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Software Process Improvement Customization: 3D Flex Model

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Abstract— Globally IT organizations are striving towards efficient and robust software process improvement frameworks/ standards to ensure success in the competitive market scenario. As market demands and client requirements vary in dynamic and swift mode, current SPI standards and frame works are not able to meet the challenges to the desired extent. To overcome this lacuna, organizations integrated different SPI frameworks and implemented into product development process. Still, the challenges of poor product quality, longer release time, expensive development cost, unnecessary rework is experienced by organizations. Another important issue with SPI is that any software process improvement cannot improve by itself rather it gets degraded with time. How to maintain SPI always pristine with current trends is also a major challenge faced by organizations.

To address this challenge, this paper comprises of case study made across multiple applications spanning over five major applications domains from six globally functioning companies is undertaken. The investigation results reveal the rationale for the challenges faced. Thus this research has led towards an introduction of 3D Flex model. This model ensures retention of standard SPI framework and realization of optimized software process improvement.

Index Terms— Compliance; Software process improvement, business value, 3D flex model, process degeneration, Customer requirements

I. INTRODUCTION

Software organizations are facing a greater pressure and constant thrust towards meeting a few of the key challenges. The prime challenges faced by software industries are to improve product quality, to reduce cycle time, render faster time to market and to reduce waste of effort, rework and money [1]. Due to practical business facts such as competition by peers, client demands and ever changing technology, afore said challenges seem as elusive target. However addressing them to the complete extent is the mandatory requirement for software organizations in order gain good business value and to embark proven track record of success in the software market[2]. Initially to meet these challenges software industries implemented process. Since the desired results were not found by implementing process, organizations employed Software process improvement (SPI)standards and frameworks such as Six Sigma, CMMI (Capability Maturity Model Integrated), ISO series, CBOIT(Control Objectives for Information and related Technology), ITIL (Information Technology Infrastructure Library) etc[3][4][5]. By implementing SPI, industries found a profound improvement in meeting the challenges to a very greater extent, though challenges were not met to desired extent. Implementing SPI had also opened a new window in the software market that SPI frame works are often utilized as stringent criteria in assessing maturity, risk and performance level of the organization and also as mandatory criteria for awarding contacts [6]. Thus SPI is an integral part of software organizations apart from serving as a tool to meet the challenges. The current state of art is that the organization can function, survive and continuously grow only by SPI.

However once the SPI is implemented, organization cannot be assured of continuous success forever. The major reason for not being able to meet the challenges completely is due to the nature of challenges. They are not static in nature but are very dynamic. Challenges vary very fast in unpredictable fashion, due to technology push and market pull[7]. Hence to equip the organization to meet the dynamic nature of challenges, SPI has to be improved continuously. Hence software organizations are focusing on continuous SPI.

In order to meet the challenges currently, organizations have stepped into implementation of contemporary SPI frameworks such as SPICE, LEAN Six sigma, Balanced score board etc and still are not able to meet challenges to the desired level[8]. Since some of the standards and frameworks focus on "What" should be done while other frameworks focuses on "How" it can be done, some organizations implemented multi model frame works. Still organizations are left with the question of addressing the dynamic and fast changing challenges effectively. This has paved a way for the empirical research.

Practical Research has been taken with the following objectives.

1. How to combat ever changing and fast changing challenges through SPI?
2. How to embed fast changing market demands into continuous software process improvement in well-timed deployment frame?

3. Does one SPI suits to different software application domains products such as Healthcare, retail, banking etc?

Research has been carried in six different globally located software companies. All the companies chosen for study have employed well known process improvement standards such as CMMI level 5, six sigma, SPICE etc[8]. Products for study were chosen from five different application domains .Research is carried over in the practical scenario to find the solution for the stated objectives. As a solution to meet the objectives, this paper introduces 3D flex model. This model is an add-on flexible model to the existing framework employed by the organization. This model can be adapted to any of the SPI frame work.

This paper is organized as follows. Section I comprises of this introduction. Section II describes related work. Section III explains research approach. Section IV explores key findings and analysis. Section V contributes 3D Flex. Section VII describes the discussion and results of the model. Section VII concludes.

II. Related work

Researchers in software process improvement sector have recognized the need of improvement in the existing SPI frameworks. Recent research has been conducted in introducing new models in place of standard SPI frameworks. Most of the research has been focused on flaws in SPI, incorporating SPI in different sized companies and comparison of SPI models. Effects of process issues on organization objectives and product quality is emphasized. To our knowledge, remote research work is found on pronouncement the practical reasons aiding the gaps in process improvement framework. To the best of our knowledge and search, we couldn't locate any practical case study mode of research in addressing the challenges of SPI framework in the enterprise level. The studies related to SPI are summarized below.

Authors in [9] have explored the significant criteria of SPI frameworks. Paper has introduced a new model called Linear SPI model to be used in place of standard SPI frameworks. Authors in [10] enumerate the high potential of international standard SPI frameworks namely ITIL, COBIT and CMMI and also their limitations. Authors expresses that these process has inconsistencies with industrial best practices and this inconsistency has to be eliminated. Authors in [11] express that the current problem with SPI is not a lack of standard or model, but rather a lack of an effective strategy to successfully implement these standards or models. Organizations should determine their SPI implementation maturity through an organized set of activities. Paper contributes a maturity model for SPI implementation in order to guide organizations in assessing and improving their SPI implementation processes. Authors in [12] has expresses the practical scenario that organizations concurrently implementing multiple process frameworks such as ITIL, COBIT, CMMI and ISO 9001.The motivation and implications of this of multiple process frameworks adoption is explored based on the survey results and a case study. Authors in [13] express that SPI is an effective avenue for companies to improve the quality and productivity of software. The authors present a framework towards implementation of SPI technologies in small to medium sized companies.

Relative lack of literature to find the proactive solution to address the challenges faced by organizations in spite of implementing contemporary SPI frameworks has led us to take up multi software industrial case study with the objective of finding the cause for not being able to address the challenges to complete extent. Our research contributes in finding the underplaying causes and has also presents 3D Flex model to effectively address the challenges faced by IT enterprises..

III. Research Methodology

Due to the relative lack of literature on the practical process improvement methods which can enable the organizations to address the challenges effectively, qualitative exploratory research method is undertaken. Since case study approach is appropriate for the undertaken research method [14], in depth multiple case studies of twenty customized software development projects developed by six products cum service based hybrid type software enterprises in India, is carried over in this research. Projects chosen for study are spread across major five potential application domains of global software development. The major domains considered are retail group, Finance, insurance and banking group, manufacturing and automobile group, Energy and utilities group and Hospital and Pharmacy coming under health care group. Projects chosen are of applications software product type. Compliance, quality frame works, standards and SPI methodologies employed in the companies is studied in detail. The major quality frameworks studied are business excellence framework, European framework for Quality management and US Baldrige Excellence framework. The major SPI methodologies employed by companies include ISO series, Lean six sigma, six sigma, CMMI level 5, Balanced score board etc. All the projects are studied from its inception till implementation and also in the annual Contract Maintenance (AMC) with particular focus on quality and the project critical factors such as defects, rework, schedule variance, functionality, customer feedback, the performance issues of the product, end user opinion. These projects are also studied to know the effect of project, strategies, quality process and business value delivered. All the projects are studied from its inception till implementation and also in the annual Contract Maintenance (AMC). Table1 gives the summary of the SPI methodologies studied in six companies denoted as A to F.

Table 1: Companies selected for study

Company	Sector	Number of projects	SPI Methodology	Contract type	Cost in M$	Compliance
A One of the large software company	Retail& Hospitality	04	CMMI, COBIT, Lean six sigma	FPP,T&M Hybrid	5-10	PCI-DSS, SB1386
B India' s brand leader software company	Banking and Finance	04	Balanced Score Board, Six sigma, ISO17799	CM, SA Hybrid, FPP	8-12	PCI-DSS, GLBA, Sarbanes Oxley
C & D India's globally reputed industrial giants	Energy and Utilities	05	ISO9001;2000,ISO9126 CMMI, ITIL	Hybrid Hybrid CM	9-13	Sarbanes Oxley, BASEL II
E &F Large software Companies	Manufacturing and automobile NP: 04	04	Lean sixsigma, CMMI, ITIL, ISO14001	FPP Hybrid SA	10-16	GLBA, PCI
A&F	Health Care and pharmacy	**03**	SPICE, CMMI, ISO9002	Hybrid FPP CM	8-14	HIPAA, SB 1386

Inferences: From table 1 it is evident that twenty projects from major application domains namely Retail and Hospitality sector four projects, banking and Finance sector four projects, Energy and Utilities sector five projects, four projects from Manufacturing and Automobile sector and three projects from health care and pharmacy is studied from six companies. Companies have employed quality standards and frameworks including ISO series, CMMI level 5, Lean six sigma, SPICE etc.. Table 1 also infers that projects cost range were from 5 to 16 million dollars and project contract type were belonging to fixed price project(FPP)or Staff Augmentation(SA) or Co-Manage(CM) or Hybrid categories. Companies are adhered to government and industry regulations such as Federal Information Security Management Act (FISMA), Health Insurance Portability and Accountability Act (HIPAA), Sarbanes- Oxley (SOX), the Gramm-Leach-Bliley Act (GLBA), NIST (US National Institute of Standards and Technology) and Payment Card Industry Data Security Standard (PCI DSS) to serve customers globally. The major lesson learnt from the table is that Enterprise requires process implementation for all its global functional products. Products may require adherence towards multiple process standards.

Analysis of every case study is performed in four dimensions based on the objectives of research stated in this paper. The four dimensions are as follows. The first dimension is project contract and development model choice such as Governance based, price based, project based or hybrid customized model. Second dimension is the enterprise perspective towards compliance, process improvement framework and quality frameworks. Apart from this, industry standard regulations for compliance requirements are also considered. Third dimension of study is oriented towards process improvement implementation issues, process flexibility to adapt towards market conditions and client demands, customer life cycle management, effects of process

Improvement frame work on risk, cost schedule variance and compliance effects were also taken into account. Finally why addressing dynamic challenges to the desired extent is still an elusive target for enterprises in spite of robust SPI implementation is considered. The result of analysis in the above said dimensions is given the following section of key findings.

IV. KEY FINDINGS AND ANALYSIS

To address the objectives of this paper, all the projects, taken under case study is analyzed in the above stated four dimensions. The key research findings are summarized below.

The SPI methods are not able to meet the desired level of meeting the challenges because of following reasons.

Finding 1: SPI framework and standards selection and implementation into projects defers from organization to organization. In a way it is organization specific. In most of the instances selection of SPI framework is not correlated with nature and domain of the project being undertaken. Popularity of the framework, experience of the SPI selection individual or customer's demands is influencing the selection of SPI standards for the chosen project than criticality, risk and regulatory environment of the system.

Research Analysis: Even if people and technology are good if process is bad, product cannot be assured of good quality. Hence, it is evident from the above finding 1 that mismatch between the appropriate SPI framework and project, results in waste of cost, rework, defects and lower quality.

Finding 2 Large deviations are observed between theoretical guidelines which describe how to implement SPI methods in projects to its practical implementation in the projects**.** Apart from this**, *i***nternal gaps between process steps, which lead to lack of continuity in implementation of SPI, are also found. Check gates for the observed deviation is not found and deviation effects on products quality are not well assessed and measured.

Research Analysis: Lack of appropriate measures to counteract the deviations in implementing SPI, is resulting in poor product quality and other related factors. This has profound impact on customer retention. Matching a process improvement framework/solution to the customer needs and nature of project is required.

Finding3: Market conditions and client demands vary in a very fast and dynamic fashion. SPI methodologies are not in pace with the speed of variation of market conditions and client demands. Research analysis: Since SPI methodologies lack to catch and adopt fast changing requirements of market and client, time to market the product gets stretched. This in turn have greater impact on ROI (Return on Investment) and business value of the organizations.

Research Analysis: A measure is required to counteract this issue. Client requirements and market demands can converted into practical requirements and if these requirements are embedded into process steps, effective ROI can be expected.

Finding 4: Product development strategies and process implementation patterns is different for each application domain. For example applications from health care domain focuses on reliability, and precision whereas applications from retail and hospitality domain primarily focus on workforce management, security and adoptability. The current frameworks / standards of SPI are often generic and distinguished needs of each application domain cannot be catered by available SPI models or by integrating the models.

Research analysis: Since SPI models are generic but not domain specific, add- on module which can cater the domain specific needs can be added to the existing SPI standards frameworks employed in the company.

The above key findings description has brought to light the major reasons for challenges faced by organizations in spite of implementing robust SPI frameworks/standards. Based on research analysis which has thrown spotlight on the practical ways to address the challenges, this paper introduces 3D Flex model to optimize the software process improvement in organizations.

V. 3D FLEX MODEL

Finally, complete content and organizational editing before formatting. Please take note of the following items when proofreading spelling and grammar.

It is evident from analysis that implementing SPI standards or integrating different models and then implementing it into projects has not yet enabled the organizations to face the challenges of product quality, reduction in rework, cost and schedule overrun. Furthermore process improvement is a continuous process because the process gets degraded over time due to dynamic market and client demands. Following international standard SPI frameworks is very essential for the products to function in global market. However to overcome the issues of SPI reflected on company ROI and on product, domain specific needs, market conditions, client requirements has to be considered and has to be implementation in timely in the process. Hence in order to follow standard SPI frameworks and also cater towards the contemporary in time needs of products, this paper introduces a 3D Flex model and it is given in figure1.

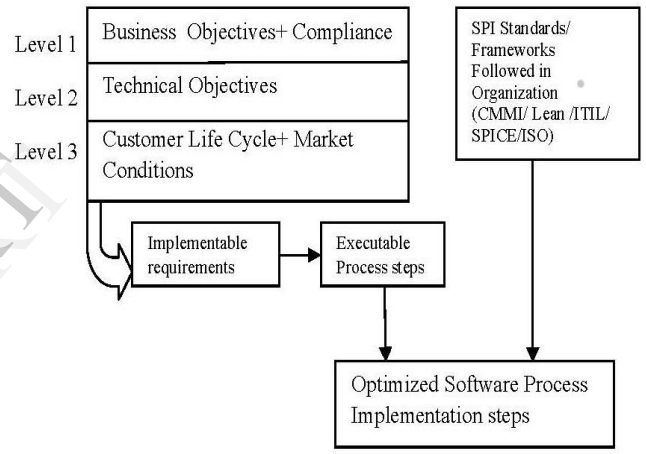

Fig1: 3D Flex model

The above given 3D flex model optimizes the process improvement. As the model is flexible which means adaptability to any framework and to any application, name flexi is derived. Since the model considers improvements in three dimensions, 3D name is adopted to model. In a nut shell as the model is flexible and functions in three dimensions, 3D flex model naming convention is used.

Model Description: Consider the model given in figure1. In order to cater the needs, requirements are gathered in three different layers. Business objectives and compliance requirements are gathered in Layer 1. Business objectives comprises of organizational goals also apart from expected business value, ROI, cost and schedule. Technical objectives are captured in layer 2. Here domain specific, application specific needs are captured. In layer three customer life cycle requirements and market requirements are captured. Customer

life cycle requirements comprises of requirements pertaining to customer acquisition, development, service and retention.

The requirements captured in three layers are given to second block. Here these requirements are validated according to organization protocols and are converted into implementable requirements. These requirements are fed to block three. It has two inputs. One from Block two and another from block 3. Block two contains the standard SPI methods followed in the industry. Block three incubates the validated requirements from block one with standard process steps from block two. The incubated output from block three is optimized software process improvement steps.

This model ensures optimized software process improvement because of complete compliance, client requirements, market demands, business needs and application domain specific process needs blended with standard SPI framework followed in the organization. If the optimized process steps given as the output of this model are implemented in the product development, organization can effectively address the challenges and reap desirable business value.

VI. RESULTS AND DISCUSSIONS

3D Flex model assures the proactive solution to all the challenges and research objectives

Effective collaboration of market conditions, domain specific needs, client requirements with standard SPI frame work ensures the model to combat the issues in product quality, cost and unnecessary rework. Thus the first research objective focusing on how to combat ever changing and fast changing challenges through SPI is answered.

Discovery of requirements in three layers address the second objective of research which focuses on how to embed fast changing market demands into continuous software process improvement in well-timed deployment frame.

Since every application domain has specific needs, a general SPI frame work cannot be implemented stringently. However 3D flex model solves this issue by capturing domain specific requirements in layer three and implementing it into process. Thus the third research objective is answered.

VII. CONCLUSION

Software process Improvement is a growing concern of software industries. Though industries have implemented contemporary SPI and interrogation of multiple SPI frameworks, process issues getting reflected on product is observed. In the current industrial scenario, due to paucity in process, the effects such as unnecessary rework, inconsistent and incomplete documentation and variation in process execution is observed. These issues of process is influencing poor product quality, cost overrun, schedule slippage, lower customer delight etc. As process issues are directly in coherence with organization business value and market survivability, process issues has to be addressed effectively.

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The major challenges are to embed ever changing market conditions, client requirements into SPI frame work in the immediate deployment period of the product but also adhere to standard SPI frame work regulations. Another important fact is every application domain has specific and unique requirements to be met apart from general requirements. SPI frame work caters only to general requirements but not in depth of each application domain needs. Hence SPI cannot be implemented stringently into product. If a new SPI model is introduced in place of existing SPI, the new model cannot be implemented unless it is globally certified and accepted. Furthermore if the product does not follow internationally recognized SPI models, product cannot survive in the global market. Practical research in the six globally located software companies is carried out to find the SPI issues and proactive solution. As a result of key findings and analysis, this paper has introduced3D Flex model. In this model contemporary needs of market, client and application are incubated with standard SPI frame work. This model can be adopted into any SPI framework and to any application domain. Any SPI frame work gets degenerated with time. But 3D flex model stands against this degeneration because it always culminates the current demands into process which delivers product. Hence, the model assures optimized SPI, if implemented.

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