

# The Current Practices and Required Knowledge for Non-Functional Requirements Elicitation in Agile Context: A Pilot Study in Jordan

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## ABSTRACT

Non-Functional Requirements (NFRs) are very important since they play a significant role for the system's behavior. Unfortunately, in Agile methods, the NFRs are overlooked until the later steps of software development. The negligence of NFRs elicitation is happened due to lack of standardized guidelines that can be referred by the software practitioners. Moreover, empirical studies on the current practices of NFRs elicitation in Agile software development organizations, specifically focused on security requirements and knowledge required are still limited. To the best of our knowledge, the study also has never been done before in Jordan context. Therefore, this study was conducted to address the abovementioned lacking issues. The study was conducted using quantitative approach. The questionnaire was distributed through online and face-to-face communication. The data was analyzed using descriptive statistical analysis. Hence, this paper presents the results from the pilot study that involves 34 software practitioners in Jordan. The items of questionnaire were highly reliable to be utilized for more analysis. The findings highlighted the current practices for NFRs elicitation specifically focused on the security requirements elicitation and the required knowledge for NFRs elicitation which are useful for formulating guideline for NFRs elicitation.

**Keywords:** Agile requirements engineering, Non-functional requirements, NFR elicitation guideline, Required knowledge, Security requirement.

## I INTRODUCTION

Agile software development (ASD) methods have been developed and evolved since the early 1990s. Basically, ASD focused on shorter software development lifecycle with iterative and incremental process. Due to that, Agile methods have been widely used in business sectors as they are able to deliver the software product faster. Unfortunately, requirements are still relatively unstable (Alam et al., 2017).

Requirements are the groundwork of all software products and it seeks to guarantee that customer demands are rightly understood (Heikkilä et al., 2015). Requirements engineering (RE) is one of the key

software processes which determines how to gather, document and review requirements (Pohl & Rupp, 2015).

In the classical approach such as waterfall method, the requirements are explained perfectly and in-detail before proceeding to design and development. Nevertheless, in agile methods such as SCRUM, eXtreme Programming (XP), Dynamic Systems Development Method (DSDM), or hybrid methods, the strategy of software development is different. The requirements are mostly explained in a simple manner via user stories and these documents will be used to start and produce the sprints (Asghar et al., 2016).

On top of that, security is a critical non-functional requirement (NFR) that needs consideration during software development. However, developing secure software is not a trivial task as it requires to take into account the security requirements from elicitation stage (Villamizar, Kalinowski, Viana, & Fernández, 2018). Yet, in majority of software projects, security is often dealt with in retrospective when the system has already been designed and put into operation (Rindell et al., 2019; Villamizar et al., 2018).

Later, when this NFR was neglected, several risks might be introduced that requires additional effort and cost to solve the problems. For example, the U.S. Army has spent almost \$3 billion on a broken system and less efficient (Silva et al., 2016; Maiti, 2016). Recently, an Indonesian airplane was crashed and killed 189 people. The specialists confirmed that the main reason for the tragedy was because of inefficiency and unreliability of the automated system, which led to the crash of the airplane (Wojcik, 2019; Gruenberg, 2019).

Regardless of NFRs importance, they are only stated in an unofficial form in agile methods (Shahid & Tasneem, 2017; Bormane et al., 2016). For example, the requirements in SCRUM are captured on 3x5 index cards with each requirement specified in 3 to 5 sentences, which is inadequate to capture the detailed NFRs (Maiti, 2016). Even though developer and customer work together to elicit the requirements in agile methods yet, it is very difficult to gather all the requirements from a single person such as Product Owner (PO) in SCRUM (Maiti, 2016; Eberlein & Leite, 2002) as the customer does not has good knowledge on the requirement elicitation practices.

Hence, having a good knowledge and understanding among the practitioners are important in helping the elicitation of NFRs (Pakki, Roy, & Kavuri, 2016; Too, Hassan, Din, & Azim, 2013). Consequently, determining the required knowledge for performing NFRs elicitation will help the practitioners to understand more on what should be taken into account during elicitation stage and what are the role of practitioners (Pakki et al., 2016; Too et al., 2013). Additionally, Younas et al. (2017) and Rojo and Oliveros (2014) reported, the main problem in the area of agile requirements elicitation is the lack of guidelines for NFRs elicitation. In general, the guideline is defined as a set of practices, disciplined activities that provide steps of instructions which help to form an opinion and support decision making concerning a course of action (Shurrab, 2016; Ramachandran, 2012).

Moreover, even though NFRs elicitation is considered as important, yet report that discusses on the empirical evidence of the current practices of NFRs elicitation in agile software development companies is still lacking especially those related to the current practices of security requirements elicitation (Villamizar et al., 2018; Curcio et al., 2018; Wagner, Fernández, Kalinowski, & Felderer, 2018). There are studies such as Curcio et al. (2018) and Wagner et al. (2018) which highlight that the current practices of NFRs elicitation are still ambiguous in agile RE and need further investigation via empirical studies. Therefore, a study was conducted to investigate the current practices and required knowledge for NFRs elicitation among Jordanian Agile software practitioners. It can be argued that the outcomes of this study will help Jordanian software companies deal with emerging challenges while eliciting the NFRs. This paper reports the outcomes from the pilot study. The NFRs elicitation focuses on the security requirements. Besides, this study also investigates the required knowledge of elicitation and the opinion of practitioners on the importance and the benefit of NFRs elicitation guidelines in Agile context.

The paper is organized as follows: Section 2 provides literature reviews, Section 3 elaborates the research method of the study, and Section 4 presents the findings and discussion. Finally, Section 5 provides the conclusion and future work.

## II LITERATURE REVIEW

There are studies which investigated the practices of agile RE by a comprehensive literature review to determine the practices such as Alam et al., (2017), Inayat et al. (2015) and Elghariani and Kama (2016). Alam et al., (2017) presented fourteen practices of agile RE and also the issues and challenges that practitioners face in the implementation of these practices. Inayat et al. (2015) presented seventeen

practices which explain how agile methods can deal with the requirements. Moreover, Elghariani and Kama (2016) provided almost similar findings to Inayat et al. (2015). However, these studies focused on the agile RE in general with less attention to NFRs elicitation and particularly security requirements elicitation practices or required knowledge for elicitation.

Moreover, Wagner et al. (2017) contributed to empirical knowledge of the state of practices and contemporary problems in agile requirements elicitation. They conducted an international survey in North America, South America, Central Europe, and Northern Europe on agile practices and problems. The study provides some useful findings related to how requirements are elicited and documented, and on common agile RE problems. However, the survey focused on FRs elicitation with less emphasis on NFRs elicitation.

Pakki et al. (2016) conducted an online survey in the United States to collect data about RE challenges and knowledge of stakeholders in agile and traditional methods. The study tried to identify the challenges faced by organizations in handling NFRs. Nevertheless, the study focused on the RE process in general with less concentration related to current practices and required knowledge for NFRs elicitation, especially security requirements elicitation practices. Furthermore, Kotze (2017) conducted a survey among employees at software development organizations in South Africa about the knowledge of stakeholders for FRs elicitation in traditional methods. Similarly, the study did not take into consideration the current practices and required knowledge for agile NFRs elicitation. More recently, Ochodek and Koczynska (2018) conducted an online survey through social network groups to gather information about agile RE practices and the importance of these practices. The study determined the perceived importance of agile RE practices and created a seven-tier ranking of the practices. Nevertheless, the survey concentrated on the RE process in general with less attention paid to NFRs elicitation practices and required knowledge for practitioners, and particularly security requirements elicitation.

It appears that most of the existing studies focused on agile RE in general with minimal attention to current practices and required knowledge for NFRs elicitation, especially security requirements elicitation practices. Also, there are studies which focused on traditional methods or FRs elicitation, however, these studies did not take into account the agile NFRs elicitation.

Besides that, most of the existing studies were conducted in North America, South America, and Europe, and limited studies from Asian countries

(Inayat et al., 2015). Jordan is one of the Asian countries, which has an increase in the software development sector due to the incentive measures followed by the Jordanian government (Yaseen, Dingley, & Adams, 2016). Based on the list of companies from Jordanian Ministry of Trade and Industry and the Jordan Business Directory Website, there are more than 880 companies that applied Agile practices in software development, which made Jordan a suitable environment for conducting such studies. Therefore, this study investigated the current practices and the required knowledge of NFRs elicitation in Jordan's Agile software development companies. Also, the opinion of practitioners on the importance of NFRs elicitation guidelines in Agile context is gathered through this study.

### III RESEARCH METHOD

This study adopted the quantitative method and the data of the pilot test was collected by utilizing a survey. The reason for selecting this method because it is a useful method to measure the opinion of respondents (Umezawa et al., 2015; Cooper & Schindler, 2011). There are three main activities involved, started with questionnaire construction, data collection, and data analysis. These activities are elaborated next.

#### A. Questionnaire Construction

The questionnaire consists of five main sections namely: 1) demographic information, 2) the current practices for NFRs elicitation, 3) the current practices for security requirements elicitation, 4) the required knowledge of practitioners for NFRs elicitation, and 5) implementation of NFRs elicitation guideline. These sections consist of 46 questions with sub-questions, that included multiple-choice and Five Point Likert scale questions (Salleh, Mat, & Othman, 2019; Jørgensen et al., 2019).

The demographic section aims to assess the qualification of respondents such as the current position and years of experience. The questions of the section were derived from different studies such as Mohamed (2015), Baharom (2006), and Tarawneh (2016). The second section of the questionnaire consists of 17 questions such as NFRs elicitation techniques, software types, historical data, detach user stories, NFRs sources, and NFRs validation. The questions of this section were derived from studies such as Estdale and Georgiadou (2018), Mairiza et al. (2010), Afreen, Nida, Khatoon, and Sadiq (2016), Maiti, (2016), and Domah and Mitropoulos (2015).

In section three, the question is regarding the current practices for security requirements elicitation which consists 10 questions such as responsibility of elicitation of the security requirements from the customer, eliciting and documenting security

requirements explicitly, the notation used to represent the security requirements, and the importance of considering security requirements. The questions of this section were derived from studies such as Estdale and Georgiadou, (2018), Mohamed (2015), Hussain and Mkpojiogu (2015).

Section four which is the required knowledge of practitioners for NFRs elicitation contains 7 questions related to the domain, communication, and system of NFRs elicitation in Agile context. The questions of this section were derived from studies such as Pakki et al. (2016), Too, Hassan, Din, Ghani and Abd (2013), Kotze (2017), Serna et al. (2017). In section five the questions are about the implementation of NFRs elicitation guideline which contains 4 questions that aim to find the opinion of practitioners on the importance and the benefit of NFRs elicitation guidelines in Agile context. This section also aims to specify the name and elements of guidelines for NFRs used by respondents. Moreover, the questions of this section were derived from studies such as Younas et al. (2017) and Silva et al. (2016).

#### B. Data Collection

The pilot test was conducted among 34 Agile software practitioners in Jordan. This number of respondents is appropriate since the pilot group size between 25 to 100 is a sufficient sample as suggested by Cooper and Schindler (2011). The questionnaire was shared through online interviews and face-to-face communication, which involved agile practitioners such as Product Owner (PO), programmers, team leader, and security advisor. The names of potential Agile software practitioners were obtained from 1) the list of companies from Jordanian Ministry of Trade and Industry, and the Jordan Business Directory Website, 2) the government and private organizations attained by the Internet and social media, and 3) communicate with friends who have relation in the Agile software industry.

#### C. Data Analysis

The collected data was analyzed using descriptive data analysis. For this purpose, the Statistical Package for Social Science (SPSS) ver. 14.0 software was utilized. The main purpose of using SPSS is to focus on describing the respondents' opinions or the frequency of certain events to occur (Oppenheim, 1992). Besides, the Cronbach's alpha was utilized in order to evaluate the consistency of internal in the components of the questionnaire (Azman et al., 2019).

### IV FINDINGS AND DISCUSSION

The questionnaire was validated by performing a pilot test to detect the respondents' understandability of the questions. Besides, it also ensures the validity of the questionnaire, completeness of the included items, readability, and estimate the time taken to answer the

questionnaire (Umezawa et al., 2015; Cooper & Schindler, 2011). More importantly, the pilot test assists in avoiding the ambiguities, obstacles, or mistakes that might arise when answering the questionnaire. The following sub sections discusses the outcome of the analysis.

### A. Demographic Information

To understand the respondents' background, they were asked to indicate their position in the company and years of experience in software development. Table 1 portrays the frequency and percentages of respondents according to their positions and experiences. Most of the respondents are PO (35%) and security advisor (29%), followed by programmers (15%), and team leaders (9%). Indeed, majority of the practitioners who participated in this pilot study have more than 6 years in Agile software development.

Table 1. Respondents' Experience and Position.

Positions	1-5 years	6-10 years	11-20 years	Total
PO	0 (0%)	9 (26%)	3 (9%)	12 (35%)
Security Advisor	0 (0%)	8 (23%)	2 (6%)	10 (29%)
Programmers	0 (0%)	5 (9%)	0 (0%)	5 (15%)
Team Leader	0 (0%)	2 (6%)	1 (3%)	3 (9%)
Project Manager	0 (0%)	2 (6%)	0 (0%)	2 (6%)
System Analyst	0 (0%)	2 (6%)	0 (0%)	2 (6%)
<b>Total</b>	<b>2</b>	<b>26</b>	<b>6</b>	<b>34</b>

### B. The current practices of NFRs elicitation

In this section the respondents were asked about the responsible person who performs the elicitation of NFRs in their organizations. Figure 1 shows that the majority of respondents answered PO (91%), followed by Team Leader (3%), Programmer (3%), and Project Manager (3%).

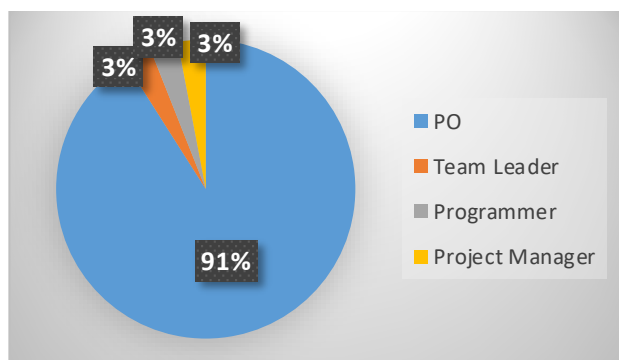


Figure 1. The responsible person who performs the elicitation of NFRs.

Moreover, the respondents were asked about the application domains that they developed and applied NFRs elicitation. They were permitted to select more than one answer. Majority of the respondents answered Mobile application (77%) and Web application (75%), followed Telecommunication Services (55%), E-learning (37%), E-banking (36%), and E-commerce (25%). In addition, the respondents were asked about the types of system that they applied NFRs elicitation. They were permitted to select more than one answer. The respondents answered Real-time systems (83.5%), Information systems (76%), Safety-critical systems (74.4%), and Controlled systems (72.7%).

Moreover, the respondents were asked whether they verify the NFRs after elicitation. Unfortunately, 77% of them, do not perform the validation. Besides, majority of the respondents (80.3%) answered the PO has the responsibility to validate NFRs after elicitation. On another side, the respondents were asked about the validation methods used for NFRs, Majority of the respondents validate NFRs with their customers 64%, while 30% use GQM. The rest 6% use expert review.

Furthermore, the respondents were asked to rank the degree of acceptance performing of NFRs elicitation practices in their companies. Therefore, Five Likert scales ranging from Strongly Disagree (value 1) to Strongly Agree (value 5) were used to describe the degree of acceptance for applying these practices. The mean score was calculated and choosing the convenient interval that represent the actual mean in order to acquire the results. To represent all levels of acceptance required an appropriate interval scale. Table 2 presents the degree of acceptance for scales representation for every practice.

Table 2. The Mean Values for NFRs Elicitation Practices.

NFRs Elicitation Practices	Mean value	Degree of acceptance
Identifying the application domain and type of system at the beginning of the project.	3.53	Agree
Focusing on face-to-face communication to elicit the NFRs.	4.67	Strongly Agree
Encouraging customer participation through natural language.	4.34	Strongly Agree
Using the historical data to defining and eliciting the NFRs.	4.34	Strongly Agree
A list of questions are prepared to extract the NFRs from the customer.	3.52	Agree
Separating the NFRs with detaching story cards.	4.57	Strongly Agree
The validation of NRs in natural language with the customer.	3.53	Agree
The validation of NRs by third party.	2.31	Disagree
Using a check-list table in case of changing requirements.	2.23	Disagree

### C. The current practices of security requirements elicitation

In this section the respondents were asked about the responsible person who perform the elicitation of security requirements. For eliciting the security requirements and documentation explicitly, 77.3% of respondents answered they are eliciting and documenting security requirements explicitly. Besides, the respondents who are dealing with security requirements were asked about who performs the elicitation of security requirements in their organizations. The majority of respondents answered PO with 73 %, followed by Security advisor (12%), Team Leader (6%), Project Manager (6%), programmer (3%), System Analyst (3%), and the remaining 3% chose no specific person.

In another side, 61.6% of respondents do not use any specific notation, 5% of respondents do not document the security requirements. 20.4% uses Misuser stories to represent the security requirements, 7% use Misuse case, 3% uses Attack tree, and 3% uses Abuse case. On top of that, the respondents were asked to rank the degree of performing these practices inside their companies. Table 3 presents the degree of acceptance for scales representation for security requirements practice.

Table 3. The Mean Values for Security Requirements Elicitation Practices.

Security Requirements Elicitation Practices	Mean value	Degree of acceptance
Eliciting security requirements separately.	2.31	Disagree
Documenting security requirements in a particular notation.	4.32	Strongly Agree
Utilizing the common attacks that occurred previously to elicit the requirements security.	4.47	Strongly Agree
Considering attackers' perspective while eliciting security requirements.	4.33	Strongly Agree
Reaching a common understanding about the security needs.	3.52	Agree

### D. The required knowledge of NFRs elicitation

The respondents were asked about the required knowledge of NFRs elicitation in order to decide the required knowledge needed to elicit NFRs in Agile context. Table 4 shows the mean values of required knowledge and the degree of acceptance.

Table 4. The Mean Values for Required Knowledge of NFRs Elicitation.

The Required Knowledge of NFRs Elicitation	Mean value	Degree of acceptance
The practitioners requires domain knowledge of various sources such as standards and norms or relevant bibliographic reference to identify the NFRs.	4.35	Strongly Agree
Training the person(s) responsible for eliciting NFRs by specialists/experts.	3.42	Agree
Awareness of the customer background (profile)	3.63	Agree
NFRs are easily missed because of the unsuccessful communication knowledge.	2.11	Disagree
The deficiency for the system knowledge will lead to the omission of necessary and important NFRs.	2.11	Disagree
The practitioners who perform the elicitation need to have a knowledge of notations.	4.35	Strongly Agree

## V CONCLUSION AND FUTURE WORK

This paper reports the result from a pilot study which aims to validate the questionnaire related to the current NFRs practices especially security requirements in Agile context. Besides, it also investigates the required knowledge for NFRs elicitation. The pilot study was conducted among Agile software practitioners in Jordan. The outcome of the study reveals the current practices and required knowledge for NFRs elicitation. The Cronbach's alpha values were above 0.7 for each item of the questionnaire. Thus, the questionnaire items are highly reliable to be utilized for more analysis. Besides, there are suggestions of improvement from the respondents during the pilot test. Among them are they mentioned that the questionnaire takes too long, having long and complex sentences, and the sequence of questions is not commensurate with the objectives. These suggestions are taken into account in order to improve the questionnaire. The next stage for this study will be collecting the real data.

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