Influence of Scope Creep on Project Success: A Comparative Study between Conventional Approach Verses Agile Approach

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Abstract—Software systems are ubiquitous in every emerging application. Software Engineering aims at delivering high quality software in order to sustain total customer satisfaction. This is achievable by developing the software within stipulated resources and constraints such as time, cost etc. Hence, project manager equipped with advanced project management skills plays a vital role during software development process to achieve project success. This paper presents a case study of three leading software industries which follows agile and perspective approaches for their software development process. Since, it is a well proven fact that scope creep is one of the significant project influencing parameter, the aim of this investigation carried out on several projects indicates that scope creep is highly influencing other project success modulation factors such as cost, time and henceforth the quality of software whenever projects are developed using traditional models. However, there is negligible impact of scope creep on projects that are developed using agile approach. This awareness of influence of scope creep on projects developed using various models ensures the project manager to effectively manage the project.


I. INTRODUCTION

Software has its impact on all domains of applications since the inception of software in industries. From the evolution of software engineering as one of the significant domains of production cycle, it is imperative to develop high quality software. High quality software is realized by developing the product within the constrains such as cost, time, technology, company policies and standards, number of personnel, their level of skill set and so on. Further, quality also depends upon the nature of the project, its complexity and mode of developing the project. Since, retention of high quality is the only path to gain complete customer satisfaction, role of project manager in effectively managing the resources also has an impact. The role of a project manager includes managing his expert team, adopting the managemnt and engineering processes, planning, scheduling, handling resources etc [11][12]. The project management techniques adapted by the project manager aims at four activities such as problem recognition, problem sequence, problem controlling, problem evaluation[7] that ensures development of high quality software.

There exist several tools, techniques and metrics which assure the process of development to be consistent quality oriented. Hence, industry targets setting of quality standards and compliances from the point of conception till the maintenance and support phase of software development cycle. This is due to the fact that quality is not a state and is a continuous process which needs to be always quantified and address instantaneously in order to reduce overheads.

Further, quality is dependent on completeness and volatility of requirements which are well communicated and well elicited by both customers and developers during software development cycle [10]. Additionally, it is also quite apparent that quality is not perceived from process of development but is also viewed in various dimensions such as the factors which modulate the level of project success and the models used to develop these projects. There exist perspective approach of developing projects using traditional models and agile approach of developing projects. However, factors such as time, cost, scope creep, availability of resources are deemed to be some of the important quality influencing factors, this research aimed at investigating the significance of scope creep upon the two popular approaches of software development namely traditional approach using perspective models and agile approach using agile models.

II. LITERATURE REVIEW

Due to the existence of high competition in the industrial market since three decades, it is necessary for industries to emphasize on developing high quality software using advancement in technology and through continual research and development process. The Software Engineering Book of Knowledge (SWEBOK) has introduced seven knowledge areas in project management techniques such as project integration management, project scope management, project time management, project cost management, project quality management, project human resource management and project communications management as the most important project
management techniques for developing high quality software [1].

Further, role of project manager has a vital role to play in the development process [11][12]. Thus, authors of Project manager through his apt choice of project management strategies emphasizes upon on four significant activities such as problem recognition, problem sequence, problem controlling, problem evaluation [7].

However, authors of [4] suggest that influence methods are commonly accepted to be a persistent facet of corporate culture and helps as an important method for business assessment [4]. According to the authors in [6], the Standish Group’s 2011 CHAOS Report has said that the success rate of the globally developed projects is 37%. In this perspective, authors further states that project managers provides reasons for failure to be due to various factors such as schedule slip, improper planning, changing or new requests, quality failing, etc [6]. Hence, influence of the factors is clearly visible in the success of the projects.

According to [5], the critical influencing factors for success of project can be categorized into three divisions such as people related factors, process related factors and technical related factors. People related factors involve the people from top management, project management team, technical team, clients. Process related factors involve factors like requirement, specifications, scope, schedule, planning, resources, budget, etc. Technical factors like technical capability, complexity and size of the project etc. Hence scope is always considered as one of the valid factor for project success. Scope creep thus always influences the success of the project.

The study made by authors in [3] indicates that occurrences of scope creep is due to the lacunae in various process such as change request, work break down structure, documentation, scope management plan etc. According to [8], scope, time and cost are integrated.

Scope creep has proven to be one of the most influential factors on project success. According to authors of [2] state that project management problems which are unearthed in-house have the tendency to mount during execution and maintenance phase of a project. Some of the issues can be attributable to rationales such as poor performance of the technical team, poor involvement of user, scope creeping requirement due to internal and external environmental changes etc [2].

It is perceptible with the literature review that scope, time and cost are some of the major factors in effectively managing the project. Hence, change in scope affects time, cost and other resources of the project. Due to the aforementioned reasons, this investigation motivated towards comprehending the role of scope creep in projects which are developed using various process models. This knowledge further enables the project mamanger to make justifiable decisions towards choice and allocation of resources in the project to achieve high quality and retain customer satisfaction.

### III. RESEARCH METHODOLOGY

In order to gain awareness of role of scope on various projects that are developed using conventional process models and agile process models, this research comprises of a deep study carried out at various software industries. These software industries are either product based or service based software developing centres which are holding CMMI Level 4 and Level 5 standard certification. The empirical data are collected from data repository databases and from industry personnel in the model of interviews, questionnaires, mails and face to face communication.

The sampled projects that are collected include projects developed for non critical applications such as Enterprise Resource Planning and Financial projects developed since 2007 onwards up to 2012. They are developed in Microsoft operating system using .Net as programming language.

Data analysis comprises of comparison of influence of scope creep on project modulating factors such as time, cost, personnel and experience level of these personnel in the projects. The comparison is made between projects developed with traditional process models against the projects developed using agile models. It is worth to note at this point that the projects depicted in this paper comprises of water fall model and Extreme Programming process models.

Data analysis infers that scope creep has high influence on projects developed using traditional process models than on the agile process models when applied to the project development.

### IV. CASE STUDY

This case study includes study made on software industries of various production capabilities such as service based and product based industries. However, due to the existence of huge population of software developing organizations, this research restricted towards companies which are certified by either CMMI level 4 or CMMI Level 5 standards. Further, to resolve the intrinsic complexity of software projects, this investigation constrained itself to study of those projects which are developed in common environment namely Microsoft Operating System and using .Net language.

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 deems function point analysis as one of the popularly used complexity measurement for large number of their application developments [9].

Analysis is carried out on projects developed using waterfall approach of traditional process models and extreme programming approach of agile models. From the investigation, in order to further resolve complexities involved such as customer satisfaction index levels varying from industry to industry and from project to project, this research broadly classifies project success to fall under three major umbrellas such as successful (Ps), challenged (Pc) and failure
(Pf) projects depending on the customer satisfaction index levels. Thus, Table 1 indicates the classification of projects.

<table>
<thead>
<tr>
<th>Classification of Projects</th>
<th>Level of Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successful Projects (Ps)</td>
<td>&lt;= 90%</td>
</tr>
<tr>
<td>Challenged Projects (Pc)</td>
<td>&gt; 70% &amp; &amp; &lt; 90%</td>
</tr>
<tr>
<td>Failure Projects (Pf)</td>
<td>&lt;= 70%</td>
</tr>
</tbody>
</table>

Table 2 illustrates a sample of 10 projects developed within the said production framework. It provides information on scope creep occurring in these projects, cost, time and number of developers involved in the project. Projects are sorted based on increasing complexity as measured using function point analysis. Further, the sampled projects are developed using waterfall process model.

Table 2 infers that project P7 is successful while projects P1, P3, P6, P10 are challenged projects and P2, P4, P5, P8, P9 are failure projects. When viewed from the perspective of scope creep, Table 2. infers that the scope creep is definitely happening in all the projects irrespective of the complexity of the projects.

- As scope creep increases, the time is modulated. Thus, time required to complete the project increases with increasing scope creep. This is visible in all the projects and variation is more in P2, P4, P5, P6, P10
- As scope creep increases, cost is varying from estimated budget. This is visible in all projects of the Table 2.
- Scope creep is also making an impact with need for allocating number of developers.
- As the scope creep increases there is a noticeable difference in the number of function points. Thereby with above variations due to the scope creep, project success too is modulated and controlled.
- Since success level of projects increases with decreased scope creep.

### Table 2: Master Table for Analysis of Factors Influencing Project Success in Traditional Model

<table>
<thead>
<tr>
<th>PF</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
<th>P5</th>
<th>P6</th>
<th>P7</th>
<th>P8</th>
<th>P9</th>
<th>P10</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC</td>
<td>86</td>
<td>102</td>
<td>112</td>
<td>180</td>
<td>162</td>
<td>260</td>
<td>380</td>
<td>1520</td>
<td>2060</td>
<td>480</td>
</tr>
<tr>
<td>Time (*)</td>
<td>300</td>
<td>350</td>
<td>350</td>
<td>400</td>
<td>350</td>
<td>380</td>
<td>1625</td>
<td>2375</td>
<td>4750</td>
<td>6440</td>
</tr>
<tr>
<td>Cost (**)</td>
<td>2.64</td>
<td>3.08</td>
<td>3.8</td>
<td>4.9</td>
<td>4.86</td>
<td>5.58</td>
<td>7.15</td>
<td>10.45</td>
<td>4.18</td>
<td>5.665</td>
</tr>
<tr>
<td>Dev</td>
<td>5</td>
<td>8</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>10</td>
<td>13</td>
<td>15</td>
<td>18</td>
<td>28</td>
</tr>
<tr>
<td>E Dev</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>FP</td>
<td>142</td>
<td>148</td>
<td>700</td>
<td>1125</td>
<td>1350</td>
<td>1625</td>
<td>2375</td>
<td>9500</td>
<td>12875</td>
<td>3000</td>
</tr>
<tr>
<td>PS (%)</td>
<td>100</td>
<td>82</td>
<td>100</td>
<td>40</td>
<td>100</td>
<td>85</td>
<td>100</td>
<td>55</td>
<td>100</td>
<td>65</td>
</tr>
</tbody>
</table>

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

### Table 3: Master Table for Analysis of Factors Influencing Project Successes in Agile Model

<table>
<thead>
<tr>
<th>PF</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
<th>P5</th>
<th>P6</th>
<th>P7</th>
<th>P8</th>
<th>P9</th>
<th>P10</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC</td>
<td>12</td>
<td>14</td>
<td>30</td>
<td>32</td>
<td>72</td>
<td>87</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>Time (*)</td>
<td>880</td>
<td>1056</td>
<td>1408</td>
<td>1450</td>
<td>2112</td>
<td>2638</td>
<td>880</td>
<td>1230</td>
<td>1760</td>
<td>1910</td>
</tr>
<tr>
<td>Cost (**)</td>
<td>6.6</td>
<td>7.9</td>
<td>8.4</td>
<td>8.7</td>
<td>12.6</td>
<td>15.8</td>
<td>5.28</td>
<td>73.8</td>
<td>10.5</td>
<td>11.4</td>
</tr>
<tr>
<td>Dev</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>8</td>
<td>12</td>
<td>13</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>E Dev</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>FP</td>
<td>158</td>
<td>190</td>
<td>253</td>
<td>261</td>
<td>380</td>
<td>474</td>
<td>158</td>
<td>221</td>
<td>316</td>
<td>343</td>
</tr>
<tr>
<td>PS (%)</td>
<td>100</td>
<td>90</td>
<td>100</td>
<td>98</td>
<td>90</td>
<td>90</td>
<td>95</td>
<td>90</td>
<td>95</td>
<td>95</td>
</tr>
</tbody>
</table>

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Table 3 illustrates a sample of 10 projects developed using Extreme Programming model of agile approach. Table provides information on occurrences of scope creep, cost, time and number of developers involved in the project. Projects are listed in ascending sequence of project complexity as measured using function point analysis.

Table 3 infers that
- With increase in Scope creep increases, the time required for project completing increases than estimated.
- With increase in scope creep the required cost of project also gets affected as is visible in all projects of the Table 3.
- Scope creep however shows minimum impact on need of number of developers and their experience in the projects.
- Nevertheless, increase in scope creep has an impact on number of function points which is apparent from projects depicted in Table 3.
- However, the success level of projects is not heavily disturbed indicating that scope creep has less or negligible impact when projects are developed using agile approach.

Figure 1 depicts the graphical representation of the inferences drawn from Table 1 indicating scope creep and project success in projects developed using waterfall model.

Figure 2 infers that when scope creep never occurred in a project also the project success is seen as 100% which is visible from P1. However, it is also quite noticeable that when scope creep exceeds 10% also, the project witness success. This is not in compliance with what was observed in traditional approach.

The fact that scope creep has less impact and sometimes negligible impact as seen from successful projects is thus ascertained.

V. CONCLUSIONS

Development of 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 also includes effective project management process. However, parameters such as scope creep, time, cost, personnel, their experience level, function points etc. has an influence on the success level of the projects. This paper therefore aims to investigate the role of scope creep in projects that are developed using various process models.

Hence, this research comprises of a case study carried in various leading software industries which are certified with CMMI Level 4 and CMMI Level 5 product based and service based productions. Empirical analysis of the projects includes those which are developed using conventional process models and agile process models. Investigation results indicate that scope creep has high impact on projects that are developed in traditional process approach than on projects developed base on agile approach. However, this paper presents analysis carried only on projects developed using waterfall model and extreme programming model. Further research is required to compare impact of scope creep on various other process models and also the impact of scope creep on other project success modulating parameters.

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