A Survey of Software Requirements Engineering Practices in Turkey

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Abstract: *Quality software products and services are becoming increasingly important as computers and smart devices are used widely. To be achieved the required levels of quality it is crucial to give importance to the software development process. The success of the software products and services depends on the accuracy and completeness of the requirements. Despite the importance of the issue, studies carried out about requirements engineering practices related to Turkey are very limited. In this study, we aimed to find out and characterize a high-level view of requirements engineering implementations in the Turkish software industry. To achieve this objective, we designed an online survey based on the Software Engineering Body of Knowledge (SWEBOK) and Business Analysis Body of Knowledge (BABOK).Although our data are not sufficient the research shows that, to draw statistically significant results, it appears that industries under regulation typically have more well-defined requirement engineering practices.*

Keywords: Requirements engineering, software engineering, software process improvement, industry practices, survey, Turkey

1. Introduction

Every organization that develops software aims to produce quality products by realizing successful projects to meet the needs of its stakeholders. The Standish Group's report published in 2015 states that considering the budget, time, scope and quality constraints of the projects, the success rate is 29%. 19% of the projects were canceled, and the remaining 52% could be completed by budget or timeout, quality loss or scope contraction [1]. According to the same report, in the top ten factors affecting the success or failure of the projects, "clearly stated requirements" are in the third place. Similarly, the changes and / or lack of requirements is the second and third among the project difficulties, and the first among the factors causing the cancellation of the project.

Requirement engineering is a process in which the possible system should be defined. Requirements serve as a guide for the software development team. The purpose of requirements engineering is to guide software development activities to produce the right software [2]. If the requirements are not achieved correctly from the right stakeholders, it is highly likely that the project will fail, even if the rest of the project is well executed. Complete and accurate requirements provide many benefits, such as avoiding errors, improving quality and reducing risk in the software development process [3, 4].

The Software Engineering Body of Knowledge (SWEBOK) defines software requirement engineering activities as the determination, analysis, specification, approval of, and management of requirements throughout the entire lifecycle of the software product [5].Another important source for business analysis and requirements management is the Business Analysis Body of Knowledge (BABOK) [6, 7].In this study, we mainly based these two sources for our field research and studies.

The goal of the survey reported in this paper is to provide a broad view of the Turkey software industry, focusing on the software requirements engineering practices. We believe this information will benefit both SWE professionals and also researchers both in Turkey and worldwide, identify the areas of strength and weakness, and encouraging more academia-industry collaborations.

The remainder of this article is structured as follows. Background and the method followed in conducting the survey of the related work is presented in Section 2. We describe the results and main findings in Section 3. Finally, in Section4, we draw conclusions and suggest areas for further research.

2. Background

In our literature review, we were observed that there have been very few studies on software requirements engineering in Turkey. Considering the worldwide studies, different studies have been carried out in many countries especially in America and Europe for many years. In this section of our study, we briefly review the existing work on field studies on requirements engineering, especially since year 2000, before we describe the results.

Most of the international studies involve companies that are much bigger than those that characterize the Turkey Software development industry [8, 9, 10, 11. 12, 13, 14]. Three studies were found that focused on small and medium enterprises (SMEs).

A study of 16 Australian companies covered 28successful software development projects was carried out in2005 [15] using both questionnaires and semi-structured interviews. The study looked at the total amount of project effort involved in all RE activities and the proportion of total RE effort that each of the RE activities represented. Among the findings were that there was a difference in RE effort between internal and external projects and that more structured processes were evidenced for mission critical and external projects.

Another study [16] concentrated on the relationship between Requirements Engineering and project success. This covered both Australian and US companies. This was a large study and one of the major findings wasthat getting good requirements and effectively managing those requirements is a strong predictor of project success.

A thorough search has resulted in identifying two studies of software development practice in New Zealand that have included specific questions about requirements engineering [17, 18].

In these studies, the researchers created a short list of 65companies and successfully conducted phone interviews with 24 of these. The findings from this study include importance of requirements tracing importance, technique usage and requirements tracing.

In Turkey, to best of our knowledge, the 2001 survey [19] by Aytaç et al. who were members of the Turkish Society for Quality, was the earliest survey on the topic. Their survey followed the Software Engineering Body of Knowledge (SWEBOK) (version2004) [20] and the ISO/IEC 15504 standard, also known as the Software Process Improvement and Capability Determination(SPICE) for design of the questions. Practices such as software requirements, project management, configuration management, verification and validation, risk management, quality assurance, subcontract management, and process management were reported.

Later in 2009, Aykol replicated the 2003 survey [19] with some revisions, and published the results as a MSc thesis [21]. The goal was to analyze the changes and trends in the SE practices in the Turkish software industry from 2001 to 2008. State of the practices remained stable between 2001 and 2008. However, this would be misleading as there were no participants from defense industry in 2008 and the author suggests that defense industry has an above average process maturity.

The study by Sökmen in 2010 [15], sponsored by the Scientific and Technological Research Council of Turkey (acronym in Turkish: TÜBİTAK), was a survey of 450 sample software firms. Most of these companies (62%) have been established after year 2000, indicating the recent growth of the software sector in Turkey. These study shows that Turkish software industry is still young and eager to grow.

Sökmen's study [22] also reported findings for some software project characteristics.

Last but not the least, there has been a series of annual surveys, called the "Turkey Business Analysis Reports", have been conducted by the BA-WORKS since year 2015 [23, 24, 25, 26]. These annual surveys focus on business analysis in general and have been conducted by soliciting input from professional business analyst in Turkey, and present various statistics about the following topics: business analysis techniques, methodologies, tools, process, maturity and skill set.

3. Research Method

The general objective of this survey is to examine the current practices of software requirements engineering processes and to identify the related issues and problems which commonly occur in conducting business analysis in Turkish organizations. In this section, we explained our research method and its application.

1.1. Survey Design

Looking at the previous research discussed in section II, most of the studies used questionnaires, interviews or a mixture of both methods. Some used observation and some used a focus group [27]. Bearing in mind the objectives of this research, it was decided to use a questionnaire to reach as many participants as possible, and to follow this up with interviews with selected sectors.

We used survey questionnaire technique to gather data on process problems. The advantage of questionnaire is to collect large amount of information from different companies in short
time and in cost effective way.

The companies for our survey were selected so that they represent different application areas, sizes, ages, etc. Thus, the survey gives a general overview of different kinds of companies and their attitudes to RE. Even if this approach leads to a situation where the companies are not fully comparable, it was selected since it gives an idea of the development path from a start-up to a large software company.

1.2. Survey Questions

We systematically designed an online survey based on RE literature [28, 29, 30, 31, 32]. We also benefited from the SWEBOK (version 2004) [5] in categorizing our survey and its questions. Additionally, we reviewed the similar past surveys and designed a draft set of questions. The authors then consulted with several industrial practitioners to do a careful peer review on the draft set of questions. Getting feedback from industrial partners in design of surveys is a well-known approach. The feedbacks from the industrial practitioners were used to finalize the set of survey questions.

After the iterative design and improvement of the questions, we finally had 24 questions. The complete list of the questions used in the survey is shown in Table 1.

Table 1: Survey Questions

Question Number	Question
Q1	Your education:
Q2	Your area of study:
Q3	Your experience in software requirements analysis:
Q4	The sector which you are working in:
Q5	Your current position in your organization:
Q6	How many people are working on the software requirement analysis in your organization?
Q7	Have you received training from an expert or person specialized in software requirement analysis during your academic education or in your business life?
Q8	Which of the following best describes your certificate status in the field of software requirement analysis?
Q9	Which of the following is the best way for software projects, change requests, and maintenance support?
Q10	Which of the following best describes the

	organization of software requirement analysis activities in your company?	
Q11	What are the most basic problems encountered in your business organization?	
Q12	Mark the appropriate analysis of your business analysis / requirements management processes in your organization.	
Q13	Which of the following techniques do you use in your software requirement acquisition work with your stakeholders?	
Q14	Which of the following techniques do you use in your work on eliciting requirements, which you make out of stakeholders?	
Q15	Which of the following techniques are used in the documentation and analysis of requirements?	
Q16	Which of the following techniques are used to model requirements?	
Q17	Which of the following techniques do you use during the prioritization of requirements?	
Q18	Do you keep the following information together with the requirements in writing and documenting requirements?	
Q19	Which of the following apply to the approval of requirements in your organization?	
Q20	Which of the following are you using to manage requirements?	
Q21	Which of the following are included in the analysis documents created in your institution?	
Q22	Which of the following types of requirements is included in the analysis document in your organization?	
Q23	Which expressions best describe your organization to ensure the quality of software requirements?	

Most of our questions had quantitative pre-designed multiple-choice answers while a few had qualitative (free text) answers

1.3.   Data Collection and Analysis Procedure

We distribute survey questionnaire among over 10 different sectors. The participants were primarily in a project management, product management, analyst developer, product owner or business analyst role, with responsibility for RE activities on the relevant project. The responses were, however, anonymous to allow our respondents to freely share their experiences made within their respective company.

The survey was hosted on an online survey hosting service called Survey Monkey (www.surveymonkey.com). The survey was available to participants for two months during November and December of 2018. Participants were asked to complete the survey online and participation was voluntary and anonymous.

To ensure that we would receive as many responses as possible, we followed the following survey invitation strategy. We sent email invitations to our network of partners/contracts in Turkish software companies. We also made public invitations to the Turkish software engineering community by placing messages in social media, e.g., LinkedIn. 158 software practitioners across Turkey took part in our online survey and our survey data includes all those responses.

The general objective of this survey is to examine the current practices of requirement processes and to identify requirement process problems. The results of the survey have been analyzed by using basic statistical methods [33]. We refrain from a detailed qualitative analysis and coding of the free-text answers, because this is out of scope of this paper. Yet, we use them to substantiate the discussion and interpretation of the ranking of importance of the problems.

4.   Survey Results and Findings

In this section, we present the study results. In section 4.1, we give an overview of the study population to deliver context information. In subsequent sections, we answer our research questions in a step-wise manner.

1.4.   Study Population

Of the 158 participants who responded to the study, 157 responded to the training question, and 89.91% of the respondents were found to have a university or higher degree.36.94% of the participants with postgraduate education. In addition, the majority of the participants, 60.76%, graduated from the department of IT or related to IT.
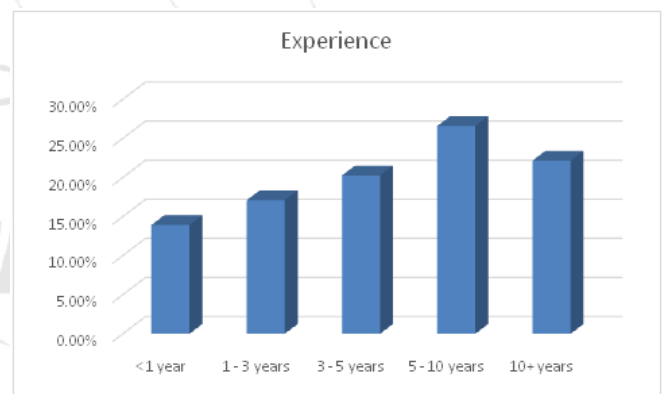

Figure 1: Experience

As can be seen from figure 1, there are no big differences among the distribution of experience of the participants. However, when we look at the sectors studied, the largest share in the 10 sectors mentioned is IT with 56.33%.The IT sector was followed by finance with 10.76, and then followed by the production sector with 5.70.

When the current tasks of the employees are examined in the institutions, managers take first place with 19.75% followed by software developers and analysts.
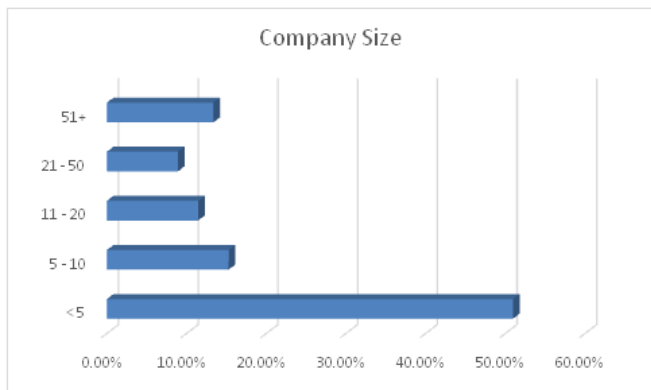
Figure 2: Company Size

It is observed that half of the participants are from start-up level companies, while the remaining 50% have a close distribution.

1.5. Survey Questions

Answers for Q7 (Have you received training from an expert or person specialized in software requirement analysis during your academic education or in your business life?) shows that half of the respondents have received some kind of training related software requirements (figure 3).
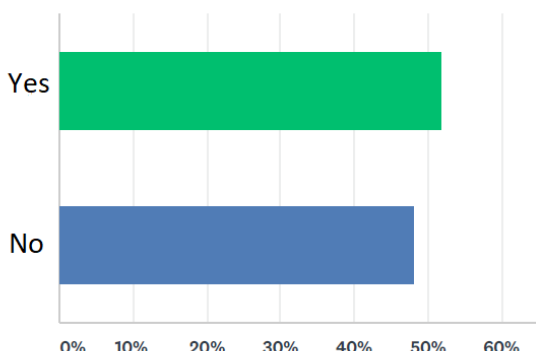

Figure 3: Training

When we look at the certificates of participants in the field of analysis (Q8), it is seen that only 14.65% of them have a valid certificate. Of the remaining 6.37% previously received a certificate, 21.66% received a training for a certificate but did not take action to obtain a certificate. 57.32% of the participants are not certified or have no planning.
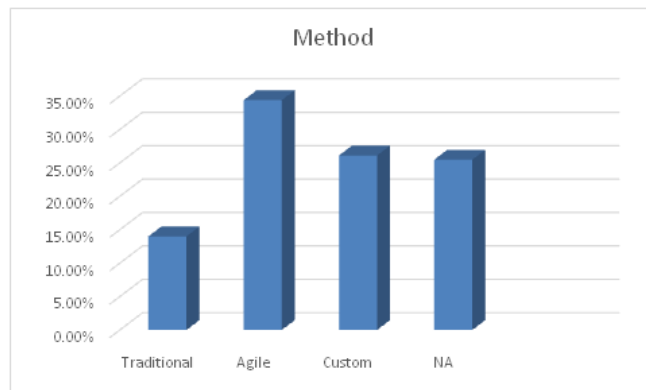

Figure 4: Repuirements Engineering Method

In figure 4 we can see the result for Q9 that questions using methodologies for requirements engineering. As can be seen from the figure Agile methodologies has found more places than the others. it is also remarkable that 25% of the participants say that they do not use a specific method.

In response to the answers to Q10, it is seen that the software requirement analysis of the institutions is preferred by IT units (43.23%), while 21.29% of the participants think that the analysis will be more accurate for the project management offices. 20.65% of the rest is carried out by analysts positioned in business units.

Q11 asks "What are the most basic problems encountered in your business organization?" and in this question where more than one option could be selected, the participants placed "poorly defined requirements" in the first place with 70.06%.In the second place, "frequent changes" take place with 63.06% while the time pressure ranks third with 56.69%.
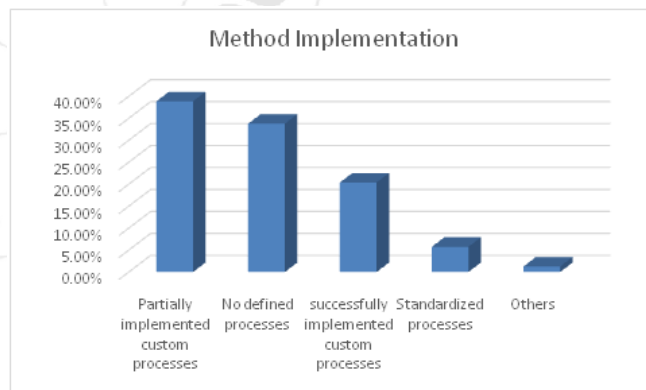

Figure 5: Method Implementation

As you can see in figure 5 for Q12, most of the respondents implementing international standardized processes, fully or partly implemented custom processes. %33, 76 of the respondents says that they do not use any specific processes defined and they conduct their activities based on their own experiences.

According to the answers given to Q13, the most preferred elicitation method is "interview" with 77.71%, while the "brainstorming" takes second place with 52.87%. In this question, where participants can mark more than one

choice, the third place is "observation in the workplace" with 43.31%.

Which of the following techniques do you use in your work on eliciting requirements, which you make out of stakeholders?

Among the answers to the Q14, where the preferred techniques are employed when working with resources other than stakeholders while eliciting requirements, the "document analysis" is placed at the first position with 76.77%. Afterward, the analysis of similar products comes with 49.68% and the comparison comes with 39.35%. In addition, it was observed that reverse engineering was applied at a rate of 22.58%.
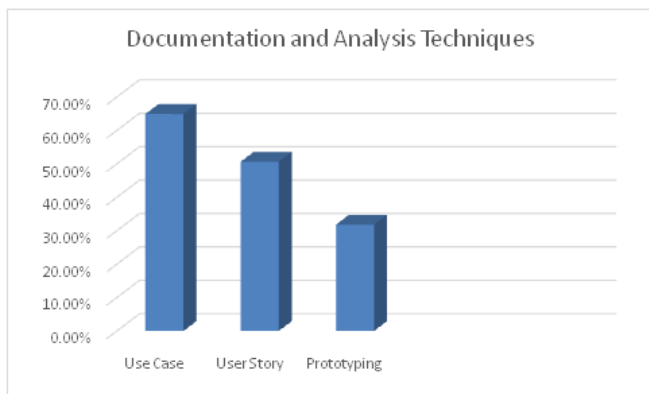

Figure 6: Documentation and Analysis Tehcniques

Participants were asked the Q15 (Figure 6), which techniques were used to document the needs of the requirements during the documentation and analysis of the requirements, and the ability to mark multiple response styles, the results are respectively Use Case (%64, 94), User Story (%50, 65) and Prototyping (%31, 82)

According to Q16's responses the most used modeling technique is "business workflow diagram" with %74, 19. Scope modeling (%35, 48), Roles and Permission Matrix (29, 03%) can be seen other two most chosen methods.
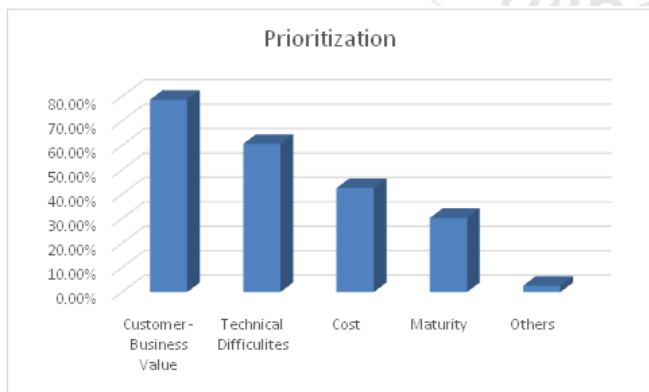

Figure 7: Prioritization

Most of the respondents say the number one prioritization technique they use (Q17) is customer business value (78, 71%). Other techniques are seen as technical difficulties (60, 65), implementation cost (42, 58%) and requirements maturity (30, 32%), respectively.

The answers given to the Q18, which were asked to the participants that which key concepts they use in the specifying and documenting of the requirements, are shown in Table 2.

Table 2: Key Concepts to Document

| Options	Responds (%)
Requirements' source	54, 25
The date on which the requirement was defined	45, 10
Dependencies between requirements	44, 44
Identify the requirement code (ID)	24, 84
Requirement type	43, 79
Version of requirement	31, 37
Requirements' author	44, 44
Requirements' status	45, 10
Priority of requirement	51, 83
The complexity and degree of difficulty required	30, 72
Justification of the need	47, 71
Other	3, 92
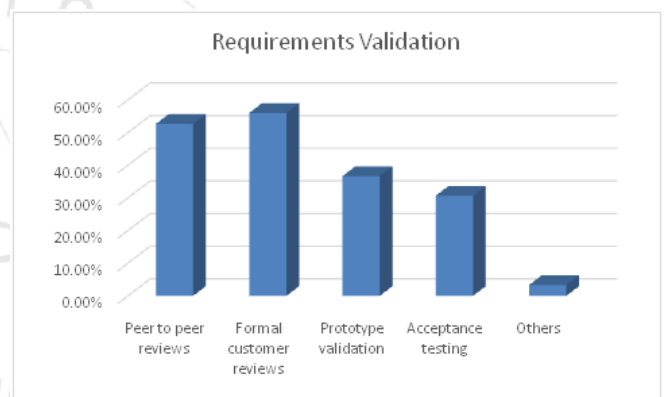
Figure 8: Requirements Validation

In figure 8 you can see the responds to Q19. Most of the respondents declare that they use formal (56%) and informal (52, 67%) reviews to validate requirements. 36, 67% using prototype validation and 30, 67% are considering acceptance testing as requirements validation.

Only 15.89% of the respondents who answered the Q20, which we asked the participants about the requirements change management in their institutions, say that they implement an organizational change management system. The remaining participants indicated that they do not have an organizational change management system or if so they are not implemented.

The answers to the Q21 indicate that the most widely used requirement documentation and management tool is spreadsheet programs with 47, 06 %. According to the results, Jira comes second with 38, 56% and word processing programs comes third with 35, 29%. In this question where more than one answer option can be marked, the participants stated that 24.84% of firms use special software developed by themselves.

The answers are given to the Q22 where the participants are asked what the content of the analysis documents are included shown in Table 3.

Table 3: Contents of Analysis Document

Options	Responds (%)
Stakeholder Definitions	43, 42
Scope, out of scope	55, 26
System, user, hardware, etc. interfaces	56, 58
Design, software and system constraints	61, 18
Characteristics of users	11, 84
Assumptions and dependencies	36, 84
Roles and authorization	53, 29
Screen prototypes	56, 58
Required diagrams	48, 03
Data, terms, abbreviations	41, 45
Other	2, 63

In the Q23, the questions given to the participants about the software requirements and the quality of the requirements management process are presented in the table 4.

Table 4: Requirements and Requirements Management Quality

Options	Responds (%)
The analysis team checks the conformity of the analysis document and requirements with the standards.	40, 69
Regular inspection of requirements and analysis documents is carried out.	26, 90
In order to review requirements, people with different specialties are reviewed.	28, 28
A checklist is used to check that the requirements and analysis document conforms to the standards.	26, 21
Check whether the requirements can be tested.	34, 48
Technical requirements for technical requirements are obtained from the technical team.	58, 62

1.6. Summary and Findings

As a result of the simple basic evaluation of the data obtained from the field study and the comparison of sectoral based results, the following major findings were reached:

1. Inadequately defined requirements and demands are identified as the number one process problem for all sectors.
2. Since they are subject to regulation, it is observed that the requirements management processes in the telecom, finance and energy sector are implemented at the institutional level and more effectively. In addition, it has been determined that the average education and experience is high in these sectors.
3. Although there are defined processes in the manufacturing sector, it is stated that there is no effective implementation as energy, telecommunication and finance sector.
4. It is observed that there is no standardization on requirement documentation. MS Word and Excel are the most commonly used tools for the documentation of requirements. Another tool used is Jira, which is developed for software developers to perform task management. It was observed that vehicles developed specifically for requirement management were not preferred.

5. There has been no variation in requirements acquisition, analysis and documentation. According to the answers of the survey participants, organizations or employees tend to use some of the techniques they designate in all projects.

5. Conclusion and Further Works

As a result of our studies to determine the overall status of implementation of requirements engineering studies in Turkey, particularly in energy, finance and industry TELECOM, it yielded positive findings. Nevertheless, it is observed that there are still many issues that are still open to improvement, especially the other sectors, 5 of which are presented in the previous section as the main findings of the study.

The main complaint of the sector independently is the immature demands and requirements. It is evident that more specific field studies are needed to determine the need for improvement in this area and the deficiencies in demand ripening. Improvements with the results of these studies can lead to more successful projects with more precise demands and requirements.

The fact that other sectors, especially production, benefit from the successful applications in energy, telecommunication and finance sector can lead us to realize a better requirements management as a nation and to successfully complete software projects.

Another field study that can be done in the field of software requirements processes may involve the re-examination of all problems within the framework of agile principles. Thus, the concerned people may have the chance to evaluate from another perspective.

This research serves as a starting point in motivating continuing research in requirements practice in industry and project success factors. We intend to conduct new focused and detailed researches in this area in the future. We hope that the results presented here would provide useful background to such a study for the other researches too.

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