Non-Functional Requirements Documentation Techniques in Agile Software Development: A Focus Group Study

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Abstract

Non-functional requirements are an essential part of any IT project, including agile projects. Addressing these requirements is a well-known challenge of agile projects because the common documentation techniques used in agile projects may be insufficient. This study examines which non-functional requirements documentation techniques industry practitioners working on agile projects use in different contexts. To this end, we conducted a literature review to identify documentation techniques proposed for agile projects. Based on the results, we organized focus groups with industry practitioners to determine when and to what extent they use these techniques in their projects. These were followed by a validation interview with a domain expert. We present our findings in the form of a list of recommendations. The list includes the conditions under which a given technique can be selected.

Keywords: non-functional requirements, agile software development, requirements engineering, requirements documentation, requirements specification

1. Introduction

Non-functional requirements (NFRs) are used to define properties and characteristics that a software system must exhibit or a constraints that it must respect, other than an observable system behavior [18]. This term encompasses a wide category of different requirements, including quality characteristics and product/process constraints, and usually have high importance to the customer and other stakeholders. NFRs are essential for the success of the IT project, because even if all functional requirements (FRs) are correctly implemented, the system with poor usability or security characteristics is unlikely to be accepted by its stakeholders [4]. This observation applies to all IT projects, including agile ones.

One of the most commonly reported challenges of Agile Software Development (ASD) is dealing with NFRs [7], [8], [15], due to neglecting them in favor of FRs [1], [15], limited requirements documentation [7], [14] or limited ability of agile methods to handle NFRs properly [3], [5]. The last issue concerns various requirements engineering (RE) activities, such as elicitation or analysis, but requirements specification (or documentation, we will use these terms interchangeably) is reported to be particularly problematic, as simplified agile requirements documentation techniques such as User Stories often prove insufficient to express some of the NFR categories [7], [8], [13]. In this paper we focus only on this challenge and investigate the available agile documentation approaches.

We formulated the following research questions (RQs): **RQ1**: What techniques are used in ASD to document NFRs? **RQ2**: How the selection of NFR documentation techniques is made by industry practitioners?

To answer RQ1, we reviewed the relevant scientific literature. To answer RQ2 we orga-

nized two focus group meetings with practitioners, followed by an analysis of the results and a validation interview with a domain expert.

The remainder of this paper is organized as follows. We outline the related work in Section 2 and describe the literature review on NFR documentation techniques in Section 3. The main research study (focus groups) is reported in Section 4. It is followed by a discussion in Section 5 and conclusions in Section 6. The more detailed results are available in the online report[1].

2. Related Work

The challenges, practices, and techniques of agile RE are widely addressed in the scientific literature. Several secondary studies investigating these challenges are available (e.g., [7], [8]). Similarly, RE practices (e.g., [8], [16]) and techniques (e.g., [16]) used in ASD are summarized. However, these sources usually do not focus on the issues examined in this paper, such as NFRs, NFR-related challenges, and NFR documentation techniques, but rather mention them among others (e.g., challenges of agile RE in general).

However, several sources dedicated to NFRs in ASD can be found. Asaquaf et al. investigated the challenges and practices related to NFRs in the context of a large distributed agile project through interviews [2] and SLR [3]. Jarzębowicz and Weichbroth identified, through SLR and interviews, the elicitation practices and documentation techniques applied to NFRs in ASD [10]. Behutiye et al. conducted a comprehensive SMS study dedicated to NFRs in ASD and rapid software development, uncovering challenges and different strategies (methods, practices, tools, etc.) of managing NFRs. Islam et al. reported on an SLR study on challenges and documentation practices in ASD (in general, not limited to requirements) [9].

The sources that provide an overview of RE techniques (e.g. [9]) usually just list them, without providing the context in which a particular technique is/should be used. While this satisfies RQ1, RQ2 requires investigating the reasons for selecting particular techniques. Also, techniques and/or practices are often juxtaposed with particular challenges as ways to mitigate them (e.g., in [4], [8]). Our research considers this only as one possible selection criterion. A technique may be selected not to address a specific challenge but rather because it is considered effective for certain NFR categories or because it is imposed by the project environment. As we did not find any sources relevant to RQ2, we consider this a research gap that we intend to address.

3. Literature Review

We began our research in early 2022. Our intention was to conduct a Systematic Literature Review (SLR) [11]. During the planning stage, we reviewed the existing related secondary studies and discovered that two studies covering our topic of interest had been conducted very recently. We decided to focus on extracting the relevant data from them and synthesizing them into a single list of NFR documentation techniques.

Therefore, we acknowledge that our answer to RQ1 is based on [10] and [4]. The first paper [10] investigates the practices related to NFRs in ASD, particularly the stage in the project life cycle when NFRs are identified, NFRs elicitation methods and NFRs documentation techniques. The reported research study consists of two steps: an SLR and a series of interviews with practitioners. Results are presented separately for each step. We procured the NFR documentation techniques found in the SLR step as an input to our research. The second source [4] reports a single research study (a Systematic Mapping Study with a snowballing search strategy) but with a broader thematic scope. The scope included management strategies related to quality requirements in agile and rapid software development, where the term "management

[1]Online Appendix: https://doi.org/10.5281/zenodo.15801752

strategies" includes methods, practices, tools, guidelines, and several other categories. Another objective was to identify challenges related to quality requirements management. The authors qualified 156 primary studies and extracted the strategies and challenges found in them. Since the categories they used (method, practice, etc.) were not always clear to us, we reviewed all the findings reported in the paper and in the additional resources published by the authors to select the studies relevant to our research.

We qualified 21 primary sources from [10] and 25 from [4]. Thirteen items turned out to be duplicates reported by both papers. After removing the duplicates, the list contained 33 sources. The selection criteria for the papers concerned the solutions they reported. Such solutions had to: (1) be classified as techniques, not software tools, for example, and (2) be used to document, not elicit, requirements and/or be reported as solutions to challenges in documenting quality requirements. We attempted to identify additional sources that were more recent or omitted from the secondary sources mentioned. To this end, we searched Scopus, SpringerLink, and IEEExplore using the search string below. However, we did not find any relevant sources not already described in the aforementioned secondary studies.

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"Systematic Literature Review" OR "SLR" OR "Systematic Mapping Study" AND
"Non-functional requirements" OR "NFR" OR "Quality requirements" AND
"Agile" OR "Scrum" OR "XP" OR "Kanban"
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We extracted data on NFR documentation techniques from qualified sources, using not only summaries from [10] and [4], but also reviewing full texts. The results are summarized in Table 1, more detailed mapping to sources can be found in Part 1 of the Appendix. We also extracted the descriptions of certain documentation techniques with the intention of using them in the next research step (see Part 2 of the Appendix). The literature review described in this section was conducted in March and April 2022. Screening and data extraction were performed by the first author and reviewed by the second author, and differences were resolved by consensus.

Table 1. Agile NFR documentation techniques reported in the literature and by FG participants

Technique	No. of uses in literature	No. of uses by FG participants
User Stories	13	6
Acceptance Criteria	9	6
Agile Loose/Use Cases	5	1
Prototypes/mockups	5	6
Structured Story Cards	4	0
Definition of Done	3	6
Epics	2	5
Traceability Matrices	2	3
Framework models	2	0
Constraints	1	6
Features	1	4
Tasks	1	6
Wiki pages	1	7
Whiteboards	1	3
UML diagrams	0	3
Decision tables	0	2
Separate SRS document for NFRs	0	1
References to standards/regulations	0	1

4. Focus Groups

4.1. Preparations and Implementation

To answer RQ2, it was necessary to obtain information from industry practitioners. We wanted to learn which NFR documentation techniques they use in agile projects and to identify the

reasons and contextual factors they consider when selecting a technique for a given project or task.

We decided that we needed to use a more in-depth method, so we ruled out questionnaire-based surveys and turned to interview-based methods. We chose focus groups as the method for this research step. Focus groups (FG) are moderated group interviews in which participants communicate with each other and build on each other's answers [12]. We expected that the FG method to allow participants to share information about their experiences in documenting NFRs and to stimulate each other to consider more factors related to the aim of our study. For practical reasons, we assumed that the FG would be organized in a remote manner using videoconferencing tools. Preparations took over two months (May-July 2022) and included recruiting participants, designing the FG scenario, and developing additional resources to be distributed to participants and/or used during the FG meeting.

Our target FG participants were practitioners with a deep knowledge of RE processes and experience in ASD. As we know of no method for systematic sampling, we had to use purposive sampling to identify and invite prospective participants. We used LinkedIn and personal contacts to send out almost 70 invitations, and about 10 invitees agreed to participate. However, we had some cancellations later on, even at the last minute, so we were finally able to organize two FG meetings with four and three participants, respectively (seven in total). The participants' backgrounds and experiences are shown in Table 2.

Table 2. Focus Group participant characteristics

ID	Job position(s)	Experience in position (years)	Experience in Agile projects (years)	Total experience (years)
A1	Business Analyst	7	5	9
A2	Business and System Analyst	8	6	11
A3	Principal Analyst, DevOps	5	5	12
A4	Project Manager, System Analyst	15	10	20
B1	Solution Manager	2	10	15
B2	Business Analyst	2	4,5	4,5
B3	Scrum Master, IT Analyst	1,5	4	4

Additional resources developed during the preparation phase include:

1. Descriptions of NFR documentation techniques (based on the data extracted in the first research step). The purpose was to mitigate the risk that some participants might know the techniques by different names or use significantly modified versions of the techniques. These descriptions can be found in Part 2 of the Appendix.

2. Definitions of key terms such as NFRs and their subcategories, including key quality characteristics. The reason for this was that, in our experience, the NFR-related glossary is not uniform among practitioners [6] and we wanted to avoid miscommunication.

3. A list of potential factors that could influence the selection of NFR documentation techniques, compiled from the literature. Participants could refer to this list when sharing how they decide which techniques to select, but they could also introduce other factors. The list is included in Part 3 of the Appendix.

4. An online Google spreadsheet consisting of 5 tabs. The first included placeholders for participant demographics. Each of the remaining tabs listed a subset of NFR documentation techniques and included placeholders for each participant to indicate whether he/she used a particular technique and to provide reasons and contextual factors for its selection. The purpose of dividing the NFR documentation techniques into 4 subsets was to limit the participants' focus to a reasonably small number of items.

Resources 1-3 were both sent to participants a few days before the FG meeting and made available as online files during the meeting. Resource 4 was only used during the meeting. Two FG meetings were held in July 2022, one week apart. The meetings were conducted remotely using MS Teams communicator. Both authors participated in each FG, assuming the roles of moderator and recorder. All participants had their video cameras turned on throughout the meeting. Each FG began with an introduction. During the introduction, the participants were reminded of the purpose and scope of the study, the working method was explained, and their consent to record the meeting was confirmed.

After the introduction, participants were asked to write their responses in a specific tab of the spreadsheet that corresponded to the topic being discussed. The focus was on one tab at a time - first the demographics (input to Table 2), then a subset of NFR documentation techniques. Participants worked simultaneously and could see each other's answers, building on them. This approach is fully equivalent to the traditional focus group based solely on discussion, in which participants can hear each other and modify or expand their answers accordingly. However, we did not limit the study to written answers. After all participants had answered, the moderator asked additional questions to better understand the influencing factors. These questions usually took the form of a discussion in which participants referred to each other's responses and positioned themselves in relation to them. The recorder wrote down a summary of the discussion in the spreadsheet so that it was visible to all participants, who could check whether the summary reflected their statements. These activities were repeated for each subset of techniques.

At the end of the meeting, participants were asked to briefly summarize their experiences with NFR documentation techniques, indicating which techniques were their "standard tools" when working with NFRs and which were used only in specific contexts. The spreadsheet and video recording were immediately saved for use in data analysis.

4.2. Data Analysis and Results

When analyzing the results of the FGs, we first examined how many of the FG participants reported using a particular technique for NFR documentation. We considered both the techniques identified in the literature and the additional techniques brought up by the FG participants. The results are included in the last column of Table 1. There are some differences in popularity among participants compared to the extent to which the techniques are mentioned in the scientific literature. However, due to the small number of focus group participants, it is not possible to make definitive statements about the extent to which the techniques are used in the industry. The table also shows the FG study's potential limitations — if a technique is seldom used by participants, they are unlikely to provide much insight on it. This should be taken into consideration when interpreting the results.

The qualitative analysis was conducted using all the collected FG results, i.e. spreadsheets and recordings. The availability of recordings proved to be very useful as we could transcribe them, replay key fragments, etc. As the FG participants could formulate their statement (both written and oral) in any way they wanted (without being limited to a number of options to choose from), we applied a coding technique [17] for the purpose of data analysis. We marked all statements related to the reasons for using a particular documentation technique, annotated them, and identified common themes.

4.3. Validation

The recommendations based on the FG results were additionally validated by interviewing a domain expert. This was done to verify that the processed FG results were understandable and aligned with the independent assessor's knowledge and experience. We used LinkedIn again to find and recruit the right person for the validation interview. The domain expert who agreed to

participate had nine years of work experience as an IT analyst in several organizations, primarily on agile projects.

The expert was provided with the list of recommendations and additional documents explaining necessary related information (e.g., descriptions of the NFR documentation techniques studied), but not the raw data from the FG. The document with the list of recommendations contained empty placeholders, and the expert was asked to use them to indicate whether or not he agreed with a particular recommendation and to provide additional comments. In case of doubt, he had the opportunity to contact the researcher (the first author) and ask for clarifications. After a few days, the expert completed the task. A short discussion followed as the researcher had doubts about how to interpret some of the comments and asked for additional explanations.

The expert agreed with all of the recommendations, except for those related to whiteboards and decision tables. These were marked as "uncertain" because the expert did not have any experience with these techniques in his work history. Therefore, no items were removed from the list, though some were modified slightly based on the expert's feedback. An example of validation feedback is included in Part 5 of the Appendix. The final list of recommendations is shown in Table 3.

5. Discussion

Our study aimed to identify which NFR documentation techniques practitioners use, when they select them, and why. Our findings suggest that many techniques are used, each with some justification. In some cases, the recommendations for when to use a technique are obvious (e.g., references to standards), while in other cases, specific contextual factors related to NFR categories, project organization, environment, or business domain are identified. More advanced techniques proposed in scientific papers, such as Agile Loose Cases, Structured Story Cards, and framework models, are rarely adopted by practitioners, at least in the FG sample. Practitioners primarily use techniques typical of ASD, such as User Stories, DoD, and AC, to represent NFRs. Also, the simple solution of using whiteboards turned out to be used by all participants. Additionally, some techniques more typical of plan-driven methodologies (e.g., SRS documents and UML diagrams) were reported as being used in ASD to document NFRs.

The most frequent reasons for selecting a given technique were the need to demonstrate compliance with requirements and the specific needs of a business domain, including regulations, policies, and contractual provisions. The close relationship between NFR and the related FRs was also an important factor in selecting techniques that could represent such relationships. Another factor was the level of knowledge of stakeholders and project team members. Surprisingly, the FG participants rarely referred to NFR types/categories (e.g., security or performance). This factor was suggested to them, but the FG discussion was not specifically oriented towards it. However, a clear distinction was made between NFRs encompassing the user's point of view and those of a more technical nature, and this distinction was reported as an important selection criterion by our participants.

Our research has several limitations and threats to validity. As for the literature review, we omitted the full consideration of threats because we ultimately based our findings on two existing secondary studies. The threat of omitting relevant sources was minimized by using two independently conducted SLR/SMS studies and by conducting additional searches for sources not included in these studies. Potential bias in data extraction and classification was mitigated by involving two researchers and reaching consensus between them. From today's perspective, the most significant limitation is that the reported research was conducted in 2022. Therefore, more recent sources are not included, and the results may not cover new techniques, such as those based on GenAI usage.

The main research study (focus groups) requires a more detailed consideration of threats. We follow the guidelines of Wohlin et al. [19] in this respect. Construct validity reflects to what

Table 3. Final recommendations for using NFR documentation techniques

Technique	Recommendations
User Stories	- For NFRs that can be expressed directly by specific FRs. - For Scrum projects, when required by team standards, by decision of the Scrum Master or Project Manager, or when required for collaboration with other teams.
Acceptance Criteria	- For describing specific NFRs for various elements of the system under development. - For refining an FR expressed as a User Story by adding related NFRs. - To ensure and prove that the requested NFRs are actually delivered in the project.
Prototypes/ mockups	- For projects where User Experience is a key issue. - When stakeholders have limited knowledge and cannot clearly define their requirements. - When there is a risk of missing key NFRs due to lack of stakeholder awareness. - For projects based on an evolutionary development approach.
Tasks	- For simple, small-scale NFRs that do not require extensive specifications. - For minor changes applied to NFRs that do not require detailed documentation.
Definition of Done	- To ensure and prove that the requested NFRs are actually delivered in the project. - In more complex projects where the list of NFRs is common to all system components.
Features	- When stakeholders have very limited IT skills and need the simplest documentation possible. - When there is very little time to spend on the requirements documentation phase.
Technical Stories	- For technical requirements without a user perspective. - When there is a need to develop a specific structure for user stories.
Traceability Matrices	- To ensure and prove that the requested NFRs are actually delivered in the project.
Requirement templates	- When business domain knowledge within the project team is limited (e.g. first project in a given domain, new team members). - When legal or regulatory requirements impose constraints on the structure and content of requirements documentation in a particular business domain.
Constraints	- When business domain considerations impose requirements on system behavior, e.g., legal regulations, security policies, SLA agreements.
Whiteboards	- When business domain knowledge within the project team is limited (e.g. first project in a given domain, new team members). - For sharing NFRs within a co-located team.
Wiki pages	- For storing additional information about NFRs that cannot be included in the main requirements representation. - When it is necessary to restrict access to project documentation (based on roles, security clearances, etc.). - For sharing NFRs within a remote team.
UML Diagrams	For NFRs related to security, performance, or data exchange.
Decision Tables	- For documenting and analyzing many different decision paths related to NFRs e.g. security access privileges based on multiple factors.
Separate SRS document	- When NFRs need to be stored in a separate, structured document due to the development methodology used or customer/stakeholder demands.
References to standards/ regulations	- When an NFR in the project is defined by an existing official document (standard, legal regulation), and there is no need to describe it in detail (redefine) in the project documentation.

extent the factors studied really represent what the researchers have in mind and investigate. In our case a possible threat that the constructs discussed would be interpreted differently by the researchers and the FG participants was mitigated by providing the participants with definitions and descriptions of all constructs relevant to the scope of the FG. In addition, both researchers were present during the FG meetings and participants were able to ask for clarification if needed. Internal validity is considered when causal relations are examined. Our study identified causal relationships between contextual factors and the choice of NFR documentation techniques. We cannot exclude the threat that in some cases there may be other selection factors not mentioned by FG participants, but the open discussion and visibility of their entered/recorded responses minimize this threat. The results may also be biased because some techniques were not popular among the small group of FG participants, meaning they could not receive sufficient attention and insight. Another limitation is the selection of participants as the results are based on their experience. External validity is concerned with to what extent it is possible to generalize the findings. Our FG study had a small sample size and was not representative of the entire target population. Therefore, its results cannot be generalized to all agile projects and organizations. However, we made an attempt to include people with sufficient knowledge and experience (business/system analysis, ASD) and from different IT companies and business sectors. Reliability refers to the extent to which the data and analysis are dependent on the specific researchers. We made efforts to reduce the risk of subjectivity in data analysis by involving both researchers and following guidelines for qualitative data analysis [17].

6. Conclusions

The research presented in this paper aimed to identify NFR documentation techniques used in ASD (RQ1) and to investigate how industry practitioners select such techniques (RQ2). We answered RQ1 by gathering information from the literature (combining recent secondary studies) and also by learning some techniques from FG participants. The answer to RQ2 is based on focus group (FG) meetings and a qualitative analysis of the meeting results. To be more useful to practitioners, the final results related to RQ2 (Table 3) are presented as recommendations indicating the contexts in which a given technique is recommended.

For this reason, our work has implications for practitioners, who can use the list of recommendations when faced with choosing documentation techniques in their projects. Implications for research include the observation that the documentation techniques described in the scientific literature are not necessarily the same as those used by practitioners in industry. Additionally, improving the recommendations presented here would require collecting more information from a larger number of practitioners by replicating our study or using another method, such as interviews. Finally, the recommendations can be further validated using a case study or action research approach in future work.

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