

# Towards Sustainable Requirements Elicitation from a Values Capability Perspective: A Pervasive Health Monitoring Case Study

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**Abstract**—Research shows that there are several dimensions to sustainability requirements, including the aspect of social sustainability, which we argue is under-represented in Requirements Engineering (RE) literature. In line with Sen’s Capability Approach (CA) we contend that it is necessary to depart from a definition of (social) sustainable development that is solely focused on the fulfilment of needs, and expand it with the notion of human capability – which is intended as “*the freedom to lead lives that people today and in the future value*”. Within this context, we observe that software systems can either expand or restrict human capabilities, and that requirements elicitation as the first step in RE, holds the promises for exploring and addressing this tension in systems design. The aim of this paper is twofold: to look at how the requirements elicitation process of values can (i) support the design of software systems that expand human capabilities and (ii) identify system designs that restrict such capabilities. We explore this question within a case study on eye-tracking technology for pervasive health monitoring.

**Index Terms**—values, sustainability requirements, capability approach, requirements elicitation, requirements engineering, pervasive health monitoring, digital health.

## I. INTRODUCTION

Requirements Engineering (RE) is considered the most crucial stage in a life cycle of sustainable system development. It determines the key leverage points for practitioners who want to develop sustainable software-intensive system [1]. Venters et al. [1] have identified that current RE and Software Engineering (SE) practices touch on several dimensions of sustainable requirements to include: environmental, economic, social, and technical [2]. We argue that the aspect of social sustainability (intended as social sustainable development) is under represented in the current literature, yet is the key for the design of sustainable socio-technical systems.

We suggest to extend the notion of sustainability beyond its most accepted definition as the “capacity to endure” [3], which is largely based on the Bruntland report’s definition of sustainable development as *fulfilment of needs* [4]. As a result, the concept of social sustainability emphasizes the *needs* but not the *freedom* to address such needs, hence our suggestion is to include Sen’s notion of freedoms as *human capabilities*.

Human freedom is what people perceive as their ability to make their own selection and decision towards fulfilling their needs, which depends on other determinants such as social and economic arrangements (e.g. private or public access to healthcare) as well as political and civil rights (e.g. the right to vote) [5].

Sen’s Capability Approach (CA) states that for a society to be sustainable one should have the capability to be healthy by his or her own choice e.g. the freedom to access health ‘enablers’ (e.g. doctors, good food, clean water). Hence, building on the Bruntland’s report definition of sustainability, Sen defines (social) sustainability as “*the freedom to lead lives that people today and in the future value*” [5, 6]. Values – whether financial, material, ethical or spiritual, are deep-seated beliefs and guiding principles influencing our decision-making processes as groups, individuals, and organizations [7]. In this paper, we adopt Sen’s notion of social sustainability and relate it to values in RE and SE work [7, 8]. Requirements elicitation plays a fundamental role in capturing not only user needs, but their values and aspirations before being developed as software systems requirements.

The aim of this paper is to look at how values requirements elicitation can (i) assist practitioners in designing software or systems that enable human capabilities and (ii) identify system designs that inhibit such capabilities. This investigation is done by mapping values derived from the requirements elicitation process conducted for a pervasive health monitoring project to the capabilities that the technology may support or hinder.

## II. CASE STUDY

Our case study is a pervasive health monitoring system that we envision will detect early signs of cognitive health

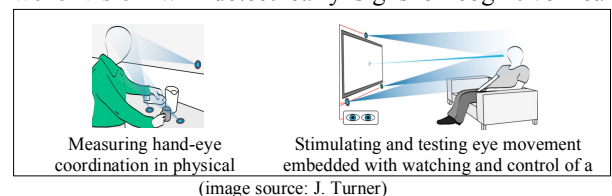


Fig.1. MODEM a pervasive eye tracking for embedded cognitive assessment

decline e.g. dementia, among older adults known as MODEM (Monitoring of Dementia using Eye Movements) [9, 10] as illustrated in Figure 1. MODEM uses eye tracking technology and currently is still under development. Its vision is to capture the eye’s movement and the people’s behaviour in the natural and relaxed mode in a home environment setting, with the natural ambience and unnoticeable technologies while they are watching TV and making tea.

We anticipate that when MODEM is realized, people may become more aware of their cognitive health condition. If people value *independence* (as the capability to conduct their live independently, i.e. live on their own in their own homes) and *trust the system* in identifying early signs of cognitive decline, then they may be likely to perceive MODEM as a technology that can support their value (independence). If *privacy* is what they value most, then MODEM may be seen as an intrusive technology that restricts their private life and they may be more prone to reject the idea of this technology.

### III. METHODOLOGY AND EMERGING FINDINGS

We conducted two requirements elicitation workshops and recruited 12 and 10 healthy older adults aged between 60 to 80 years old in each workshop. A slide presentation of pervasive home monitoring scenario was presented to engage the participants in discussion about MODEM. We then conducted brainstorming sessions to elicit values that evolve from their acceptance level towards MODEM. The workshop sessions were audio-recorded and transcribed.

We performed a thematic analysis and categorized the transcription according to Meta-Inventory of Human Values classification by Cheng and Fleischmann [11]. We chose Cheng and Fleischmann meta-inventory since, to our knowledge, it is one of the most comprehensive and detailed as they performed an extensive review of 12 value systems including Friedman Values Sensitive Design (VSD) [12] and Schwartz’s Universal Values structure [13] (empirically robust values system). From the workshop, we identified 4 out of 16 human values classification that are relevant to our study. We captured these values as users’ non-functional requirements. Table 1 maps verbatim quotes from the workshops to the 5 identified values; and according to whether the technology is seen as a *capability inhibitor* or an *enabler*.

TABLE I. PARTICIPANTS’ QUOTES FROM THE WORKSHOPS

Values	Technology as an Inhibitor	Technology as an Enabler
Freedom (including privacy)	<ul style="list-style-type: none"> <li>• “If it was put in and I didn’t know it was put in, I’d angry about.”</li> <li>• “I’d find it intrusive because I do find that my privacy is sacred.”</li> <li>• “I would be worried about my family member’s privacy.”</li> </ul>	<ul style="list-style-type: none"> <li>• “I don’t think I have a problem if it’s just eye movement.”</li> <li>• “We also wanted to make sure that there was control over the [...] equipment and it was very definitely the person’s choice.”</li> </ul>
Security	<ul style="list-style-type: none"> <li>• “Technology [is] acceptable, big question is <b>who the agencies are?</b> How do they <b>handle it</b>, what is the <b>security?</b>”</li> <li>• “Could this equipment be <b>hacked?</b>”</li> </ul>	<ul style="list-style-type: none"> <li>• “if there was <b>something in the home that monitored you every now and then</b> I would have thought a lot of people would have found that acceptable.”</li> </ul>
Wealth	<ul style="list-style-type: none"> <li>• “The <b>cost element is a worry.</b>”</li> </ul>	

Honesty	<ul style="list-style-type: none"> <li>• “It really bugs me ... basic monitoring system ... <b>do you trust the systems work? Do you trust the people that are operating the system?</b>”</li> <li>• “<b>Do you trust, do you believe that the outcomes are going to be what they say?</b>”</li> </ul>	<ul style="list-style-type: none"> <li>• “We thought it was very important that you didn’t just get a letter when you got dementia that you’d need to get regular feedback so you don’t fear anything coming”</li> </ul>
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### IV. CONCLUDING REMARKS

It can be observed that participants perceived the benefits of MODEM as a technology that is capable to monitor their cognitive health condition notwithstanding several concerns about *freedom, security, honesty and wealth* values. We understand that there are barriers to acceptance, but equally there are indications on how these barriers can be addressed. The design of the technology must critically reflect and address these barriers as requirements to better understand what are the true enablers and inhibitors in socio-technical systems design.

### V. ACKNOWLEDGEMENTS

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