

A Research Study on Critical Challenges in Agile Requirements Engineering

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Abstract -: Now a days, agile software development methodologies are gaining popularity. Many Information Technology (IT) companies are motivated to implement these methodologies for software development. Effective Agile adoption increase overall productivity and quality of software but the complexity of software projects and multidisciplinary nature of requirements engineering (RE) makes the agile implementation a cumbersome process. The objective of this research work is to identify challenges in terms of agile requirements engineering. A qualitative research methodology was used to conduct a survey analysis for agile requirements engineering and capture key challenges and significant barriers that recurrently appears in the pathway of efficacious requirements engineering that will affect the overall software development. The survey was conducted on more than 80 respondents having sound experience in the IT field. The respondents are working in IT companies located in North America and India. However, the results depict that the acknowledged challenges are often not limited to any specific agile method like scrum or extreme programming but its general to overall agile software development. Thus, we can accomplish with the fact that companies are still dealing various problems against agile implementation particularly, in terms of effort estimation, architectural structure, documentation and end-user involvement.

Key Words: Agile software development, Agile Requirements Engineering, Information Technology, Requirements Engineering, Scrum, Software Engineering etc.

1. INTRODUCTION

Traditional Software Development Models like waterfall, rapid application development and spiral models, employ immense planning, organized process, intensive reuse, rigorous documentation, vast design and coding process [1]. They are also known as heavyweight development models. However, several traditional models have been developed to deliver substantial throughput, but none of them are free from these main issues like budgets overrun, missed deadlines and faulty products [2,3]. These models are unsuccessful to offer advances in productivity, consistency, and in trustworthiness [3].

In current Information Technology (IT) world, Agile Software development (ASD) methodologies are widely gaining popularity to the solution for the issues in traditional software development. Agile is a lightweight iterative software development methodology that was originated to well-match with the rapid development [4]. As an iterative methodology, each iteration in the agile methodology depicts a small scale and confined Software Development Life Cycle by itself [4]. All software development phases have to be completed in a single iteration. One the most striking features of agile methodology is that requirements are not fixed, it supports frequently changing requirements that makes it highly flexible and more adaptive to fluctuating environments. Agile software development methods adoption not only offers numerous benefits such as better quality of product, reduced cost and development time, but also creating certain challenges in front of software developers [5]. When there is constant change in requirements, project development gradually become complex that leads the project into risk [6]. It has been observed that security should be included since the inception of software system that is requirements engineering phase [7]. Many researchers are working to explore challenges in Agile Requirements Engineering by means of diverse research methods. The aim of the present paper is to identify critical challenges in agile requirements engineering.

The remainder of this research paper is as follows: next section depicts the research contribution of researchers related to agile requirements engineering. Methodology section describe the research methodology implemented to conduct the present study. Result and analysis section discuss the issues and challenges of the agile requirements engineering discovered via survey analysis. Finally, the conclusion and further research work describe future research direction.

2. LITERATURE REVIEW

Literature reveals that various researchers are underway on different facets of agile requirements engineering. Many researchers used different methods to find the challenges in the field of agile RE. A collection from the trend setting research works are briefly discussed below:

B. Ramesh, L. Cao and R. Baskerville presented a systematic study about agile requirements engineering practices used in industries. They collect data from sixteen organizations situated in three United States metropolitan areas to discover details of RE practices along with the benefits and challenges. The agile challenges they found in their study are related to cost and schedule estimation, negligence of non-functional requirements, end-user involvement, minimal documentation, requirements prioritization and insufficient requirements verification [9].

E. Bjarnason, K. Wnuk, B. Regnell performed an investigation to identify how agile Requirements Engineering can overcome the challenges of traditional requirements engineering approach with a help of a case study with nine practitioners of a large software development company. The major issues found with the case study is related to planning for agility, weak requirements prioritization, ineffective effort estimation, schedule overrun, lack of documentation of requirements and quality issues [10].

Mohamad Kassab conducted a web-based survey to understand the real requirements engineering practice in agile environments. The participants are professionals from industrial background and from different geographic locations. The survey was created using QuestionPro survey tool and survey was completed in April and July 2013 with two hundred forty-seven participants from twenty-three countries. The survey responses are filtered and comparatively analyzed according to the traditional and agile requirements engineering. The findings of this research depict some current industrial practices like considerations of non-functional requirements in effort estimation, introduction of new terms in existing methodologies like user stories in waterfall [11].

I Inayat, S.S. Salim, S. Marczak, M. Daneva, S. Shamshirband performed an organized literature review on agile requirements engineering practices to get more detail knowledge about the challenges. They conducted literature review on twenty one research papers published from 2002 to June 2013. They formulated and applied particular criteria for the selection of research papers. With this systematic review seventeen agile requirements engineering practices and eight agile RE challenges were identified. The most common challenges identified are dealing with non-functional requirements, team organization, minimal documentation, end-user accessibility, unsuitable architecture, cost and deadline estimation, contractual limitations, changing requirements and its valuation. The study suggested researchers/practitioners to perform more research on agile RE practices in order to resolve the challenges [12].

H.F. Soares, N.S.R. Alves, T. S. Mendes, M. Mendonca, R.O. Spinola, conducted an exploratory study and literature review in order to find the documentation debt. The outcome of both studies depicts a list of reasons that incur

documentation debt while working with agile requirements. The reasons of requirement prioritization, dealing with non-functional requirements, lack of information and volatility of requirements, inter dependencies among requirements, changes of impacts, communication and alliance with end-users and requirements validation. In order to manage the technical debt, this is a vital step from a preventive perspective [13].

V.T. Heikkila, D. Damian, C. Lassenius, M. Paasivaara performed a mapping study in agile requirements engineering to review the systematic literature. Total twenty-eight articles from time span 2004 to 2014 were studied. The results show the benefits from effective agile RE includes minor overheads, improved understanding of requirements, effective resource utilization, awareness to changing environment, speedy delivery of product value, and better customer relationships. The major challenging areas are also found from the study are insufficient the user story format, requirements prioritization, rising technical debt, implicit requirements acquaintance, and vague effort estimation [14].

Kaiss Elghariani and Nazri Kama presented a paper to describe RE practices along with the challenges faced by agile team members. Author selected twenty-two research papers and eighty organized literature assessments are conducted. They discussed about detailed knowledge of requirements engineering activities in agile approach. The presented research findings help the researchers to understand the implementation problems faced by software experts in RE practices in Agile environment [15].

Wasim Alsaqaf, Maya Daneva and Roel Wieringa investigated an exploratory case study of real life largescale distributed agile projects to realize the challenges agile teams face in terms of requirements. They conducted Eighteen semi structured open-ended in-depth interviews with agile practitioners working in six different organizations in the Netherlands. They identified nine major challenges that affect agile implementation [16][18].

Rashidah Kasauli, Grisha Liebel, Eric Knauss, Swathi Gopakumar, Benjamin Kanagwa Chalmers, conducted multiple case study through two car manufacturers, one telecommunications company, and a one technology company. They describe the scope of agile methodology, challenges of requirements engineering and its impact on system development with the help of twenty qualitative interviews, five focus groups, and two cross-company workshops. They conclude with the fact that holistic requirements engineering model with agile software practices possibilities gains high-speed development, flexibility, and improve overall product quality [17].

Omer Uludag, Martin Kleehaus, Christoph Caprano, Florian Matthes performed a systematized literature review on frequent challenges in large-scale agile software

development. They examined wide range of IEEE journals, Scopus indexed journals, conference proceedings using ACM Digital Library, and Web of Science for conducting effecting literature review. They acknowledged seventy-nine challenges that are grouped into eleven groups [19].

3. RESEARCH METHODOLOGY

The purpose of this research study is to find the most significant challenges, existing in current state of art in agile development. The study gets insights into agile methodologies with the help of more than eighty respondents working in IT companies situated at India and North America. To get insight into actual problematic areas in agile requirements engineering, we gathered data from 18 multi-national organizations that uses agile approaches. The survey was a web-based survey created using the web-based SurveyMonkey tool and data was collected in February 2019. The survey consisted of twenty questions. After collecting the responses from the participants analysis of the data is done. Figure 1. depicts the overall survey approach.

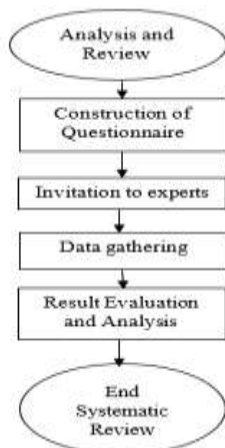


Fig1- Survey analysis approach

4. EXPLORATORY STUDY OF THE SURVEY ANALYSIS CONDUCTED USING THE TOOL-SURVEYMONKEY

The aim of this study is to investigate the present state of agile requirements engineering process compared to traditional methods for aiming to illustrate agile requirements phase, difficulties and limitations, in the context of software project development, from the vision of software experts and practitioners.

4.1 Survey Respondents and Projects Domain Features

To get deep insight in respondents' knowledge numeral questions were asked regarding their personal experience and project characteristics. Almost 79.52% respondents having more than one year of working experience and 20.48% respondents having less than 1 year of experience in agile.

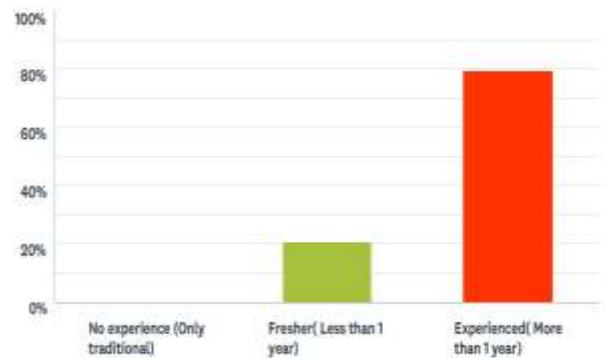


Fig 2- Respondents Experience in Agile Methodology

Survey analysis also reported about agile methodology used in the organization. Nearly 73.81% organization uses scrum methodology and 25% uses extreme programming, 2.38% organization uses Adaptive Software Development (ASD) and Dynamic System Development Method (DSDM), 1.19% uses Feature Driven Development (FDD). Respondents reported that 90% of the projects having release cycle of two weeks. Only 9.52% projects having release cycle of three weeks.

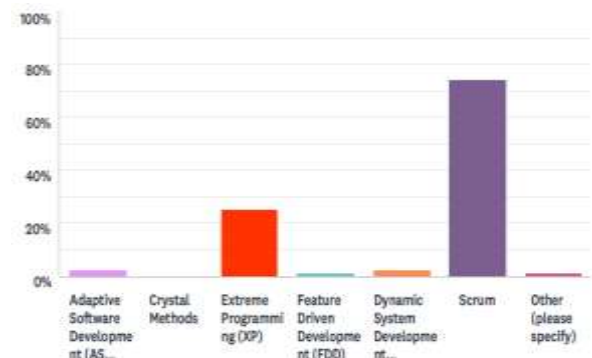


Fig 3- Agile Methodologies used in the companies

Respondents are accompanying with dissimilar organizations dealing with different project domains like banking/finance/insurance, manufacturing, telecommunications, publication, healthcare system, travel, education, government etc. Almost 40.48% respondents are

dealing with banking projects, 20.21% respondents are working in healthcare projects. 13.10% of the data was collected from telecommunication and travel domain software development projects.

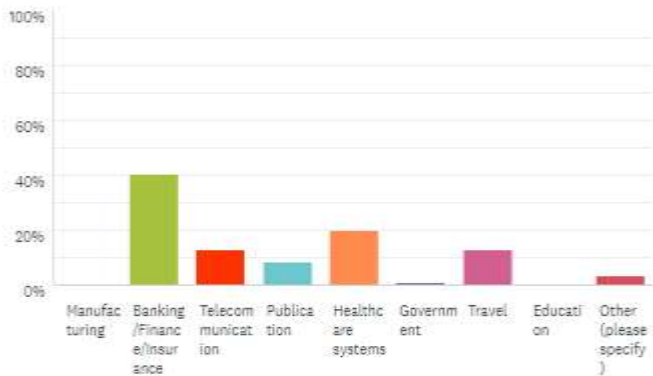


Fig 4- Project Domain

4.2 Agile Requirements Engineering Challenges Reported

This research study explores agile requirements engineering challenges. It has been observed that the most critical challenges in agile development are weak effort estimation, Inappropriate Architecture and Minimal Documentation etc. Table below depicts the challenges reported in survey analysis.

Table 1. Agile Requirements Engineering Challenges

Serial number	Challenges Reported	Description
1.	Minimal Documentation	User Cards such as user stories and task description only documentation used in agile that results in <i>problems to track dynamic requirements.</i>
2.	Weak effort estimation	Due to dynamic requirements it is not possible to make upfront estimations <i>that results in cost overrun and late delivery of product.</i>

3.	Inappropriate Architecture	Inappropriate requirements can affect other development phases like software design and implementation that results in <i>defective product outcome.</i>
4.	Inefficient quality assurance	No appropriate quality assurance technique is used this <i>affects overall product quality.</i>
5.	Customer availability	Clients <i>handiness</i> sometimes <i>results in overwork allocation.</i>
6.	Difficulties with coordination	Team members are located in different geographic location and work in different time zones that leads to <i>coordination issues between members.</i>
7.	Lack of Communication	Due to different geographic locations and cross-functional team members always need <i>additional communication.</i>
8.	Requirements volatility	Continuous dynamic requirements come with various <i>implementation and dependability issues.</i>
9.	Inadequate requirements verification	Misinterpretation and insufficient requirements verification by analyst results in <i>rework.</i>
10.	Staff with inadequate qualified skills	Team members with insufficient training leads to <i>project schedule overrun.</i>
11.	Lack of information	Functional Requirements are recorded as user stories only. No details of Software requirements are provided hence <i>Software Requirements Specification document is not prepared.</i>

12.	Gap between long- and short-term planning	There is a long-time gap between planning and actual execution that <i>results in changing the scope and rework.</i>
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requirements change dynamically throughout the development process. An exploratory study on recent state of agile requirements engineering is discussed in detail. Some of the current literature work is also elaborated in this paper.

Researchers have made vital advancement in this area. The presented research work delivers the deep knowledge of various challenging aspects that should be overcome during requirements engineering phase to get improved software product on time. It has been observed that the most critical challenges in agile development are weak effort estimation, Inappropriate Architecture and Minimal Documentation.

All the above-mentioned challenges may be overcome by refining the cross-functional communication between team members and effective effort and user stories calculations in order to delivery product on agreed schedule and cost.

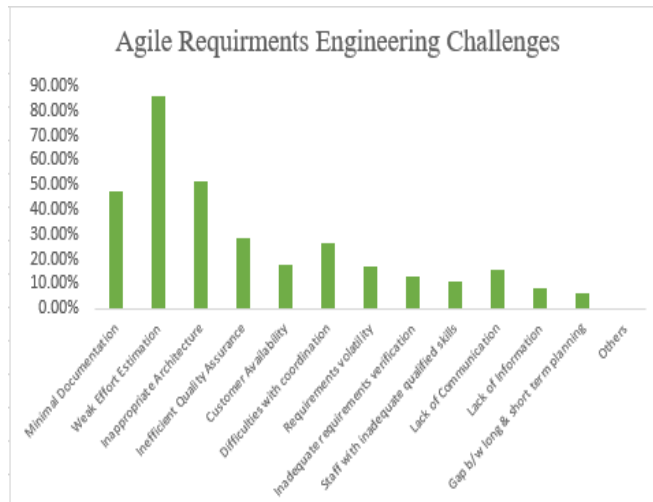


Fig-5 Graph depicting the challenges in Agile Requirements Engineering

4.3 Satisfaction Level with Agile Methodology

The survey analysis depicts that respondents are moderate satisfied with agile software development. There are various promising challenges that are becoming barriers in this field. Weak effort estimation, inappropriate architecture, inefficient quality assurance etc.

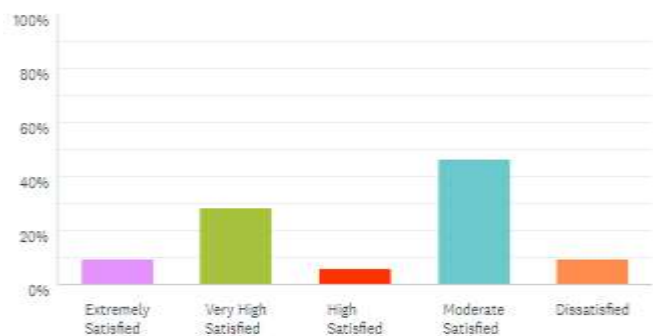


Fig-6 Satisfaction level with Agile Methodology

5. RESULT OF THE ABOVE SURVEY ANALYSIS AND CONCLUSION

Requirements engineering is the most difficult phase in which diverse stakeholders have different perspective and expectations about software system. Handling and implementation become more problematic when

6. Future Work

To reform and improve the outcome of this research work, number of respondents may be increase in survey analysis and also may be included from other geographical locations. Future work may also be done by using different research methods to identify issues in agile practices. This research work helps practitioner’s and researchers to improve agile methodology.

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BIOGRAPHIES



Mona Batra currently pursuing Ph.D. in the Department of Computer Science, Birla Institute of technology, Mesra, Ranchi, Extension Center Jaipur, India. She has completed her B. Tech from Rajasthan Technical University in 2011 and M. Tech (Computer Science) from JaganNath University, Jaipur. She is having four years of teaching experience. She has published various national and international papers on requirements engineering and security. Her research area includes: Vulnerability Assessment, Formal Methods, effort estimation and Requirements Engineering etc. Currently, she is working in the area of Agile Requirements Engineering.



Dr. Archana Bhatnagar is currently working in Birla Institute of technology, Mesra, Ranchi, Extension Center Jaipur, India. She is having more than 25 years of teaching experience. She has published various national and international papers in reputed journals. Her areas of interest are Software Engineering, Computer Networks, Computer Architecture, Data Structures, Design & Analysis of Algorithms.