Exploring users perception on security and satisfaction requirements of context-aware applications: An Online Survey

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1 Introduction

1.1 Research problem

Our lives are being transformed by innovative software applications with important social, environmental, and economic implications. For instance, context-aware software systems can be found in different domains such as health-care, telecommunication, transportation, etc. It is expected that in the near future software-intensive systems will behave autonomously thanks to the continuous sensing and monitoring. In this proposal, given the complexity of this kind of systems, and the social implications behind emerging wearable sensing technologies, we aim to empirically investigate some quality attributes that contribute to the social sustainability from a consumer perspective.

In a previous work [3], experts recognised that security and satisfaction requirements are the cornerstone to get healthy social implications of software applications. However, do end-users perceive the same importance?

1.2 Motivation to conduct the study

In this live study proposal, we start from the hypothesis that users perceive the importance of some software requirements in different ways due to their different profiles (e.g. background, preferences, experiences, personality) [1], [7]. Moreover, we focus on investigating security from a user perspective because according to West in [12], security is harder to be appreciated by end-users because of *end-users do not think they are at risk* or *safety is an abstract concept.* So, we would like to investigate this psychological phenomenon.

Therefore, in order to investigate how users understand and perceive the security and satisfaction of context-aware software applications, that are built based on the HAPPYNESS framework [1],[4], we investigate a set of quality attributes related to security and satisfaction. To do that, we present the design and plan of an online survey to be conducted with the REFSQ attendees.

2 Scenario

In this section, we introduce the scenario that illustrates the context of the use of happyParking, an application built based on the HAPPYNESS framework, that we plan to use it in our live study proposal.

Frank lives in a city where the amount of parking spaces per unit is becoming scarce. Given the difficulty of finding a parking space, Frank uses a mobile application called happyParking. The application uses multiple input sources of contextual information to provide a certain degree of probability of finding a parking spot in different locations. happyParking is empowered by HAPPYNESS, and Frank uses the E4-Wristband[1] for monitoring emotional data at runtime, HAPPYNESS determine the actual QoS levels of happyParking services from a user perspective, increasing in this way our awareness of a potential issue with the services, what could eventually lead to actions addressing the issue.

3 Study Design

3.1 Hypothesis, goal and research questions

In this study, we start from the *hypothesis* that educational background and type of personality are key factors that can influence on the perceived importance of some quality requirements [2],[7]. Moreover, we focus on investigating security from a user perspective because in contrast to the importance of security perceived by experts –the findings reported in [3] demonstrate that security requirements (*i.e.,* confidentiality, authenticity) and satisfaction (in terms of trust and usefulness) were identified as high contributors of social sustainability– West in [12] reported that users do not think they are at risk, users are not motivated in security, safety is an abstract concept, security is considered as a secondary task, losses perceived disproportionately to gains. Therefore, the live study presented in this paper aims to *analyse* a context-aware application *for the purpose of* understanding user perception with respect to security and satisfaction requirements *from the viewpoint of* a service consumer *in the context of* smart parking, where REFSQ volunteer participants will be illustrated with certain scenarios of use of happyParking.

From this goal, the following research questions are derived:

RQ₁: *How service consumers perceive the importance of security and satisfaction of a context-aware software-intensive system?*

RQ₂: *Do the educational background and personality influence on the importance perceived of security and satisfaction of context-aware software applications from a service consumer perspective?*

Type and relevance of study for research and/or for practice.- This study is performed through a survey (online-questionnaire), and its objective is to test the hypothesis formulated above.

3.2 Variables and metrics

Response variables.- Security and satisfaction are operationalised regarding: i) the perceived importance of quality attributes, which can be measured by means of 6 items formulated in 5-points ordinal scale (from "not important" to "very important"); ii) the level of agreement on security requirements, which can reach values from 1 (strongly disagree) to 5 (strongly agree); and iii) the perceived recommendation measured with the Net Promoter score [10],which can be used as an indicator of user satisfaction.

Factors.- The mobile application that needs wearable sensors is identified as a variable that could affect the response variables. Our treatment is the happyParking and the E4wristband device. Personality is another important variable identified in our study, which will be measured using the Big Five Inventory questionnaire (BFI) [5]. And the educational background that will be determined through the demographic questionnaire.

3.3 Population of interest

Profile of the intended subjects.- We plan for 40 participants as a minimum number of subjects to conduct the survey. Students, senior researchers, and practitioners are very welcome. Prior knowledge of security is not required. We choose REFSQ'19 to run this online survey thanks to the knowledge in requirements engineering (RE) of REFSQ's attendees.

Benefits to the subjects of participating in the study.-

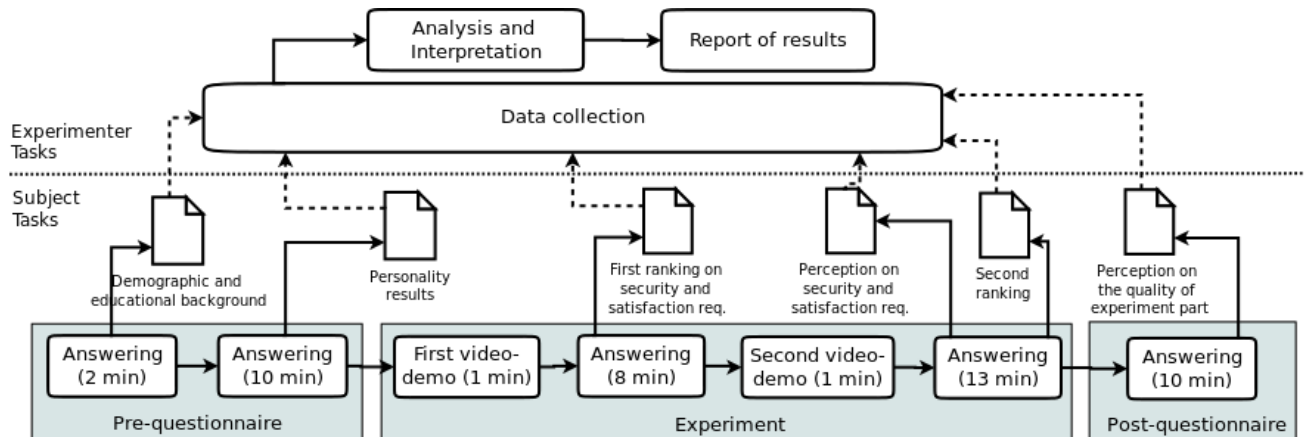[1]https://www.empatica.com/en-eu/research/e4/

Figure 1: The live study's procedure

Given requirements are the key leverage point for practitioners (e.g. software architects, testers) who want to design software systems with an acceptable quality level, we think that this survey might benefit to the participants by getting:

- knowledge on how to elicit requirements (e.g. security, trust) of context-aware applications that are harder to be perceived by end-users.

- experience in running empirical studies with the exploitation of video-demos as a medium in requirements engineering.

- access to the instruments such as an online version of the BFI questionnaire, which could be used for profiling participants in any further human-based empirical studies.

3.4 Study design

The study is composed of three parts (see Figure1): (i) a *pre-questionnaire* that aims to collect demographic, educational background and personality information, (ii) the *online questionnaire* that gathers service consumer perceptions on security and satisfaction requirements of context-aware applications, (iii) and a *post-questionnaire* that aims to evaluate the quality of the live study.

Instrumentation.- The instruments to be used in the study are a demographic questionnaire (*e.g.,* sex, age), an educational background questionnaire (*e.g.,* educational degree, domain expertise), a personality test, animated demonstration videos, and a web-based questionnaire designed to assess the service consumer perceptions on security and satisfaction requirements.

Questionnaire (see Figure 1) consists of two sub-parts: ***First one:*** items that correspond to security and satisfaction quality attributes listed in Table 1, these items (*i.e.,* definitions and examples of quality attributes) are formulated as questions on an ordinal scale to measure the first perception about the importance of security and satisfaction quality attributes according to the first video[2].

Second one: questions regarding the level of agreement on security requirements (according to the second video[3]) are formulated. Additionally, questions on an ordinal scale for the re-evaluating importance of security and satisfaction quality attributes are formulated. We include also question on a ordinal scale for collecting data regarding the overall satisfaction.

3.4.1 Procedure of live study

The procedure of the study is summarized in Figure 1, which includes the estimated time required for each activity. A first version of the online questionnaire that we plan to use can be found at `https://goo.gl/forms/65pJEjz4RroYDq153`.

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[2]`https://www.youtube.com/watch?v=iJ7Og8hTtXk`
[3]`https://www.youtube.com/watch?v=xDYqzzGSw8s`

Table 1: Qualities attributes with respect to security and satisfaction requirements [3]

Quality attributes		Scale
Security	Confidentiality	
Security	Authenticity	5-point ordinal scale,
Security	Accountability	5-point Likert scale
Security	Integrity	
Satisfaction	Trust	5-point ordinal scale, ratio scale (from 0 to
Satisfaction	Usefulness	10) measured with the Net Promoter Score

4 Plan of data collection and analysis

Following our previous experience when eliciting requirements from software reconfiguration [7], we conceive our study based on three-stage process, which involves the contribution from the crowd of potential service consumer of context-aware applications, as well as from domain experts of social impact and requirements: **(Stage 1)** A pilot of our study is performed with experts on social sustainability. This pilot allows us to check and improve the survey process and its conduction. It has been already executed in October 9th, 2018 in MEGSUS workshop [11]. We collected feedback from 7 participants working on topics of software sustainability. This feedback was used to improve the study that is presented in this paper. **(Stage 2)** We then perform an improved design and plan of the study with REFSQ participants, who have a strong background on Requirements Engineering. The objectives of this stage are twofold: i) to analyse the service consumer perception on security and satisfaction requirements of context-aware applications,by involving high-qualified participants; ii) to evaluate the quality of the online survey by means of a post-questionnaire. **(Stage 3)** Finally, we plan to perform an improved version of the study with the potential service consumers of context-aware applications. For this stage, we are going to use the crowd-sourcing platform: Amazon Mechanical Turk [4] for gathering the participation of end-users.

In the rest of the section, we introduce the plan of data collection and analysis related to *Stage 2*.

Execution of data collection.- The data will be collected through an online survey, nobody will be obligated to participate, only volunteers will participate of it. To assure that, a consent document will be signed by participants before performing the live study, in this document we will briefly explain confidentiality and privacy terms.

Execution of data validation.- To understand participants' personality, we use the Big Five Inventory (BFI) questionnaire. Responses related to demographic, educational background and personality can be used as inputs to identify user profile. User profiles could allow us to improve the understanding about diverse user behaviours and its implication in the perception of security and satisfaction requirements of context-aware applications.

5 Threats to the validity and ethical issues

The main threats to validity concern internal, construct and external validity [9]. **Internal validity**: concern *additional factors* that may affect an observed variables. We mitigate this threat by requesting to all participants perform the live study in similar conditions, by using the same material (e.g. videos showing different situations when a user uses happyParking).

Construct validity: It concerns *generalizing the result of the experiment to the concept or theory behind the experiment.*. In order to mitigate the threat related to the following two social factors: *Hypothesis guessing*, we do not reveal the research goal before the study. *Evaluation apprehension*, as some people are afraid of being evaluated/tested, the completion of both personality test and online questionnaire are going to be anonymous. Regarding the threats related to the design of the study: *mono-operation bias*, as we include only one treatment (happyparking app), the study could be under-representing the identified constructs (perceptions on security and satisfaction). To mitigate this threat, we carefully selected the software domain (IoT applications for the smart parking sector), which we think it is enough representative for measuring our two response variables. Moreover, It is important to remark that we explore both variables, by formulating questions at least in two different scales, such is shown in Table 1. Also we considered other relevant factors as personality, which is going to be measured by means of the BFI questionnaire, defined and validated in the psychology field [5]. For our analysis, we are going to focus specially on a sub set of constructs that can have an effect on the Technology acceptance [8] (i.e. neuroticism, agreeableness, openness). Regarding the questions in ordinal scale (importance level) we added the option: "No opinion" to avoid forcing respondents in choosing one level of importance.

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[4]https://www.mturk.com/

External validity: concern the *generalization* of the findings beyond the validation settings. This threat is partially mitigated by the fact that REFSQ attendees are diverse in terms of personality and educational background such as master/PhD students, software architects, requirements engineers, business analysts, etc. However, a further replication, involving participants with non-technical background such is described in stage 3 of our study, is necessary.

6 About the researchers

Nelly Condori-Fernandez is an assistant professor at the Universidade da Coruna(Spain) and research associate of the Vrije Universiteit Amsterdam (The Netherlands). Her main empirically-driven research focuses on topics related to quality requirements prioritization and requirements validation. She has a particular interest in applying Human Computer Interaction technologies to support requirements engineering activities. Her research interests also include software sustainability design and assessment with special emphasis on social and technical aspects. She executed three empirical studies in the live study track of REFSQ, whose results have been published in different venues (e.g. [2], [13], [3]).

Denisse Muñante is an assistant professor and research associate at the engineering school ESTIA (France). Her main empirically-driven research focuses on decision-making for requirements prioritization. Her research interest also includes security information, self-adaptive software, and model-driven engineering. She executed two empirical studies, one of them was published in RE'17 [6], and the second one will be submitted to IST Journal by the end of 2018.

Franci Suni Lopez is a research associate of the San Pablo Catholic University of Arequipa, Peru. He has a master in computer science. His main research focuses on using human emotions to empower the self-adaptation capability of software services. His research interest also includes software engineering for mobile development and self-adaptive software.

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