

Influences of Requirement Change on Software Failure

Syed Adnan Afaq, Department of CA, Integral University, Lucknow, India
Md. Faisal, Department of CA, Integral University, Lucknow, India

Article Info

Volume 82

Page Number: 4178 - 4184

Publication Issue:

January-February 2020

Abstract

Most of the software requirements are not unfurnished in the initial level of development procedure of software. Software requirements are usually unavoidable due to frequent changes in user needs, changes in market and business policy and operating environment. Basically, requirement change management is also an important and challenging part of the software development process. Changing requirements are one of the main reasons of project failure or cancelled. The success and failure of any software project mostly depend upon project manager that how he manages the requirement change.

Several Requirement change management models and methods are introduced and performed different activities for mitigating the impacts of requirement changes.

The paper explores research effort done in the field of requirement change and helps to identify the goal of the study.

Article History

Article Received: 18 May 2019

Revised: 14 July 2019

Accepted: 22 December 2019

Publication: 21 January 2020

Keywords:- Requirement Change, Requirement Change Management, Requirement Engineering

I. INTRODUCTION

Software products are contributing at a very large level in any country's growth & development. Nowadays Number of people are depended on the software product, software product play a major part in human life. These types of software products can be seen in the working place, offices, home, the Internet, etc. Software product provides facilities in almost every business like education, hospitality, entertainment, economic analysis, research areas, manufacturing industry, and other several areas. Software products are contributing at a very enormous level in any country's growth & development, but the gorge side is that software industries are facing major challenges in terms of software success rate.

Software development has grown to be one of the leading at globally. The major objective of software engineering to design and produced a quality software product which fulfils the user expectations. Most of the software projects are failed due to several reasons like- Lack of Requirement Analysis, Poor Requirements Quality, Incomplete Requirement, **Changing Requirements & Specifications**. Requirements change refers to manipulations of requirements at the time of software development process [1].

Shalinka Jayatilleke et al. proposed a method to analyze the requirement change which is introduced at advanced levels. This process exist three steps i.e. Analyzing the requirement changes, identifying requirement change difficulties and identifying dependencies of the requirement [2]. M. Azeem, Jawad et al. described a system to analyze

the requirement change", "AZ-Model of software requirements change management in global software development"[3].

The literature has identified the root causes of change, impacts of changes and drawn several methodologies to tackle it.

II. Objective and Current scenario of Research

This paper describes previous research work relevant to Requirement Change. However, numerous of effort has been done in Requirement Management, and several methods have been introduced and exist in the industry, but still there are some lacks of analysis and methods which can minimize the different negative impact of requirement change.

In order to discover the associated effort completed in the field of requirement Change, dependencies in requirement management and different effects of requirement change etc., numerous research databases are explored, such as:

- Science Direct
- Springer-Links
- IEEE
- ACM
- Google scholar

There are more than 35 papers are filtered for finding the relevant work. To accomplish this, the parts of the papers are read. When a research work was found appropriate, it is examined and analysed.

The overall objective of this study was to enhance the knowledge in field of requirements change, looking for interrelated efforts, analysing whichever study has been completed in the area of requirement change.

The outcome of this research study discovered that however innumerable work has been finished in the field of requirement change, but still there is no special method or technique which emphasizes on negative impact of requirement change.

III. Software failure at a glance:

Projects Cancelled or Failed	Challenged	Succeeded	Reported year and reference
22%	39%	39%	2011 [Chaos 2015]
17%	46%	37%	2012 [Chaos 2015]
19%	40%	41%	2013 [Chaos 2015]
17%	47%	36%	2014 [Chaos 2015]
19%	45%	36%	2015 [Chaos 2015]

Table1.Chaos Report

The Chaos report classifies projects as: successful (which is completed on esteemed time and within esteemed budget),

challenged (which is not completed on time and within budget, failed (cancelled or not completed). Figure 1 shows a 5-yr Project assessment [4].

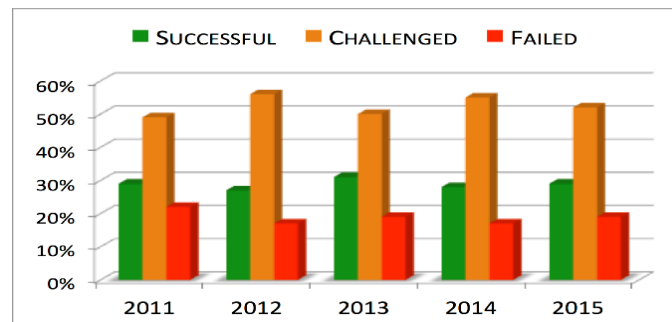


Figure 1. Chaos Report outcomes 2011-2015

Most of the software projects are failed due to several reasons like- Lack of Requirement Analysis, Poor Requirements Quality, Incomplete Requirement, Changing Requirements & Specifications. The organisations are classified by Standish Group according to their revenue such as large, intermediate and small organisation. A large organisation is such an organisation which revenue is higher than \$500 million dollars per year, an intermediate organisation which revenue is from \$200 million to \$500 million per year and a small organisation which revenue exists between \$100 million to \$200 million.

S. No.	Project Factors	Impaired % of Responses	Percentages of Response
1	Partial Software Requirements		13.00%
2	Absence User Involvement		12.3%

3	Absence of Resources	10.5%
4	Impractical Anticipations	9.8%
5	Inappropriate Executive Support	9.4%
6	Changes in requirement	8.8%
7	Unstructured Planning	8.2%
8	Unmannered IT Management	6.20%
9	Technical Knowledge	4.31%
10	Other	9.90%

Table 2. : Project Failure Factors

IV. Literature Review:

Changing requirement and specification is the main reason of software deficiency. Changing requirement and specification is a challenging task of software development

procedure. The major reason of requirement change is dynamic nature of user requirements, enhancement in shareholders' needs, customer structural changes, modifications in market strategies and obtainability of recent mechanism.

Didar Zowghi et al. (2002) performed "A Study of the Impact of Requirement volatility on Software Project Performance" [5]. This work describes the different effect of Requirement modification on different software system by different Literature review. This work also observed that requirement change has an important impact on budget and time exceed in any software development. This work also focuses on probe factors that are present to changing requirements at the time of the software enhancement process and different effect of requirement change on desired software achievement. This work also focuses on factors that include the primary requirements description, methodology that is used for system development, the focus on several software units, improper conversation between users and development party, capacity of the project, industrial and environmental factors.

The results show there is an uncooperative connection among requirement change and performance of the software system. Performance, measured by project accomplished on actual schedule and on esteemed budget. This is a direct symptom that the more changeable software specification converted the more expected it is that the system will be finished overdue schedule and over budget [6].

Romi Satria Wahono (2003) published a paper on "Analyzing Requirements Engineering Problems". This work describes the problems of requirement engineering. Romi described that there are several problems in requirement engineering like absence of user involvement, partial requirement, and specification, Changes in requirements [7].

N Nurmuliani et al. (2004) published a research paper on "Analysis of Requirements Volatility during Software Development Life Cycle" [8]. This work is totally focused on requirement change during software development. According to Didar, changes in requirement cannot be escaped; there are several scope to reframe our understanding regarding requirements change problem and effects of change. The problems of requirement change must be evaluated, what are actual reasons and sources of changes. This work describes that analysis of requirement volatility starts by gathering requirement change demand information. Requirement change demand papers remained gathered, divided, and investigated. The work indicates that the project manager must understand the changes, this contain; explanation of the requirement alteration, causes of requirement modifications, types of modification (addition of new requirement, removal of requirement, and variation of requirement), influences of volatility on system performance or papers, work assessment, period, and the individual who appeals the alteration.

Saffena Ramzan et al. (2005) published a paper on "Making decision in requirement change management" [9]. In this work, Saffena described that Software requirement is interlinked and often interdependent on several software

requirement and altering one constraint surely influence other requirement. This work focused on the decision-making process in change management. This process starts by the modification management scheme identifying that alteration is inescapable. Decision creation is an action which is achieved through software software development process; there must be presence of some accurate base of evidence on the basis of which any conclusion is taken. This effort indicate that it will improve the decisions through the organizations tackling requirements alteration and decision makers skilled enough to have several causes, that what is need of change, and why it is necessary.

N Nurmuliani et al. (2006) paper on "Requirements Volatility and Its Impact on Change Effort: Evidence-based Research in Software Development Projects" [10]. In this work, Nurmuliani says that effect of Requirement alteration is generally underestimated. This work focuses on the practice of requirements alteration categorization to assist in recognizing and appraising the degree of work essential applying requirements variations. The result show that Requirements volatility, especially adding new software requirements, after post-development phases are a major risk because change will directly impact on cost & schedule of the project. This paper represents empirical study on requirement change and associated budget by two dissimilar software systems inside a complex global software development environment.

Sangim Ahn et al. (2007) produced a work on "Requirements Change Management On Feature-Oriented Requirements Tracing" [11]. Sangim Ahn and Kiwon Chong talk about requirement change. This work proposes a model for managing requirements change constructed on the basis of requirement's characteristic. It is completely dependent on traceability link of the software requirement. This work includes requirement alteration hierarchy mechanism to create user requirements modification demand simplify by its characteristic. This model is normalized connection through alteration demand, atomic requisite, and characteristic. The process of change management include change demand, modification impact study, change request alternative plan, change appeal implementation, change appeal evaluation.

Alan M. Davis et al. (2008) produced a work "Requirements Change: What's the Alternative" [12]. The work says that each and every person takes the requirement change as a negative phenomenon. The study investigates the outcome of not creating requirement change with respect to variations in user desires. The work indicates that a lot of researchers have claimed that requirements alteration, increase probability of system failure. The work talk about this phenomenon is important, equal consideration must be assumed to alternation to consumers' and clients' needs, over which users cannot compromise.

Susan Ferreira et al. (2009) produced an effort "Understanding the effects of requirements volatility in software engineering by using analytical modelling and software process simulation" [13]. This work produced a simulation model with executable system dynamics to support the project team in comprehending the intricate

influences associated with requirement change. This paper describes comprehensive output since two scenarios that represent important budget, time, and excellence effects as an output of requirement alteration. This simulant can be employ such as a powerful mechanism to represent the different set of element connections and consequence belong to requirement change.

Rahul Thakurta et al. (2010) performed a work on “Understanding Requirements Volatility in Software Projects – An Empirical Investigation of Volatility Awareness, Management Approaches and their Applicability” [14]. This work focused on risk due to requirement change during software development. This is founded on a grouping of interviews and a survey in two stages and pursues towards analysis the structural exercises in handling with this hazard, and how it is exaggerated by the particular project performance system with regard to process model assortment decision.

D. Kavitha et al. (2012) performed a work on “Requirements Volatility in Software Maintenance” [15]. This work focused on the taxonomy of requirement volatility. Classification of requirement volatility consists of three elements: Type of requirement Change, causes of change, and what is the Source of change. This work includes the several impacts of requirement volatility and defines several guidelines to tackle it.

Arif Ali Khan et al. (2012) performed a work on “A Process model for Requirements Change Management in Collocated Software Development” [16]. This work produced a requirement change model that collect data from distinct RCM reports, case studies and research papers. This model includes seven steps i.e. change application, validation of application, rejection of application, collection, implementation of change, verification and updating of change.

Muneera Bano et al. (2013) performed a review work on “Causes of Requirement Change” [17]. This research work is focused to identify the reasons of requirement volatility. In this work causes of software requirements volatility are classified into two main types, essential causes, and accidental causes.

Arda Goknil et al. (2014) performed a work on “Change impact analysis for requirements: A metamodeling approach” [18]. This work indicates that whenever a change occurs in requirement, it is draft in SRS. But Requirement engineer must have manually analyzed the impact of a single change in requirement.

Zahoor et al. (2015) produced a work on “Impact Minimization of Requirements Change in Software Project through Requirements Classification” [19]. This work is based on the classification of requirement. The requirement can be classified into three classes; permanent, fewer likely to alteration and furthestmost expected to alteration. Requirement which don't have the chance of unpredictability will come under stable category, the requirement which has fewer chances of alteration will exist under less likely to change category and requirements having more possibilities of change will come under most likely to change category.

D. Kavitha et al. (2015) performed a work on “Comprehensive View on Defect Analysis and Change Control Process” [20]. This work includes defect analysis due to requirement change during software development. This work also includes the improvement of software quality and identification and prevention of defects. It also covers the change request analysis. Requirement change are logged by the change management using the software change application form.

Hussin et al. (2016) published a work on “Current Challenges of Requirement Change Management” [21]. This work includes the several tasks of requirement change management. This work indicates that important challenges of Requirement change management have been identified as reusability of requirement, requirement change anticipation, change activity measurement, clear connectivity with software artifacts and change management automation.

Mohammad Faisal et al. (2016) performed a work on “Stable Requirement Specification Framework: requirement volatility perspective” [22]. This work proposed a structure that can handle the requirement change in a quickly changing environment. This framework identifies the early requirement changes, predict the requirement changes and analyze the impact of changes. This framework is based on Stable Requirement Specification and effective into three classes; Volatility prediction, Volatility Identification, and Volatility assessment and management.

Khloud et al. (2016) published a work on “Identify and Manage the Software Requirements Volatility” [23]. This work proposed an outline that represents the reason of requirement modification and organization of requirement unpredictability at the time of software development. The proposed framework consists of four major activities such as Requirement elicitation and analysis of requirement, requirement Specification validation, causes of requirement volatility and manages volatility phase.

Waqar Hussain (2016) performed a work on “Reflections on Requirements Change Management in Global Software Development: A Multiple Case Study” [24]. This work covers the challenges and problems of requirement change management in worldwide distributed software projects. Basically, this work emphasizes on a formal interview for collecting and analyzing the requirements.

Abeer et al. (2017) published a work on “Software Requirements Change Management – A Comprehensive Model” [25]. This work is basically a comprehensive model. Abeer AlSanad designed a model for requirement change management that is known as CRCM model. It is compared with three available RCM model. Requirement engineer can change on requirement smoothly and easily with this model.

Shouki et al. (2017) performed a work on “Towards measuring software requirement volatility: retrospective analysis” [26]. This work is based on use cases to measure and analyze the requirement change of object-oriented system. Shouki used retrospective analysis for examining the expanse of change functional in the sequential model of a software system.

Research Work	Description	Limitation
Analysis of Requirements Volatility during Software Development Life Cycle (N Nurmuliani et al., 2004)	This work focuses on requirement change process that covers up the maximum Requirement change activities.	<ul style="list-style-type: none"> Validity is not approved. Single case study Approach
Understanding the effects of requirements volatility in software engineering by using analytical modeling and software process simulation. (Susan Ferreira , 2009)	It is a simulation model with executable system dynamics to assists the project manager in comprehending the intricate effects associated with requirement change.	<ul style="list-style-type: none"> Core issues are not addressed.
A model for requirement change management in GSD (Sultana et al., 2014).	It is a structure for multi-site development environment That covers different RCM actions.	Validity is not approved.
Current Challenges of Requirement Change Management (Ahmed et al., 2016)	This work indicates that important challenges of Requirement change management have been identified as reusability of requirement, requirement change anticipation, change activity measurement, clear connectivity with software artifacts and change management automation.	Validity is not approved.
A method of requirements change analysis (Jayatilleke et al., 2017)	This method exist three steps i.e. Investigating the requirement alterations, finding the change difficulties and recognizing the requirement dependencies.	Validity is not approved at complex system.
AZ-Model of software requirements change management in global software development (M. Azeem, Jawad et al., 2018)	This method is categorized into three stages: Coordination Stage, Analysis Stage and Development and Analysis Stage. This method used time boxing approach for proper time management.	This method does not include the obstacles of RCM procedure in the perspective of multi-site development environment.
A Qualitative Study on Using GuideGen to Keep Requirements and Acceptance Tests Aligned (Hotomski et al., 2018)	It is a tool-oriented method for keeping requirement and acceptance tests associated. When a requirement is altered. It automatically make assistance on how to inform acceptance tests when their parallel requirement changes.	Application of this tool is not validated at Industrial level.

Table 3. Comparison with related work

Shalinka et al. (2017) published a work on “A method of requirements change analysis” [27]. This work proposed a method to analyse the requirement volatility which is started at advanced levels. This approach exist three different steps i.e. investigating the requirement changes using several functions, finding the requirement change complications and finding the requirement alteration dependencies by using matrix. An analyst can better understand by these three steps that which portion of the available design will be affected.

There are large number of analysis has been done in various area of requirements change management for example; change impact analysis, complexity analysis of

requirements change, change identification, causes of change etc. There are huge no. of research activity associated with requirement change management have been probed on research theme like identifying causes of change, Requirements change classification and requirements change development models [28]. Various models are developed for requirement Change such as Dean et al. model (2000), Niazi et al. model (2008), Husain CRM model 2017.

V. Conclusion and Future work

The research study confirms that requirements change is inescapable and it has a several negative effect on the software development procedure. As a dynamic source of risk, the different effects of requirement change are underestimated; although a small change can impact on the whole project. This review paper focuses the research effort done in the area of requirement change management. The objective of this paper is to examine and study the relevant work completed so that a scholar can identify the intentions and goal of the work to be done. The future work of this paper to recognize the research gaps in the area of requirements change; examine the reasons for modifications, change impact on project parameters like budget and time where the possibility for new exploration.

References:

1. Daniel D. Galorath, Galorath Incorporated. (2006). the 10 Step Software Estimation Process for Successful Software Planning, Measurement and Control. Galorath Incorporated, 13
2. Jayatilleke, S., Lai, R., & Reed, K., "A method of requirements change analysis". *Received: 27 June 2016 / Accepted: 4 July 2017*, Springer-Verlag London Ltd. 20171–16.
<https://doi.org/10.1007/s00766-017-0277-7>, 2017.
3. Shafiq, Muhammad Ahmad, Jawad Mateen, Muhammad, "AZ-Model of software requirements change management in global software development" 2018 International Conference on Computing, Electronic and Electrical Engineering (ICE Cube) eidelberg 2007.
12. Alan M. Davis and Nur Nurmuliani, "Requirements Change: What's the Alternative?" 0730-3157/08 \$25.00 © 2008 IEEE DOI 10.1109/COMPSAC.2008.216
13. Susan Ferreira et al, "Understanding the effects of requirements volatility in software engineering by using analytical modeling and software process simulation", *Journal of Systems and Software* , Volume 82 Issue 10, October, 2009.
14. Thakurta, R., & Ahlemann, F., "Understanding requirements volatility in software projects - An empirical investigation of volatility awareness, management approaches and their applicability". *Proceedings of the Annual Hawaii International Conference on System Sciences*, 1–10. <https://doi.org/10.1109/HICSS.2010.420>, 2010
15. Kavitha, D., & Sheshasayee, "Requirements Volatility in Software Maintenance", N. Meghanathan et al. (Eds.): CCSIT 2012, Part III, LNCS 86, pp. 142–150, 2012. © Institute for Computer Sciences, Social Informatics and Telecommunications Engineering 2012.
16. Arif Ali Khan, "A Process model for Requirements Change Management in Collocated Software Development", *IEEE Symposium on E-Learning*,
4. James et al. "Grounding IS Design Education in the First Principles of a Designerly Way of KnowingWaguepack", *Information Systems Education Journal*- 2017
5. D. Zowghi and N. Nurmuliani, "A Study of the Impact of Requirements Volatility on Software Project Performance", in the proceeding of the 9th Asia- Pacific Software Engineering Conference, Gold Coast, Australia, 2002.
6. Harsh Dev and Ranjana Awasthi, "A Systematic Study of Requirement Volatility during Software Development Process", *IJCSI International Journal of Computer Science Issues*, Vol. 9, Issue 2, No 1, March 2012 ISSN (Online): 1694-0814.
7. Romi Satria Wahono "Analyzing Requirement Engineering Problems" *Proceedings of the IECI Japan Workshop* 2003.
8. N. Nurmuliani and D. Zowghi, "Analysis of Requirements Volatility during Software Development Life Cycle", *ASWEC'04*, Australia, 2004.
9. Saffena Ramzan and Naveed Ikram, "Making Decision in Requirement Change Management", 0-7803-9421-6/05/\$20.00 C2005 IEEE.
10. N Nurmuliani, "Requirements Volatility and Its Impact on Change Effort: Evidence-based Research in Software Development Projects", *AWRE 2006 Adelaide*, Australia.
11. Sangim Ahn & Chong, K "Requirements Change Management on Feature-Oriented Requirements Tracing", Gervasi and M. Gavrilova (Eds.): ICCSA 2007, LNCS 4706, Part II, pp. 296–307, 2007. © Springer-Verlag Berlin H E-Management and E-Services, IS3e 2012, (October)
17. Bano, M., Imtiaz, S., Ikram, N., Niazi, M., & Usman, M. "Causes of requirement change - a systematic literature review". *16th International Conference on Evaluation & Assessment in Software Engineering (EASE 2012)* (pp. 22–31). <https://doi.org/10.1049/ic.2012.0003>, 2012.
18. Goknil, A., Kurtev, I., Berg, K. Van Den, & Spijkerman, W., "Change impact analysis for requirements: A metamodeling approach", *Information and Software Technology*, 56(8), 950–972. <https://doi.org/10.1016/j.infsof.2014.03.002>, 2014.
19. Ahmad, Z., Hussain, M., Rehman, A., Qamar, U., & Afzal, M.), "Impact minimization of requirements change in software project through requirements classification". *Proceedings of the 9th International Conference on Ubiquitous Information Management and Communication - IMCOM '15*, 1–5. <https://doi.org/10.1145/2701126.2701174>, 2015.
20. Kavitha, D. "Comprehensive View on Defect Analysis and Change Control Process", *International Journal of Innovative Research in*

Computer Science & Technology (IJRCST) ISSN: 2347-5552, Volume-3, Issue-3, May- 2015.

21. Ahmed, H., Hussain, A., & Baharom, F., "Current Challenges of Requirement Change Management". Journal of Telecommunication Electronics and Computer Engineering, 8(10), 173–176. <http://journal.utem.edu.my/index.php/jtec/article/view/1390>, 2016.
22. Faisal, M., Sadia, H., "Stable Requirement Specification Framework: Requirement Volatility Perspective", International Journal of Scientific & Engineering Research, Volume 7, Issue 10, October-1342ISSN 2229-5518, 2016.
23. Abd, M., & Latif, E. L., "Identify and Manage the Software Requirements Volatility", (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 7, No. 5, 2016.
24. Hussain, W., "Reflections on requirements change management in global software development: A multiple case study". Proceedings - 11th IEEE International Conference on Global Software Engineering Companion Proceedings, ICGSEW 2016, 77–79. <https://doi.org/10.1109/ICGSEW.2016.25>, 2016.
25. Abeer AlSanad, "Software Requirements Change Management – A Comprehensive Model". © Springer International Publishing AG 2017 Á. Rocha et al. (eds.), Recent Advances in Information Systems and Technologies, Advances in Intelligent Systems and Computing 569, DOI 10.1007/978-3-319-56535-4_80, 2017.
26. Ebad, S. A. "Towards measuring software requirements volatility: A retrospective analysis". Malaysian Journal of Computer Science, 30(2), 99–116. 2017.
27. Jayatilleke, S., Lai, R., & Reed, K., "A method of requirements change analysis". Received: 27 June 2016 / Accepted: 4 July 2017, Springer-Verlag London Ltd. 20171–16. <https://doi.org/10.1007/s00766-017-0277-7>, 2017.
28. Sharon McGee, "Towards an understanding of the causes and effects of software requirements change: two case studies" Requirement Engineering, Volume 17, Issue 2, pp 133–155, June 2012.