Can User Stories and Use Cases Be Used in Combination in a Same Project? A Systematic Review

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Abstract Requirement elicitation (RE) is one of the main tasks that must be performed in order to guarantee the correct implementation of a software development. Its incorrect specification can cause unnecessary overdue costs for the project and, in some cases, its complete failure. The objective of this paper is to provide a state of the art of the elicitation models that makes simultaneous use of two well-known techniques: the use cases model and user stories. The systematic literature review was chosen as a supportive investigation methodology. From the 45 found publications, the search strategy identified 11 studies and 3 methodological proposals: Athena, K-gileRE and NORMAP. Finally, after having reviewed the literature, it was found that there are a few validated proposals that makes use of the combination of user stories and use cases models. Also, there is not enough information to acknowledge the actual efficacy of combining both techniques.

Keywords NFR · Non functional requirements · Requirement elicitation · Requirements engineering · Software engineering · SLR · Systematic literature review · Use cases · User stories

1 Introduction

The requirement elicitation (RE) process is one of the main tasks to be performed in order to guarantee the correct implementation of a software product. Unnecessary costs or even the project failure can be derived from its incorrect implementation.

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Boehm et al. [1] reported that the 45 % of errors that exists in a software product are originated during the RE and the preliminary design. Also, fixing these errors would demand more effort than fixing the errors originated during the coding process. In 1995, the Standish Group [2] presented in the Chaos Report that the ambiguity of the requirements and its incompleteness is one of the reasons that explains the failure of software projects.

According to Barbacci et al. [3] during the software RE, non functional requirements (NFR) related to the quality attributes of the software product tend to be ignored or ambiguously specified. Consequently, the software architect is the responsible on identifying and prioritizing these attributes. However, his decision may differ from the priorities and expectations of the stakeholders. Nord and Tomayko [4] indicated that in some software projects the architecture design task does not get enough importance.

There are two well-known techniques which may be used during the RE process. The first one is the use case modeling technique, which is a group of organized scenarios that are used to define the purpose of systems and software Alexander and Zink [5]. Its main goal is to help during the RE process defining the interactions between the environment (actors) and the system. In its description, the function-alities that the software must meet are included Gallardo-Valencia et al. [6].

Cockburn [7] defines use cases as a group of requirements that can detail the software behavior if they are correctly specified. Use cases do not require including all of the functionalities that had been indentified; however, they must include the most relevant ones. They have the following elements: (i) Name, (ii) Objective, (iii) Brief Description, (iv) Flow of events, (v) Preconditions, (vi) Post-conditions, (vii) NFR, (viii) Supportive Diagrams.

The second technique is known as user stories. According to Cohn [8] and Winbladh et al. [9], they are short stories that describe some feature that needs to be included in the system. They are centered in the needs of the user and are com-monly used in agile projects. User stories have the following components: (i) The Card, which is a description of the story where the user role, the task to be per-formed and the task's goal are presented; (ii) The conversation, which contains additional information that can complement the Card; (iii) The confirmation, which is a group of tests that can be used to verify the completeness of the user story.

The objective of this paper is to provide an overview of the state of the art of the elicitation methods that simultaneously use the use cases model and the user stories. Then, identify how they can improve the RE process by adequately specifying NFR and which of them are not only proposals but have been validated by the academia or evaluated by the industry.

This document is organized as follows. Section 2 presents the review protocol that was followed; the proposed research questions; the execution of the search and the data analysis of the found results. Section 3 proposes answers for each one of the research questions based on the search results. In Sect. 4, the threats to validity of this study are analyzed. Finally, Sect. 5 presents the conclusions and proposes future studies that can be done.

2   Review Process

A Systematic Literature Review (SLR) was performed. According to Kitchenham and Charters [10], this method would allow the identification, evaluation and interpretation of a set of researches from the same topic. The objective of this study is the identification and review of RE modeling techniques that simultaneously use the user stories and the use cases model. Figure 1 shows the review protocol proposed by Ahmad et al. [11] that was followed on this paper.

2.1   *Planning*

Research Questions. The 5 PICOC (Population, Intervention, Comparison, Outcomes & Context) criteria were used in the construction of three secondary research questions that would help answering the main question:

RQ1: *Are there any proposed models that make simultaneous use of user stories and use cases model?*—This question makes use of the Population and Intervention (PI) categories of the PICOC technique. As shown in Table 1, the goal of this question is to obtain the current state of the art of all the available publications in software engineering or requirement engineering that makes simultaneous use of use cases and user stories.
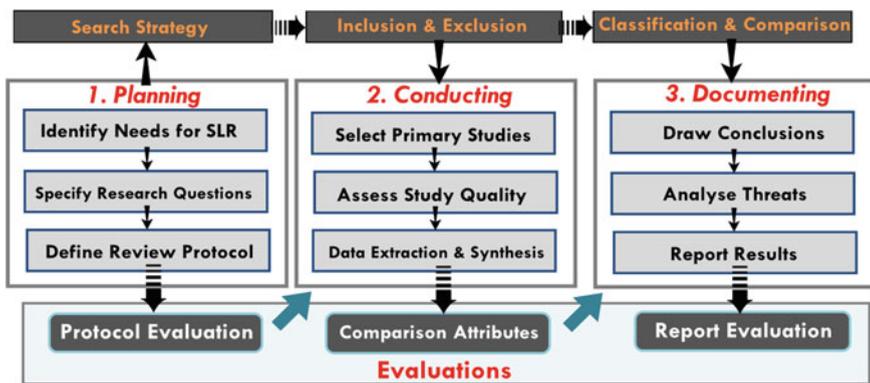

Fig. 1   Systematic literature review protocol proposed by Ahmad et al. [11]

Table 1   PICOC for Q1

Criteria	Scope
Population	Software engineering OR software requirements OR software development
Intervention	Techniques that make use of uses cases and user stories

Table 2 PICOC for Q2

Criteria	Scope
Population	Software engineering OR software requirements OR software development
Intervention	Techniques that make use of uses cases and user stories
Outcome	Non functional requirements elicitation

Table 3 PICOC for Q3

Criteria	Scope
Population	Software engineering OR software requirements OR software development
Intervention	Techniques that make use of uses cases and user stories
Context	Application on academia or industry

RQ2: *Do any of the proposed models take into account the elicitation of non functional requirements?*—Making use of the results achieved through RQ1, this question's goal is to find which of the proposed models considers the elicitation of NFR. Table 2 shows the structure of the question.

RQ3: *Do any of the proposed models have been validated or are used by the industries?*—From the results of the RQ1 and considering the paper classification proposed by Wieringa et al. [12]: evaluation, proposal, validation, philosophy, opinion, personal experiences. This question's goal is to find out if any of the proposed models has been applied in the industry or in the academia. Table 3 shows the structure of the question.

2.2 Execution

Selection of Studies. The following inclusion and exclusion criteria were applied over the publications found during the primary and secondary searches.

Inclusion Criteria. (i) The publications must be written in English. (ii) The full text of the paper must be accessible. (iii) Only the following classifications will be considered: reviews, proposals, validations, evaluations [12].

Exclusion Criteria. (i) Papers which are not proposing a model that makes simultaneous use of use cases and user stories. (ii) Papers which are not validating or evaluating the combined use of both techniques, use cases and user stories. (iii) In the case of duplicated papers, only the most complete paper will be considered.

Search Strategy. For the primary search, the 5 steps proposed by Ahmad et al. [11] were followed. These steps are described in Table 4.

For each one of the research questions, a string query was built:

SQ1: (("user story" OR "user stories") AND ("use case" OR "use cases")) AND ("software development" OR "software construction" OR "software project" OR

Table 4 Steps performed during the primary search

Steps	Description
Build the search queries	The search queries were built based on the terms listed on the Tables 1, 2 and 3
Consider synonyms	Synonyms were considered for each term used on the search
Combine the search terms	The logical connector "OR" was used to connect the synonyms and the connector "AND" was used for connecting the criteria
Divide the search string	The search string was divided in substrings so they can be executed on the different data sources
Manage the found references	The Mendeley tool was used for managing the references

"software projects" OR "software process" OR "software processes" OR "software engineering" OR "requirement* engineering" OR "requirement*")

SQ2: **SQ1** AND ("Non Functional Requirement*" OR NFR)

SQ3: **SQ1** AND (study OR studies OR experiment* OR verificat* OR validat* OR evaluation*)

The queries were executed on April 2015 in the following data sources: Sciverse Scopus (SS, http://scopus.com/), IEEExplore (IEEE, http://ieeexplore.ieee.org), ACM Digital Library (ACM, http://dl.acm.org/) and ISI Web of Science (ISI, http://isiknowledge.com). The included search fields were title, abstract and keywords only if the data source provided those options. No publication year filter was applied over the search.

The primary search returned a total of 42 studies published between the years 2003 and 2014. There were 16 duplicated studies. Then, the inclusion and exclusion criteria were applied over the abstract of the unique results reducing the number of papers to 15. Finally, the full text of the 15 papers was reviewed, reducing the number of relevant studies to 8.

On the secondary search there were reviewed (i) papers that cite the primary search results and (ii) papers that are cited by the primary search results. In both cases the selected papers must fulfill with the inclusion and exclusion criteria. Through applying the secondary search to the abstract of the studies, 3 additional publications were found.

The full list of selected publications is shown on Table 5.

Studio Quality Assessment. The quality of the 11 selected studies was evaluated using the checklist proposed by Zarour et al. [23]. For each question, there were 3 possible answers (Yes = 1 point; No = 0 point; Partially = 0.5 point). The quality assessment checklist and the results are presented on Tables 6 and 7.

Only publications with a score higher than 2.5 were accepted. From the selected studies, the lowest score achieved was 3.0 and the average was 3.95. Then, the result of the quality assessment test shows that the 11 publications are acceptable.

Data Extraction and Synthesis. The next step was to extract and synthesize the data of the selected publications listed on Table 4.

Table 5 Selected studies from the primary and secondary search

Reference	Digital Source	Proposal	Classification [12]	NFR	Type
Farid [13]	–	NORMAP	Proposal validation	Yes	Secondary
Farid [14]	ACM	NORMAP	Proposal	Yes	Primary
Farid et al. [15]	SS, IEEE, ISI	NORMAP	Proposal validation	Yes	Primary
Farid et al. [16]	SS, IEEE, ISI	NORMAP	Proposal validation	Yes	Primary
Farid et al. [17]	–	NORMAP	Proposal validation	Yes	Secondary
Gallardo-Valencia [6]	SS, IEEE, ACM	–	Validation	No	Primary
Gallardo-Valencia [18]	SS	–	Validation	No	Primary
Hvalshagen [19]	SS	–	Philosophy validation	No	Primary
Kumar et al. [20]	SS, ACM	K-gileRE	Proposal validation	No	Primary
Laporti et al. [21]	SS, ACM, ISI	Athena	Proposal Validation	Yes	Primary
Liskin [22]	–	–	Validation evaluation	No	Secondary

Table 6 Quality assessment checklist

ID	Question	Yes	Partially	No
QA1	Is the aim of the research sufficiently explained?	11	0	0
QA2	Is the presented idea/approach clearly explained?	10	1	0
QA3	Are threats to validity taken into consideration?	2	2	7
QA4	Is there an adequate description of the context in which the research was carried out?	10	0	1
QA5	Are the findings of the research clearly stated?	7	4	0

Publications yearly distribution. From the results, it was found that all of the selected studies were published from 2007 to 2015. The years 2007 and 2012 were the ones with the most studies published. However, there were no published studies on 2014.

Most relevant publishing sources. According to the information on Table 5, IEEE SOUTHEASTCON is the source where the most number of publications has been published. Also, 81.8 % of the publications were Conference papers, 9.1 % were Journal papers (Computers in Industry) and the rest were Thesis publications (NSU Thesis).

Table 7 Quality assesment result per selected publication

References	QA1	QA2	QA3	QA4	QA5	Score
Farid [13]	1.0	0.5	0.0	1.0	1.0	3.5
Farid [14]	1.0	1.0	0.0	1.0	1.0	4.0
Farid et al. [15]	1.0	1.0	0.0	1.0	1.0	4.0
Farid et al. [16]	1.0	1.0	0.0	1.0	1.0	4.0
Farid et al. [17]	1.0	1.0	0.0	1.0	0.5	3.5
Gallardo-Valencia et al. [6]	1.0	1.0	1.0	1.0	1.0	5.0
Gallardo-Valencia et al. [18]	1.0	1.0	0.0	1.0	0.5	3.5
Hvalshagen et al. [19]	1.0	1.0	0.0	0.0	1.0	3.0
Kumar et al. [20]	1.0	1.0	0.5	1.0	0.5	4.0
Laporti et al. [21]	1.0	1.0	0.5	1.0	0.5	4.0
Liskin [22]	1.0	1.0	1.0	1.0	1.0	5.0

Publications' synthesis. After reviewing the full text of the selected studies, there were identified 3 RE proposals that make simultaneous use of use cases models and user stories (Athena, K-gileRE and NORMAP). The main characteristics of each proposal were extracted in order to compare their similarities and differences. In all of them, the user stories are applied differently before the use cases. Athena and K-gileRE construct the user stories through collective communication between the stakeholders and analysts. In NORMAP, each of the system requirements must be converted into a user story following the W^8 card format extension.

Furthermore, although Athena mentions its capacity for handling NFR elicitation, that skill depends on how much detail has been included in the user stories. Consequently, the method will fail if the information related to the NFR requirements is ambiguous or incomplete. On the other hand, NORMAP has pre-established a list of metrics that allows the correct detection of NFR and its impact during the project's risk analysis.

3 Discussion

This Section presents the answers for each of the research questions proposed on Sect. 2.

RQ1: *Are there any proposed models that make simultaneous use of user stories and use cases model?*

Three RE methods that combines the use of user stories and use cases have been identified from the selected papers: Athena [21], K-gileRE [20] and NORMAP [13–17].

RQ2: *Do any of the proposed models take into account the elicitation of non functional requirements?*

From the found methods, NORMAP makes use of an user story extension for getting additional information of the client necessities like quality attributes prioritization and impact analysis evaluation. It also proposes 3 new components for the requirements modeling: AUC (a simplified use case diagram), ALC (for representing NFR associated to an AUC) and ACC (proposed solutions for an ALC).

On the other hand, even though the authors of Athena affirm that it can be used as a tool for NFR elicitation, this method does not have enough tools to guarantee the correct elicitation of these kinds of requirements.

RQ3: *Do any of the proposed models have been validated or are used by the industries?*

From the 3 found methods, none of them has been evaluated in a non-academic environment. In the case of Athena, its authors proposed to evaluate the method in a real environment in a future study. K-gileRE has only been validated in a small project where it showed good results; but it is necessary to validate the method in bigger projects, so its behavior in real projects can be predicted. Moreover, the NORMAP method was validated making use of a real project data and documentation; however it is necessary to validate the method over a more diverse list of projects before its results can be generalized.

Even though the papers of Hvalshagen et al. [19] and Gallardo-Valencia et al. [6, 18] do not propose a RE methodology, the results from their experiments related to the combined use of user stories and use cases bring a significant input for the proposal of new solutions or for improving any of the found techniques.

4   Threats to Validity

According to Jedlitschka et al. [24] there are 4 possible threads to validity that must be discussed.

Construct Validity: The search queries were built from words' synonyms of each research question's PICOC and were ran in each of the selected data sources. Some relevant studies might have not been included due to being indexed in non-included data sources or they might have terms which were not considered during the building of the query.

Internal Validity: In order to mitigate the risk of the study selection bias, the adviser validated the analysis performed by the main researcher.

External Validity: In order to mitigate the threat related to the incapability of generalizing the results of this study, the search process was run multiple times.

Conclusion Validity: In order to mitigate the threat of excluding relevant studies during the SLR, the inclusion and exclusion criteria were carefully built. Also, the quality of the relevant studies was evaluated through a quality assessment checklist.

5 Conclusion and Future Work

The objective of this review was to identify and evaluate RE methods that simultaneously used user stories and use cases modeling. From the 45 found studies, 11 publications were selected. From them, 3 proposal solutions were found: Athena, K-gileRE and NORMAP. Each of these proposals has been validated in an academic controlled environment; however, none of them have been evaluated in a real life environment. Consequently, it is not possible to measure their actual efficacy.

Moreover, each of the methods has some characteristics and assumptions that do not necessarily apply to a real environment situation. In Athena and K-gileRE there is no guarantee that the stakeholders will willingly have the availability and interest to work collectively or that the analysts will share with the stakeholders their knowledge on the requirements analysis. In the case of NORMAP, because of its complexity, is highly dependable of its CASE tool (NORMATIC) even though it was developed for being applied in agile projects. Furthermore, in spite of the fact that its proposed use cases give input related to the NFR of the software to be implemented, it does not include the necessary information to identify which actor initializes a specific use case.

In conclusion, there have been a few publications that has presented the advantages (or disadvantages) of combining the use of both techniques, so future studies on this topic can analyze the benefits of applying these techniques on agile (or non-agile) projects and how its combination can affect the level of ambiguity or completeness of requirements during the software development life cycle. Also, from the identified solution proposals, it is recommended to evaluate them in the industry in order to measure their efficacy and how much they do satisfy the needs of the people who applied them during the elicitation process.

The next step will be to evaluate if the simultaneous usage of user stories and use cases benefits communicability and transparency during the requirements elicitation.

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