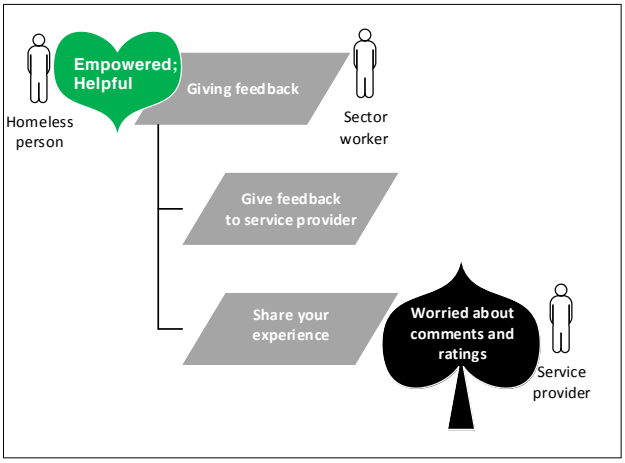

Fig. 5: Extract of the Motivational Model

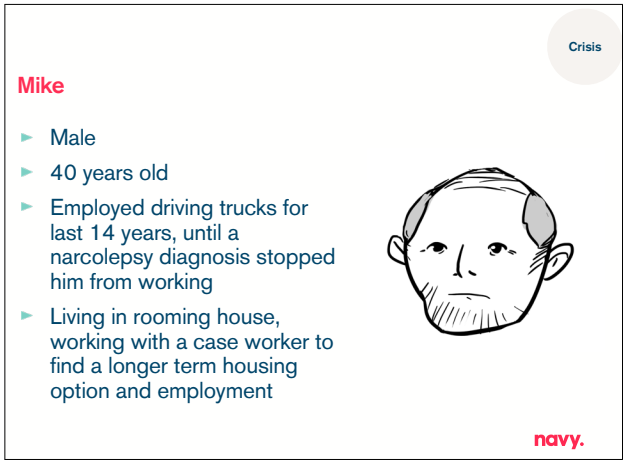

Fig. 6: Example Persona created by Navy Design

do not need access to services, however, their situation can quickly become unstable; for example, kicked out of home by parents and sleeping on a friend's couch. From here, crisis situations can occur, which is the most typical stereotype of homeless people — sleeping on the street or in a rooming house, unable to find employment. Importantly though, once people are set up with longer-term housing and employment, they are in a recover state, in which their likelihood of transitioning back to unstable is much higher than when they are stable. Understanding the diverse set of needs required for each type of situation was important in the Ask Izzy design; for example, people in crisis often need to address much more immediate concerns, such as access to meals and short-term housing, while those recovering are looking for longer-term options to improve their well-being and get back to stability.

Figure 4 is a partial view of the motivational model. It represents the key goals of an important capability of the system. The top functional goal is *Find Services*. This goal is comprised of three sub-functional goals: *Discover Service*, *Find Next Step* and *Take Next Step*. If we consider the quality goals (clouds), it is possible to see that the system needs to be *Simple* as those experiencing homelessness will frequently fluctuate between situations where they are recovering through to overwhelming situations where they are in crisis (as represented in Figure 3). In moments of crisis it is difficult to interpret complex information. In particular, participants explained that the information presented when *Discovering Services* needed to be *Clear* with *No Jargon*. In this example there are 9 emotional goals that are placed next to their associated functional goal. For instance, we can see that the functional goal of *Find Services* needs to allow users to feel *Connected* during this activity.

Figure 5 shows a separate extract of the same motivational model. In this case, discussions with several stakeholders

showed that there was a desire for homeless persons and sector workers to be able to provide feedback to service providers, but also importantly to be able to share experiences with other people looking for services. Much of this feedback is already shared by word of mouth, but this can only go so far. However, the model also demonstrates the apprehension that services providers have about such ratings, which could be used to e.g. cut their funding, which is already stretched.

Finally, Figure 6 shows a *persona*: a hypothetical archetype of an actual user that helps to drive decision-making in systems [45]. Providing 'stand ins' for real users create a rich, but realistic view of potential users, and triggers people to empathise with the persona, helping to avoid the situation in which designers base design decisions on people similar to themselves.

C. The Final System

The motivational model was constructed and subsequently used to guide the design of the final system. In this section we provide an overview of the key capabilities. The final system developed, called *Ask Izzy*, is a mobile web app and is currently attracting over 10,000 users each month. Figure 7 illustrates the two screenshots that provide the capability to search for help. A typical use of Ask Izzy involves starting at the *browse/search page* shown in the left screenshot in Figure 7. A user is presented with 16 *help categories*. Examples of the categories are Housing, Food and Money Help. The user can choose to give their location and is guided through a series of *category-specific questions*. Based on these answers, the user is presented with a *service list* compiled via a *service filter process* detailing results of services that match their criteria, and potentially ordered by relevance. A user can select a particular service and view its *detailed service page* as shown in Figure 7 on the right. The *detailed service page* displays information about how to connect with the particular service, how to get there, who it is for and what clients should expect.

D. A Sample of Requirements Decisions

Shortly after the initial deployment a new objective was to further improve the support for emotional goals and improve support for user segments that had lower engagement levels. The user segments were those identifying as Aboriginal and Torres Stait Islanders, and, those who were a victim of domestic violence. A selection of design decisions were made solely for the purpose of addressing socially-oriented requirements. In this section we describe a sample of these design choices. For further information we refer the reader to existing reports online ([46]). Figure 7 present two screenshots of the system after the changes had been implemented. The list of changes is as follows:

- Cultural Representations:
  - Displaying the flag of Aboriginal and Torres Strait Islander communities in a more prominent position.
  - Co-creation of Aboriginal artwork in the page header.
- Focus on Safety Features, especially for cases of domestic violence:
  - An 'Exit' button placed prominently at the top-right corner of every page that immediately exits the application and goes to a weather website (see Figure 7).
  - Increased information for this specific user group.
- Language Style and Messaging:
  - Removal of questions where people had to identify themselves. For instance, instead of asking people if they identified as Aboriginal or Torres Strait Islanders, simply asking them if they would like to see Aboriginal and Torres Strait Islander services first.
  - Improve clarity of value proposition that is displayed: The tagline 'Find the help you need, now and nearby' was used instead of 'A to Z of Homeless Help'.
- Inclusive Design Process:
  - Avoiding stigmatisation of asking for help by using the tagline: 'No Shame - Ask Izzy' in marketing materials.
  - Large number of community engagements to improve awareness and demonstrate that voices have been heard.
- Other:
  - Increased use of colour while retaining a modern look and feel, to respond to feedback that the it felt too 'government-y' and too much like the Australian Medicare website.

E. System Evaluation

We conducted both a quantitative and qualitative evaluation of the final system. Information from these interviews allowed us to evaluate the impact of the built system and reflect on the effectiveness of using motivational modelling to inform requirements. Anonymous usage data was also collected over a period of two years after the system was deployed; the purpose was to complement the qualitative interviews and monitor high-level usage trends from different user segments. As mentioned earlier, an in depth discussion about the unique technology needs of people experiencing homelessness has been published already [46], [43]; we therefore provide only an overview of the system evaluation results in this work.

Measure (Weekly)	Version 1 No. Users	Version 2 No. Users
Mean	817	2287
Median	836	2328
Std. Dev.	219	622
Range	895	2557
Min.	473	1046
Max.	1368	3603
Total	42464	118949
Obs.	52	52

TABLE III: Descriptive Statistics

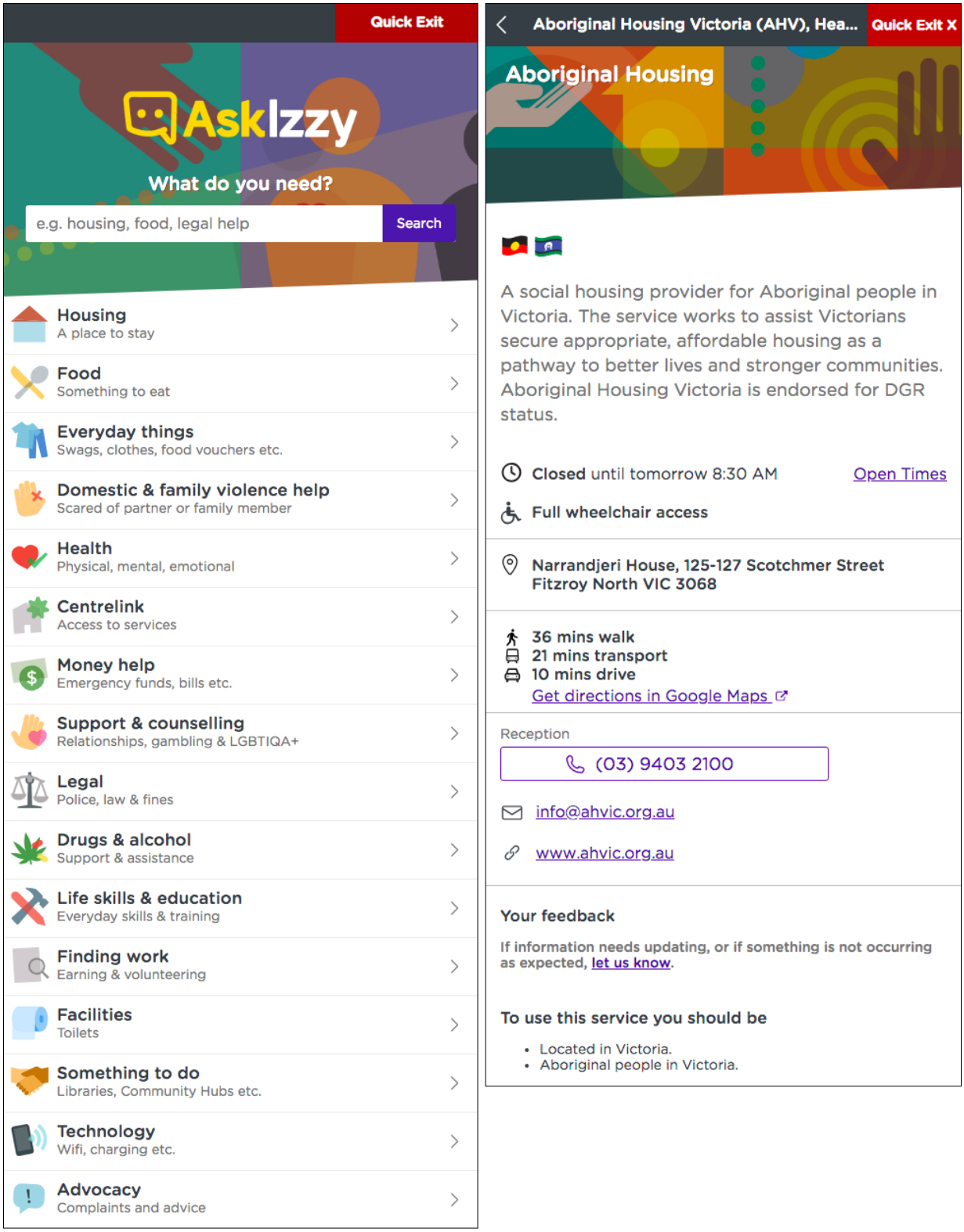

Fig. 7: Two screenshots of Ask Izzy. Left = Landing Page, Right = Service Description Page. https://askizzy.org.au/

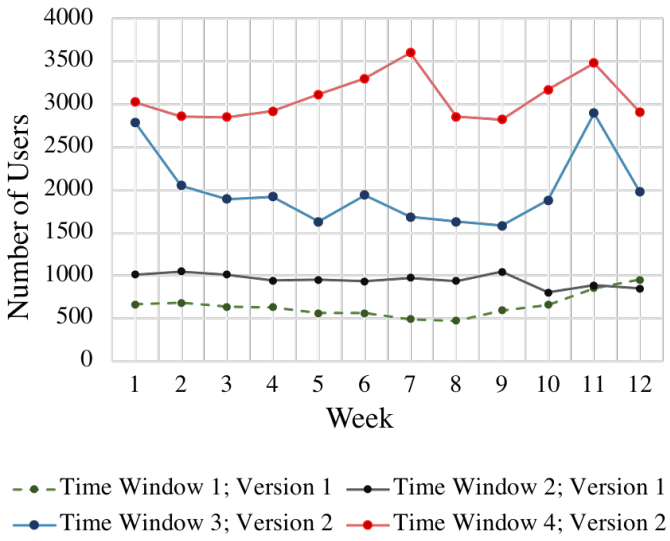

Fig. 8: Number of users over four time windows.

Table III provides descriptive statistics of the number of users before and after the design decisions were implemented (see Section IV-D).

Figure 8 shows four windows of time. Each window corresponds to a 12 week sample of the year. Time Window 1 and Time Window 2 correspond to the first release of the system. Time Window 3 and Time Window 4 correspond the the second release of the system after design changes had occurred. These time windows were selected in order to capture aggregate usage data that was representative of the normal use while spanning enough time to account for seasonal variations and preserve anonymity. A key concern for this system was that the people would cease to continue to use it in the long term. We therefore capture usage data over a longer-term. For instance, demand for services typically spikes in winter and around New Year (Australian summer).

The findings indicate that overall use of the system drastically increased. The average number of users in the first year of deployment was 817 each month. After the emotion-led changes had been implemented this increased to 2287. Over 10,000 users are now accessing Ask Izzy each month which is evidence that a large proportion of people are choosing to seek information online via this system.

V. Lessons Learned

Our practical experience with motivational models has allowed us to understand the role that they play in this industrial software project. We found them useful to facilitate a project-level awareness amongst the team and stakeholders, to navigate ambiguity, and support communication and sensemaking. The results section provides a sample of shared artifacts and motivational models that were utilised. We now reflect on these experiences and discuss the lessons learned.

A. Maintaining Project-Level Awareness

A shared understanding of project goals is important for all teams and projects. In this case, multiple non-technical stakeholders were involved in the creation of the design. We found the construction of a motivational model allowed us to easily visualise all goals during the discover phase, and scope the solution to a minimal viable product during the define phase. This supports the key characteristics of effective shared artifacts. It provides a shared language, makes it easy to understand the differences and dependencies between various stakeholders and provides a means to evolve this model as requirements are defined, developed and delivered. An example of this can be seen in Figure 5. The functional goal of *Giving Feedback* is also associated with an emotional goal; the desire for homeless people to feel *Empowered* and *Helpful*. We can clearly see on this model that different stakeholders are involved and affected by the way this goal is addressed in the software design. Specifically, there is a concern from Service Providers that potentially negative comments will have an adverse affect causing people to avoid seeking help. The association between these two goals visually highlights an important dependency that required a balanced judgement. Requirements decisions throughout all phases of development reflected on the impact that any significant choices would have on this goal tension.

Negotiating and reconciling this design requirement therefore required understanding from people within the software development team, as well as from a variety of stakeholders. During the evaluation interviews, many participants who had experienced homelessness found the increased accessibility to information *empowering*. Without their use of Ask Izzy one participant estimated that the information would have taken years to gather [46].

Additionally, we found that motivational models were a quick way to involve new stakeholders in the project. Our project involved many government funded service providers who often undergo organisational reform and charities who operated on a strict budget. The consequences of this is that individuals who contribute to the project frequently swap roles. Presenting and discussing the motivational model to new stakeholders was an efficient way to quickly gain a project-level overview.

B. Navigating Ambiguity

Addressing requirements that appear to be ambiguous is a difficult task in requirements engineering. In industry projects, it is instinctive to immediately resolve or avoid ambiguity and aim for clear actionable requirements. This is because many requirements artifacts and processes rely on traceability in order to progress. Existing work has already discussed that the abstract nature of emotional goals [21], and socially-oriented requirements causes them to be inherently and unavoidably ambiguous [22], [23].

In our project, we found that when dealing with socially-complex requirements, a larger proportion of goals will remain ambiguous for longer periods of time. Often, it is not possible to evaluate these requirements until after the system has been deployed; for example, evaluating whether Ask Izzy made people feel *respected* could not be done in a lab evaluation. In

this sense, the motivational model maintains the information of high-level goals that are progressively evaluated at different stages of development.

We found preserving ambiguity in some goals was beneficial. Exploring ambiguous goals further often uncovers tacit knowledge and important contextual information that needs to be taken into account. As one example, initial requirements elicitation interviews revealed that *stigma* around being homeless often caused people to avoid asking for help. It was important to create a design that allowed people to feel *respected* and *dignified*. The goal model shown in Figure 4 acted as a visual reminder in order to prompt new ideas and interpret the merits of any suggestions. It was initially ambiguous causing uncertainty around how this goal would be addressed in the design as it was subjective, nuanced and open to multiple interpretations. However, over time, numerous design ideas were generated to support this goal. For instance, the description of the system was changed in order to reduce emphasis on the website being for people who are homeless and increase emphasis on it being for anyone feeling vulnerable. Additional specific examples of changes are listed in section IV-D; one decision involved changing the tagline displayed in on the front page, and another decision involved changing the language used in marketing material.

C. Supporting Communication and Sensemaking

One of the lesser studied aspects of shared artifacts in requirements engineering is how they support communication and sensemaking. In fact, the emotional goals of the system were not only used to communicate within the project team, they were also presented in marketing materials to communicate to the general public. The ability for shared artifacts to support communication is important as previous research has extensively shown how creativity is enabled by collaborative processes [47].

Many existing studies will predominantly evaluate the effectiveness of shared artifacts based on model comprehension by testing if the reader is able to understand the full model [21]. Interestingly, we found that many stakeholders only needed to glance at the model for a few seconds before they saw something of interest and a starting point for a conversation. In this case, we believe the motivational model reduces the barrier to contribute to conversations for non-technical stakeholders.

As an example, one goal that was elicited and represented in the model was *Hope*. It is visually attached to the functional goal of *Find Next Step*. Many service providers emphasised the importance of balancing the competing goals between motivating users to find help while simultaneously managing user expectations. It was therefore important to take into account that design decisions needed to consider that the goal of reaching a stable housing situation may take a number of years and multiple interactions with multiple service providers. A key design challenge here was that the software features themselves were only one part of the solution. In fact, the feeling of hope was subsequently supported (or not) by interactions with multiple service providers after initial engagement with the system. The design team, service providers and those who had experienced homelessness needed to reflect on various interpretations of this goal, alongside complimentary shared artifacts (e.g. Figure 3).

D. Limitations

This is an experience report reflecting on requirements engineering in a realistic industrial setting as opposed to a controlled experiment. For this reason, it is important to acknowledge that there are many factors that may have influenced requirements-related decisions. Further research is needed in a variety of application domains to investigate motivational models in realistic settings and increase the generalisability of our findings to build on the knowledge gained in existing motivational modelling case studies [21], [9], [20], [33]. The second limitation is related to the decision to use a thematic analysis method [42]. This is a popular method and comes with a risk of those themes being open to a subjective interpretation by coders. To reduce the risk we used very open questions and allowed participants to lead the conversation to salient topics related to their experiences and goals concerning the system. We also followed recommended steps of comparing and merging results with more than one investigator.

VI. Conclusion

This paper presents an industry experience using an emotion-led shared artifact to advocate for the goals of stakeholders in a socially-complex application domain. We interviewed 100 participants to elicit knowledge that was used to construct and utilise motivational modelling embedded within the double diamond requirements engineering process.

We found that motivational models possess a variety of characteristics that allow them to be effective share artifacts. Firstly, the shared syntax allowed the project team to maintain high-level awareness of key goals. Secondly, it allowed us to navigate ambiguous goals and avoid sidelining stakeholder needs that were not immediately fully understood. Finally, it supported communication in order to facilitate a sensemaking process where individuals can jointly synthesise and evolve their knowledge. More generally, our focus on eliciting information about the emotional goals of stakeholders acted as a useful shortcut to important contextual information for socially-oriented requirements.

Acknowledgment

This research has been made possible by the support and collaboration with Infoxchange a not-for-profit social enterprise developing technology for social change. We are also thankful to the many participants for generously contributing their time and energy to this project. This research was funded by the Australian Research Council Discovery Grant DP160104083 Catering for individuals emotions in technology development.

REFERENCES

[1] M. S. Ackerman, "The intellectual challenge of cscw: the gap between social requirements and technical feasibility," *Human–Computer Interaction*, vol. 15, no. 2-3, pp. 179–203, 2000.

[2] D. A. Norman, *The design of everyday things: Revised and expanded edition*. Basic books, 2013.

[3] K. El Emam and A. G. Koru, "A replicated survey of it software project failures," *IEEE software*, vol. 25, no. 5, pp. 84–90, 2008.

[4] G. Baxter and I. Sommerville, "Socio-technical systems: From design methods to systems engineering," *Interacting with computers*, vol. 23, no. 1, pp. 4–17, 2011.

[5] A. Mavin, P. Wilksinson, S. Gregory, and E. Uusitalo, "Listens learned (8 lessons learned applying ears)," in *2016 IEEE 24th Intl Requirements Engineering Conference (RE)*. IEEE, 2016, pp. 276–282.

[6] C. Burnay, J. Horkoff, and N. Maiden, "Stimulating stakeholders' imagination: New creativity triggers for eliciting novel requirements," in *Intl Requirements Engineering Conference (RE)*. IEEE, 2016.

[7] M. Glinz, "Very lightweight requirements modeling," in *18th IEEE Intl Requirements Engineering Conference*. IEEE, 2010, pp. 385–386.

[8] D. Wüest, N. Seyff, and M. Glinz, "Flexible, lightweight requirements modeling with flexisketch," in *2012 20th IEEE International Requirements Engineering Conference (RE)*. IEEE, 2012, pp. 323–324.

[9] A. A. Lopez-Lorca, T. Miller, S. Pedell, A. Mendoza, A. Keirnan, and L. Sterling, "One size doesn't fit all: diversifying the user using personas and emotional scenarios," in *Proceedings of the 6th International Workshop on Social Software Engineering*. ACM, 2014, pp. 25–32.

[10] I. Ramos and D. M. Berry, "Is emotion relevant to requirements engineering?" *Requirements Engineering*, vol. 10, pp. 238–242, 2005.

[11] S. Thew and A. Sutcliffe, "Investigating the role of'soft issues' in the re process," in *Intl Requirements Engineering Conference*, 2008.

[12] E. Yu, "Social modeling and i," *Conceptual Modeling: Foundations and Applications*, pp. 99–121, 2009.

[13] L. Sterling and K. Taveter, *The art of agent-oriented modeling*, 2009.

[14] J. Marshall, "Agent-based modelling of emotional goals in digital media design projects," in *Innovative Methods, User-Friendly Tools, Coding, and Design Approaches in People-Oriented Programming*. IGI Global, 2018, pp. 262–284.

[15] T. Miller, S. Pedell, L. Sterling, F. Vetere, and S. Howard, "Understanding socially oriented roles and goals through motivational modelling," *Journal of Systems and Software*, vol. 85, no. 9, pp. 2160–2170, 2012.

[16] D. A. Norman, *Emotional design: Why we love (or hate) everyday things*. Basic books, 2005.

[17] D. Rapp, A. Hess, N. Seyff, P. Spörri, E. Fuchs, and M. Glinz, "Lightweight requirements engineering assessments in software projects," in *Intl Requirements Engineering Conference (RE)*, 2014.

[18] G. Valen *et al.*, "Requirements negotiation model: A social oriented approach for software ecosystems evolution," in *International Requirements Engineering Conference (RE)*. IEEE, 2013, pp. 393–396.

[19] D. Renzel, M. Behrendt, R. Klamma, and M. Jarke, "Requirements bazaar: Social requirements engineering for community-driven innovation," in *2013 21st IEEE International Requirements Engineering Conference (RE)*. IEEE, 2013, pp. 326–327.

[20] S. Pedell, T. Miller, F. Vetere, L. Sterling, and S. Howard, "Socially-oriented requirements engineering: Software engineering meets ethnography," in *Perspectives on Culture and Agent-based Simulations*. Springer, 2014, pp. 191–210.

[21] T. Miller, S. Pedell, A. A. Lopez-Lorca, A. Mendoza, L. Sterling, and A. Keirnan, "Emotion-led modelling for people-oriented requirements engineering: the case study of emergency systems," *Journal of Systems and Software*, vol. 105, pp. 54–71, 2015.

[22] J. Paay, S. Pedell, L. Sterling, F. Vetere, and S. Howard, "The benefit of ambiguity in understanding goals in requirements modelling," *International Journal of People-Oriented Programming (IJPOP)*, vol. 1, no. 2, pp. 24–49, 2011.

[23] J. Paay, L. Sterling, F. Vetere, S. Howard, and A. Boettcher, "Engineering the social: The role of shared artifacts," *International Journal of Human-Computer Studies*, vol. 67, no. 5, pp. 437–454, 2009.

[24] A. Ferrari, P. Spoletini, and S. Gnesi, "Ambiguity and tacit knowledge in requirements elicitation interviews," *Requirements Engineering*, vol. 21, no. 3, pp. 333–355, 2016.

[25] G. CanforaHarman and M. Di Penta, "New frontiers of reverse engineering," in *2007 Future of Software Engineering*. IEEE Computer Society, 2007, pp. 326–341.

[26] P. R. Carlile, "A pragmatic view of knowledge and boundaries: Boundary objects in new product development," *Organization science*, vol. 13, no. 4, pp. 442–455, 2002.

[27] N. Maiden, S. Jones, K. Karlsen, R. Neill, K. Zachos, and A. Milne, "Requirements engineering as creative problem solving: A research agenda for idea finding," in *2010 18th IEEE International Requirements Engineering Conference*. IEEE, 2010, pp. 57–66.

[28] C. Frauenberger and P. Purgathofer, "Ways of thinking in informatics," *Communications of the ACM*, vol. 62, no. 7, pp. 58–64, Jun. 2019.

[29] S. Konrad and H. Degen, "Lessons learned from the use of artifact models in industrial projects," in *2009 17th IEEE International Requirements Engineering Conference*. IEEE, 2009, pp. 349–354.

[30] A. Dix, J. E. Finlay, G. D. Abowd, and R. Beale, *Human-Computer Interaction (3rd Edition)*. Prentice-Hall, Inc., 2003.

[31] M. a. Krumbholz, J. Galliers, N. Coulianos, and N. Maiden, "Implementing enterprise resource planning packages in different corporate and national cultures," *Journal of IT*, vol. 15, no. 4, pp. 267–279, 2000.

[32] E. Alatawi, A. Mendoza, and T. Miller, "Psychologically-driven requirements engineering: A case study in depression care," in *Australasian Software Engineering Conference (ASWEC)*. IEEE, 2018, pp. 41–50.

[33] L. Sterling, R. Burrows, B. Barnet, S. Taffe, and R. McDonald, "Emotional factors for teleaudiology," in *Tele-Audiology and the Optimization of Hearing Healthcare Delivery*. IGI Global, 2019, pp. 1–18.

[34] A. Lopez-Lorca, R. Burrows, and L. Sterling, "Teaching motivational models in agile requirements engineering," in *Proceedings of the Requirements in Education and Training workshop at RE'18*, 2018.

[35] "Australian bureau of statistics," http://www.abs.gov.au/ausstats/abs@.nsf/mf/2049.0.

[36] J. A. Hersberger, "Are the economically poor information poor? does the digital divide affect the homeless and access to information?" in *Proceedings of the Annual Conference of CAIS*, 2013.

[37] J. P. Woelfer and D. G. Hendry, "Stabilizing homeless young people with information and place," *Journal of the American Society for Information Science and Technology*, vol. 60, no. 11, pp. 2300–2312, 2009.

[38] C. A. Le Dantec and W. K. Edwards, "Designs on dignity: perceptions of technology among the homeless," in *Proceedings of the SIGCHI conference on human factors in computing systems*. ACM, 2008.

[39] S. Weise, P. Coulton, and M. Chiasson, "Designing in between local government and the public–using institutional analysis in interventions on civic infrastructures," *Computer Supported Cooperative Work (CSCW)*, vol. 26, no. 4-6, pp. 927–958, 2017.

[40] "The british council; double diamond design process," *http://www.designcouncil.org.uk/about-design/how-designers-work/the-design-process/*, 2005.

[41] "ThoughtWorks", "The double diamond: Strategy + execution of the right solution," https://www.thoughtworks.com/insights/blog/double-diamond.

[42] V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qualitative research in psychology*, vol. 3, no. 2, pp. 77–101, 2006.

[43] R. Burrows, A. Mendoza, L. Sterling, T. Miller, and S. Pedell, "Evaluating ask izzy: A mobile web app for people experiencing homelessness," in *European Conference of Computer Supported Cooperative Work (ECSCW)*, 2019.

[44] R. Burrows, A. Mendoza, S. Pedell, L. Sterling, T. Miller, and A. Lopez-Lorca, "Co-creating technology for societal change: A mobile app addressing homelessness," in *Proc. European Network of Living Labs OLLD'19*. ENOLL, 2019.

[45] A. Cooper, *The inmates are running the asylum:[Why high-tech products drive us crazy and how to restore the sanity]*. Sams Indianapolis, 2004.

[46] Infoxchange, "Inclusive design," https://www.infoxchange.org/au/news/2017/10/new-inclusive-design-ask-izzy, 2018.

[47] B. Shneiderman, "Creativity support tools: Accelerating discovery and innovation," *Communications of the ACM*, vol. 50, no. 12, pp. 20–32, 2007.