

Factors Influencing Project Success during Software Development Process an Analysis

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Abstract— Effective project management is influenced by several factors such as scope creep, time, cost, number of personnel and complexity of project and so on. However, existing project management strategies mainly rely on domain knowledge and experiences of the project personnel than on analytical procedures. This has a considerable impact on the failure rate of the projects in IT industry. Further, every partial, if not full failure of project accelerates the overhead required to resolve those failures affecting the continuous process improvement in the industries. This paper presents an empirical analysis of several projects developed at various software industries in order to comprehend the impact of scope creep on various factors influencing the project success. Investigation results indicate the need for effectively managing the scope creep to ensure increased production of successful projects and henceforth continued sustainability of the organization in the industrial market.

Index Terms — Project Success, Software Quality, Scope Creep, Software Development Life Cycle, Software Metrics, Software Engineering, Project Management.

1 INTRODUCTION

Software development process comprises of series of activities that aims to achieve a defined set of objectives for developing high quality software product which is one of the most significant characteristic to attain customer satisfaction. It is worth to recall that total customer satisfaction is the only promising path for any organization to continue to exist in the ever growing IT business frontier. The characteristics of high quality and customer satisfied software includes development of the software product within resource constraints such as budget, schedule, resource personnel, technology, scope of the formulated objectives etc. Developing defect free software within the aforementioned constraints is yet again a challenge [1].

Author of [3] have highlighted the overlap that exists between projects and project management process and the perplexity that can arise from the common use of these terms. Efficient project management is one of the assuring techniques that ensure development of high quality product through its effective implementation mechanisms. However, this strategy can be successful only when important elements in the project management process are managed efficiently by the project personnel. This process involves the activities of planning, execution, monitoring, control, closure of a project etc. by a project manager, in order to keep the project on contractual constraint of scope, time, cost and quality. Thus, scope of the project is also deemed as one of the most important factors in project management process.

Project scope always demands the team to have a good hold on business objectives and requirements which when neglected may result in scope creep. The survey reports of [3] states that more than half of projects developed between 2002 and 2010 in the software industries at global level were either challenged or met with failures. Challenged project requires re-work on the complete project which leads towards expensive overheads and hence is also not well appreciated either by the business perspective or by customer perspective. Hence, it is vital for any organization to engineer successful projects in lieu of either challenged or failure projects.

It is a well known fact that software development process is never static and is intrinsically dynamic in nature due to the advancement in technology and need of the customers. Hence, requirements always keep evolving during software development span which comprises from time of inception to the time the product becomes obsolete. Hence, the scope which is initially defined during the commencement of the project has probability of undergoing modifications. These modifications include addition of scope which further creates an impact on various other project influencing factors such as time, cost etc.

The aim of this paper is therefore to analyse the influence of scope creep on factors which modulates the success level of the projects. The knowledge of scope creep and the current lacuna existing in scope creep management process initiates the research to progress towards the introduction and implementation of effective scope creep management strategies during project development. Further, it enables the industries to continue successfully in the competitive industrial market.

2 LITERATURE REVIEW

Efforts are persistent to ensure complete success of the software products which are developed in software organizations. Managing the projects effectively therefore is one of the elementary processes during software productions to accomplish

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the above requisite need. Hence, research evolves in all facets of effective project management process.

Authors of [2] view the project and project management in different perspective where they emphasize on project management to focus towards achieving specific and short-term targets when compared to the wider aims of a project. Therefore, author in [11] recommend project management to be deemed as a significant focus during software development process exclusively when an organization is concerned in implementing new deeds for development of innovative products [11]. However, authors of [4] indicate the significance of role of project managers in order to achieve effective project management process. Hence, authors of [7] suggest various best practices to be followed by the project manager to ensure adequate requirement information for attaining successful project development process [7].

Author in [6] strongly states that project management process has gained an increasing amount of attention to improve a firm's competitive position in terms of quality. However, authors in [12] emphasize on managing the project scope creep in order to effectively manage the project. They state that initial formulations of requirements which are made during requirements phase are most of the time prone to undergo changes enabling the scope to creep throughout the developmental activities. Hence, a failure to define a precise system scope results in architectures that yield to poor requirements definition thereby inviting scope creep [5].

Nevertheless the type of impact of scope creep on project success, authors of [8] suggests implementation of metrics to provide rigorous information regarding the requirement effort and the boundaries of the IT deliverables. They have further suggested the choice of apt metrics during the developmental process [8].

Since, metrics play a major role in evaluating the quality of software, it becomes highly inevitable also to measure the quality from various dimensions which includes process, products and human resources. Accordingly, authors in [9] have recommended management metrics to measure various resources such as cost, time, etc. They additionally suggest the implementation of metrics for traceability and stability of requirements which is considered to play a vital role in project success [9].

However, author in [10] strongly express the need for developing new metrics which can predict the success of the project as they feel that the traditional project management metrics have served the project management community over the years and therefore has proven its lacking ability in predicting whether a project will be successful ultimately or not [10].

Authors of [14] have therefore recently introduced two quality metrics to measure the quality of software inspections through process and people metrics namely Depth of Inspection (DI) and Inspection Performance Metric (IPM) which aims towards

improving project success through their predictive metrics.

However, there are several metrics through which every facet of software development can be measured for enhancing the quality of their production [15].

This paper however focuses upon the study of various factors which modulates the success of the project in terms of scope creep. This knowledge further enables one to orient towards implementation of quality project through analytical mode than conventional methods of software development process.

3 RESEARCH METHODOLOGY

Success of the project also depends upon the apt decisions made during project management process. Hence, this study aims to comprehend the impact of scope creep on project management process and other factors influencing project success during the process of software development.

This investigation includes a deep survey conducted on several range of projects drawn from various leading software industries of varying production capabilities. The projects considered in this investigation are non critical service based projects which are collected from quality assurance department and also from the data repository of the industries under the study. Tools used for empirical data collection from the projects includes interviews, mails and face to face communication with various software developing team members such as quality assurance team, project management team, technical managers, system analysts etc. The empirical projects are sampled using random sampling technique.

4 RESEARCH WORK

The critical factors influencing project success that are analysed in this investigation include scope creep, time, cost, developers, function points, technology, experience etc.



Fig1 : Project Success Influencing Factors

Technology used in the development of the project is constant and do not undergo modifications throughout the development of the project and hence is deemed as an uncontrollable

factor which is ignored for this analysis. Figure 1 depicts the factors influencing project success.

The study made on these projects indicates the significance of scope creep management and its influence on other project modulating factors in realizing project success. The deep analysis on these influencing factors has led to the comprehension of impact of scope on those influencing factors which affect the project success. Our forthcoming research work will explore various facets of scope creep.

This research comprises of investigation carried out on various projects that are developed in several service based software industries. There were several challenges that required establishment of hypothesis to overcome the challenges.

Challenge 1: Software industries under this investigation have varied software developmental policies.

Challenge 2: Existence of varying application domains and complexities in the projects that were developed in these organizations.

In order to overcome challenge 1, this research considered service based software industries which are CMMI level 5 certified and hence developmental policies in all those industries adhere to the same standards. To overcome challenge 2, this work focuses on non critical application projects such as banking, financial sector and enterprise solutions domain. Establishment of hypothesis has further led to the realization of precise analysis and inferences drawn in this research.

Hypothesis 1: All projects are developed in similar environment and using similar software languages.

The sampled projects are developed using asp.net in windows operating system environment. The rationale for considering projects developed using asp.net is that amount of effort required for the developing personnel is comparatively less due to the availability of large number of automated tools. The amount of effort required during software development by the developing personnel therefore depends on complexity level of the project, which can be measured using function point

analysis and number of person hours of development.

Software industries measure their process maturity level based on certification standards such as ISO, CMMI, Six Sigma, TQM and so on. As an instance the authors in [13] proposes the interface-related descriptions in requirement phase and they introduced the using of COSMIC ISO 19761 to estimate the functional size.

Function points play a vital role in estimating the factors of the project management such as time, cost, managing scope creep etc. Function Point Analysis is one of the proven, consistent methods for estimating the software project complexity. Nevertheless, the variations in organizational implementation standards, majority of the software industries follow functional point analysis as one of the popularly used complexity measurement for large number of their application developments. This focused the research to further narrow down with the formulation of hypothesis 2.

Hypothesis 2: Projects are classified as small, medium and large project based on function point analysis.

Hence, the projects are considered to be small projects having fewer complexity when the estimated function points are below 700, while projects having function points varying between 700 and 5000 are considered as medium sized projects, and those of the projects whose function points are above 5000 is considered as large projects. Table 1 depicts 10 projects which are sampled using deliberate sampling technique for collection of projects based on number of function points.

The rationale behind this mode of selection of deliberate sampling technique indicates the initial level of investigation and our forthcoming paper presents the subsequent analysis of data with randomly sampled empirical information. Table 1 indicates the data sampled from the companies under the framework of hypothesis as explained in section III and section IV of this paper. It further provides information about factors such as scope creep, time, cost, function point and finally the success rate of the complete project.

TABLE 1 : FACTORS INFLUENCING PROJECT SUCCESS

PF	P1		P2		P3		P4		P5		P 6		P 7		P 8		P 9		P10	
	Exp	Act	Exp	Act	Exp	Act	Exp	Act	Exp	Act	Exp	Act	Exp	Act	Exp	Act	Exp	Act	Exp	Act
SC	15	15	112	180	162	186	260	380	1520	2060	480	580	165	180	750	975	1520	2060	2400	2850
Time(*)	790	790	350	565	490	565	1625	2375	4750	6440	1500	1820	1500	1640	2500	3250	4750	6440	8000	9500
Cost(**)	4.7	4.9	3.8	4.9	4.86	5.58	7.15	10.45	4.18	5.665	1.32	1.59	14.85	16.2	2.5	3.25	4.18	5.665	8	9.5
Dev	2	2	5	4	10	13	15	18	28	32	22	38	8	10	12	18	28	32	35	42
E Dev	3-4	3-4	2-4	2-4	2 - 4	2 - 4	3-6	3-6	3-5	3-5	3-6	3-6	2-4	2-4	3-5	3-5	3-5	3-5	3-5	3-5
FP	142	148	700	1125	1350	1550	1625	2375	9500	12875	3000	3625	4125	4500	6250	8125	9500	12875	20000	23750
PS (%)	100	99	100	40	100	85	100	55	100	65	100	79	100	90	100	70	100	65	100	82

PF – Project Factors, SC - Scope Creep; (*)- Measure in Person Hours; (**) – USD; Dev – Number of Developers; EDev – Average Experience of Developers; FP – Function Points; PS – Project Success;

For the purpose of analyzing the impact of scope creep on project and henceforth on various other factors, the sampled projects are arranged in increasing order of function point complexity. Table 2 indicates the variations of estimated and actual utilization of project factors.

Table 2 infers that when there is no scope change as shown in project P1 the success is 99%. However, with the increase of scope creep the project success has reduced. Hence, it is evident that scope creep has an impact on the success of the project.

TABLE 2: FACTOR VARIATION VALUES

PF	P1	P7	P3	P10	P6	P8	P5	P9	P4	P2
VSC(%)	0	9.09	14.81	18.75	20.83	30	35.29	35.5	46.15	60.71
VT (%)	3.8	9.33	15.31	18.75	21.33	30	35.48	35.6	46.15	61.43
VC (%)	3.5	9.09	14.81	18.75	20.83	30	35.29	35.5	46.15	60.71
VD (%)	0	25	30	20	72.72	50	38.46	14.3	20	75
VFP(%)	0	9.09	14.81	18.75	20.83	30	35.29	35.5	46.15	60.71
PS(%)	99	90	85	82	79	70	65	65	55	40

VSC – Variation in Scope Creep; VT – Variation in Time, VC – Variation in Cost; VD – Variation in Number of Developers; VFP – Variation in Function Points; PS – Project Success

Further, the subsequent investigation was to explore the impact of scope creep on other factors. From Table 2 it is visible that when there was no scope creep as observed from project P1 the variations with respect to factors such as time, cost, number of developers, average level of experience is not having high variations exceeding 10% which is an acceptable variation of project resources in any industry.

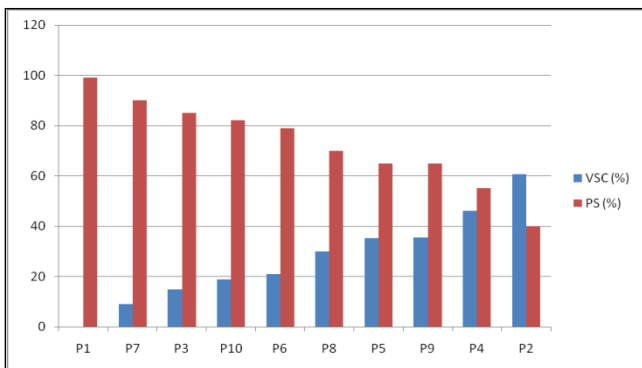


Fig 2: Comparative analysis of scope creep and project success

However, with increase in scope the variations observed from the estimated to the actual utilization of the above said resources has also increased. This observation clearly indicates that scope creep has an impact on the aforementioned factors which also modulates the success of the project. However, scope creep in the sampled projects remains unaffected on the

experience level of developing personnel which is again further research that needs to be explored.

Figure 2 depicts the influence of scope creep on project success for the sampled projects illustrated in Table 2.

Figure 2 infers that the success rate of the project is decreasing with the increase in scope creep. Figure 3 depicts the impact of scope creep on other project factors.

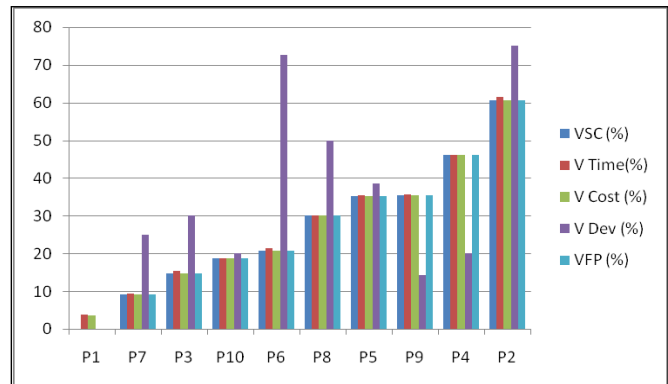


Fig 3: Comparative analysis of scope creep and project influencing factors

Figure 3 infers that the scope creep further has an impact on other factors of project such as time, cost, number of developers, number of function points etc. Rationale for appending of scope creep during project development process can be due to inconsistency, ambiguity or incomplete requirement engineering process.

Further, the variations observed in scope leading to scope creep have resulted in variations in number of function points. It may be noticed through Figure 3 that there is related variation between scope creep and function points. Additionally, it is significant that scope creep is also influencing the time and cost. Thus, we can visualize scope creep in a mathematical perspective where there exists relation between scope creep, cost, time and function points which further has a direct relation in quality of the project and henceforth the success level of the project.

Further proceeding in this investigation, the study led towards analyzing the mathematical relation that exists between scope creep and project influencing factors considered in this research. Accordingly, scope creep is found to be proportional to time, number of function points and cost.

$$Sc \propto \{T, Fp, C\} \quad (1)$$

Where SC -Scope Creep, T -Time, FP - Number of Function Points, C - Cost

Further scope creep is inversely proportional to the success of the project.

$$SC \propto 1/PS \quad (2)$$

Where PS – Project Success

From the analysis, it is visible that scope creep is directly influencing time, cost and function points. Hence, with increased variations in scope creep from estimation to implementation consequently increases the variations in other aforementioned resources. From the above observations, it is evident that scope is one of the highly modulating factors in the project management to realize high quality software and hence managing scope creep is deemed to be one of the vital challenges in project management process.

Thus, with effective scope creep management, it is quite promising to increase the quality of software in terms of development within estimated resource constrains. It certainly aims towards increase in productivity due to reduction in rework or overhead cost and time. This research therefore directs one to effectively manage the project with effective estimation and assignment of resources based on scope creep as the most significant modulating factor for the effective project management process. The aforementioned investigation results are applicable to the projects which fall under the framework of the established hypothesis as explained in section II and section III of this work. Hence, the above inferences may have skew results with variations in the hypothesis. Our forthcoming work explores the sensitivity analysis of scope creep on individual factors influencing the project success.

However, the impact of scope creep with the number of developing personnel in the project is yet to be explored as a future study.

5 CONCLUSIONS

Developing high quality software products has become one of the rudimentary needs of the day in software industry. Generation of high quality software is influenced by several factors which includes scope creep, time, cost, developing personnel, their experience level etc. In order to comprehend the scope creep on various factors of project success, this research aimed at investigating several projects developed at various software industries. This paper throws light on some of the factors influencing the project quality and their impact in realization of success level of the project in terms of scope creep. This knowledge leads towards framing strategies resulting in enhanced productivity, quality and improved business performance which ensures total customer satisfaction.

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REFERENCES

- [1] T. R. Gopalakrishnan Nair, V. Suma, Nitya G. Nair, "Estimation of Characteristics of a Software Team for Implementing Effective Inspection Process and Inspection performance Metric", Software Quality Professional Journal, American Society for Quality (ASQ), USA, Vol.13, Issue 2, pp.14-26, 2011.
- [2] A K Munns and B F Bjeirmi, "The role of project management in achieving project success", International Journal of Project Management Vol. 14, No. 2, pp. 81-87, 1996.
- [3] Jeff Sutherland, Ken Schwaber, "The Crisis in Software: The Wrong Process Produces the Wrong Results", <http://www.controlchaos.com/storage/S3D%20First%20Chapter.pdf>, pp 3 - 16.
- [4] T. R. Gopalakrishnan Nair, V. Suma, Shashi Kumar, N.R., "Significance of Project Manager in Effective Defect Management in Software Development Process", The 5th Malaysian Software Engineering Conference (MySEC2011), Johor Bahru, Malaysia, 13th–14th December 2011.
- [5] Managing Scope Creep: Don't Gold Plate My Project! Visit <http://www.projectsmart.co.uk/managing-scope-creep.html>.
- [6] John Favaro, "Renewing the Software Project Management Life Cycle", 0 740-7459/10 © 2010 IEEE, IEEE SOFTWARE 17 pp 17 – 19, January/February 2010.
- [7] June M. Verner, William M. Evanco, "In-House Software Development: What Project Management Practices Lead to Success?", IEEE SOFTWARE, Published by IEEE Computer Society, pp 86-93, J a n u a r y / F e b r u a r y 2005.
- [8] Paul POCATILU, Bucharest, Rumania, "IT Project Management Metrics", Revista Informatica Economica, nr. 4(44)/2007, pp 122 – 125.
- [9] Raymond A. Paul, Tosiyasu L. Kunii, Yoshihisa Shinagawa, Muhammad F. Khan, "Software Metrics Knowledge and Databases for Project Management "IEEE transactions on knowledge and data engineering , vol. 11, no. 1, pp 255 – 264, January/February 1999.
- [10] Brian K. Willard, "Project Success: Looking Beyond Traditional Project Metrics" Project Management Wisdom, publication 11/22/05 and is copyright to Brian K. Willard © 2005.
- [11] William R Duncan "A Guide to Project Management Body of Knowledge", Project management institute, Pennsylvania 2000.
- [12] Robert Armstrong, Gillian Adens, "Managing Software Project Risk", <http://www.tassc-solutions.com/downloads/Managing%20Risk.pdf>, copy-right 2001-2010.
- [13] Khalid T. Al-Sarayreh, Alain Abran, "A Generic Model for the Specification of Software Interface Requirements and Measurement of their Functional Size" 2010 Eighth ACIS International Conference on Software Engineering Research, Management and Applications, Published by IEEE Computer Society pp 217 – 222 .
- [14] Gopalakrishnan Nair, T. R., and Suma, V.: 'Implementation of Depth of Inspection Metric and Inspection Performance Metric for Quality Management in Software Development Life Cycle', International Journal of Productivity and Quality Management (IJPQM), InderScience Publishers, USA, 2011.
- [15] Linda Westfall, '12 Steps to Useful Software Metrics', The Westfall Team, 2005.