The Critical Success Factors in implementation of Software Process Improvement Efforts:

CSFs, Motivators & Obstacles

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Abstract

The Software Engineering Institute statics shows that: the development and cost of software projects have become relatively very high due to complexity of systems that make software process more complex to be managed. Thus, it is essential to consider the SPI factors that directly affect the process and try to explore the best solution that helps in best management of the software process which ultimately produce the desirable result i.e. help in meeting the basic attributes of the project i.e. time, delivery and the quality. While in the comprehensive literature review, it becomes obvious that CSFs plays a vital role in the implementation of SPI and change process. However, effective used of factors such as management commitment, staff involvement etc. that influence the change process is still an argument questions. Number of research conducted in this regards but this question still un-answered. Literature review also explores that motivators and obstacles both have positive and negative impact on the SPI process respectively. These motivators and obstacles also help in motivating and removing hurdle in the change process, if carefully identify and appropriately used.

To answers, the above questions we conducted this study (thesis) that is based on empirical study that comprises of structure interview with eight SPI practitioners in 5 different organizations across Sweden, Pakistan, Denmark and Norway. The study (thesis) result shows the lists of CSFs, motivators and obstacles that have positive impact on change management. The finding of study (thesis) guides the practitioners in the overall process of SPI initiatives program that provides better mechanism to manage the SPI activities. Additionally, helps in enhancing the overall productivity and in the cost effective implementation of the process improvement program.

The report is written in English.

Keywords: Software Process Improvement, Critical Success Factor, Motivators and Obstacles.

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1 Introduction

1.1 Problem domain

The Standish Group in 1994 had published CHAOS Report, which stated that: in a year, more than $250 billion dollar is spend on IT development projects each year on approximately 175,000 projects. The average cost of the development projects for large companies was $2,322,000, for medium companies it was $1,331,000 and, for small companies the costs was $434,000. However, great many projects failed.

In 1994, The Standish group conducted a survey that contains sampled 365 respondents. The survey contained more than 8300 software implementation projects. These projects were undertaken from different companies, which were large, medium, or small and covered almost every major industry segments. According to the report, only 31.1% of the projects were cancelled before they were completed. Only 16.2 % of the software projects were able to meet their basic key attributes i.e. quality in terms of expected value, time and on allocated budget and, have been called "succeeded". The remaining 52.7% were defined as "challenged" in the report. (SGR, 1994)

The reasons for the failure of the software projects are: the software industry are faced with greater challenges that did not exist before; client demands and their expectations has also increased quite extensively in terms of full functional software with the high level of quality that delivers on the agreed time. (Scacchi & Raffo, 2002; Abrahamsson, 2001) The role of the software systems increased tremendously in recent decay and the software organization are faced with lot of challenges in terms of time and cost constraint due to highly dynamic global markets. Along with this, the client expectations have also increased comprehensively. To cope with this dynamic situation and the issues, organisations need to take the SPI initiatives to strength themselves to enhance their capabilities. Different methodologies and approaches can be used to improved software process maturity and the quality e.g. by using different methodologies and approaches like CMM, CMMI, Spice, Agile etc. (Abrahamsson, 2001)

A Data and Analysis Centre for software (DACS) published a report in 1996. According to this report, successful implementation of SPI reduced the defects by 95%, software development schedule by 71%, and increased productivity in terms of LOC or function points 222% per day. In addition, SEI reported return on investment in successful implementation by 5:1 (Abrahamsson, 2001). Some other well know case studies also reported successful implementation of SPI such as IBM (Nichols & Connaughton, 2005), NASA (Basili et al., 1997), Raytheon (Dion, 1992), Siemens (Mehner et al., 1998), NAVAIR (Wall et al. ,2005) and SIS (Capell, 2004).

In order to meet the present as well as future challenges, issue and pressures which have originated due to the dynamic global markets, the researchers of the IT domain are trying to modify and develop new theories, tools, languages and technologies that assures rapid development and a quality product along with the low cost. The results of these efforts were:

progress from extreme programming towards well planned "product line development" and, "open source" software development. As research continued to progress in these areas, it got lot of attention which helped to cut down the above pressure (Scacchi & Raffo, 2002). Due to these efforts of the researchers and the practitioners, a large number of methodologies and model are introduced in last twenty years including SPI.

Software Process Improvement that aims to provide the quality is relatively new domain that only exists from last twenty years. Most of its ideas, concepts, methods, and theory have been adopted from the quality concept in manufacturing system development (Serrano, 2004). The authors Taipale & Smolander (2006) have stated that, Software Engineering aim is to reduce the overall development costs and at the same time enhance the quality of software system. To achieve this goal, Software process improvement plays a vital role. The author Harter and Slaughter (1999) very rightly stated that, the software quality improvement is an issue that has not yet been resolved and is still a question: How the quality can be tested?

1.2 Background

> "Since SEI introduced the SPI approach many organisations take initiative to accommodate those changes there is lot of success stories and critical evaluations about SPI is available in exiting literatures reported. The underling SPI problems and the organization commitment towards SPI and the awareness of maturity model to guide SPI work reaction to change and knowledge barrier." (Borjesson, 2006).

In 1979 a well know researcher, Rockart, introduced the concepts of Critical Success Factor as a phenomenon that is used to provide information to CEOs. A review of SPI literature reveal that some of the factors play crucial role in success of SPI and that these factors have great influence in implementation of the SPI (Niazi et al., 2006 ; Dyba, 2005 ; Abrahamsson, 2001 ; Abrahamsson, 2000) and (Abrahamssona, 2002) etc. Hoverer, these CSFs concepts neither are well utilized nor have much more great stand in research. The SPI is an ongoing improvement process and learning phenomena where people learn from their own mistakes. CSFs are identified only after successful implementation of SPI and after finishing certain activities (Niazi et al, 2006). Management commitment is frequently citied CSFs in existing literatures and real life practitioners have reported lack of management commitment as the main barrier in successful implementation of SPI initiative. Although most of the researchers and practitioners agreed on the importance of management commitment but, these terms not reflect clear picture about the actual structure and the meaning of "management commitment" in context of improving the processes. Therefore, the results of these research studies do not establish any significant signs between "management commitment" and "SPI initiatives". A concept of champion is most suited for the successful implementation of SPI projects (Abrahamsson, 2000a). Nevertheless, successful implementation of SPI is still an arguable and challengeable

issue; although exiting SPI literatures provides evidence of few case studies that have reported successful implementation of the SPI. However, these research efforts are limited and have lot of loopholes that leads towards ambiguous questions that were not answered. These research studies fail to provide sufficient theoretical and psychometric justification in terms of construction of instrument and their measurement. (Dyba, 2005)

The numerous studies had been conducted that investigated the critical factors which influence Software Process Improvement and its positive and negative impact on the implementation. Rainer and Hall (2001) quoted Herbsleb & Goldenson and Pajerek studies that; practitioners look for guidance on how to improve rather then what to improvement.

Brief extracts of some of the studies that suggested factors necessary for implementing a successful software process programme are given hereafter:

- Niazi et al. (2006) present finding from the empirical study conducted of the CSFs, this include 34 SPI practitioners from 29 companies and, 5 companies is among those which have been awarded best process achievement by IEEE Computer society. In addition to empirical study, 47 published experienced reports, case studies and articles were analyzed. The aim of this study is to explore the issues related to SPI implementation and provided detail knowledge to SPI practitioners about the positive impacts of these issues and in the implementation process. The purpose of this study is to help SPI practitioners, in planning, adopting better strategy and better development of SPI implementation program. In the study seven factors were identified namely: (higher management support, training, awareness, allocation of resources, staff involvement, experienced staff and defined SPI implementation methodology) that are generally considered critical for successfully implementing SPI. While comparison of the empirical results with the analyzed literatures they identified two new CSFs i.e. (SPI awareness and defined SPI implementation methodology) that are not available in the literatures.

- Dyba (2005) presents the models from empirical investigation of key factors for success in SPI. Companies conducted tests for conceptual model and hypothesis for the study and a quantitative survey of 120 software and quality mangers among 55 companies. The findings of the study reported six factors i.e. Business orientation, involved leadership, employee participation, concern for measurement, exploitation of existing knowledge and exploration of new knowledge. The SPI success critically depends upon these factors and is explained by more than 50% in the outcome variables. The main contribution of this study is to provide researchers and practitioners with important new insights regarding the critical factors for success in SPI.

- El-Emam et al. (1999) presents re-analysis of factors that influence the success of SPI. The prior report was based on analyzed univariate and bivariate statistics methods but, their current study is based on multivariate analysis that duplicates the earlier study's results. In their current study, more in dept analysis and importance about the interactions and comparisons among the factors that formulate process improvements efforts possible to succeed or fail, is consider. The sample size of 61 appraisals which comprises of 138 respondents had been taken. The sample was taken from SEIs Process

Appraisal Information System (PAIS) database. The assessments were conducted in USA and Canada in 1992 and 1993.

- Stelzer and Melis (1999) in their study identified ten factors that influence the organizational change in SPI initiatives based on CMM or the ISO 9000 quality standards. The study was based on analysis of experience reports and case studies of 56 software organizations that have implemented ISO 9000 CMM based process improvement initiatives. The study were divided in two stages and a total of 20 mangers from German companies had been interviewed along with the analysis of experience reports and case studies from 16 European companies who had implemented ISO 9000 based SPI initiatives. In first stage, explorative study was conducted to identify the factor that affects the organizational changes in SPI. In the second stage, 56 of those companies were taken which had gone through the process improvement efforts and, their experience reports were systematically analyzed in order to find the significant of the factors found in earlier (first) stage.

- Badoo and Hall (2002) studies presents empirical findings about analysis of the motivators factor that stimulate practitioners in SPI and gathered information analyzed using classic motivation theory. The study used focus group discussion of 13 UK companies and involved almost two hundred software practitioners. The authors visited the software companies from September 1999 to March 2000 and conducted 49 focus groups interview. The group's size varied between four to six members and 21 developers, 16 project managers and 12 senior managers. The main purpose of the study is to identify SPI motivators according to developer, project manager and senior manger staff groups. The authors also identified some similarities and differences between different practitioners groups and gave suggestions in terms of findings that can be useful for the SPI managers.

- Hall et al (2002), the study collected both quantitative and qualitative data to exemplify the SPI implementation. The data was gathered from 85 UK companies who had implemented SPI. The study generated the maturity-based framework that aids the SPI mangers in accelerate the SPI implementation. Authors also identified some critical factors that help SPI mangers in controlling and implementing the SPI.

- Rainer and Hall (2002) used multi-strategy approach for this study: firstly, combining qualitative and quantitative analysis of case studies. Secondly, comparing their case study results with previously conducted survey study results. In previously published study three set of analysis was conducted (general analysis, maturity-based analysis and success-based analysis. SPI factors were identified by using concept: major or no impact on implementation). All together, 26 factors were identified by the authors that potentially affect the SPI. The factors found in the case studies and survey study that are relevant to SPI were executive support, experienced staff, internal process ownership, metrics, procedures, reviews, and training. Two additional factors have been found in both the case studies and survey: reward schemes and estimating tools; but are not relevant to SPI. Three additional factors were also found that need to be further

investigated as practitioners suggested. These factors may be determined in SPI: people, problems and change.

- Bechams et al (2003) study collected qualitative data from 45 focus groups discussions that involved around 200 software staff represented from 12 different software companies having experienced problems in software development. The result of different practitioners groups is represented through using correspondence analysis. The aim of the study is to provide overview of the problem faced by the practitioners and, the approach they adopt to improved the software process. The findings of the study show that there is association between the company's maturity levels and the problem reported. Different practitioners group faced different type of the problems e.g. Senior manager cited goals, culture and politics while developers problems were more associated with requirement, testing, communication and technology etc. The findings also confirmed that company's on high-maturity faced more organizational type problems while, the company's on low-maturity faced more project type problems such as documentation, time-scales etc.

No change management program or CMM or ISO 9000 standards family guarantee successful process improvement. The CMM or ISO 9000 family only guides practitioners "what" to improve but didn't specify "how" to effectively or successfully implement the process improvement initiatives. Practitioners that wish to implements the process improvement initiatives require a comprehensive understanding of the factors that influence the success and failure of improvement activities.(Stelzer and Melis, 1999)

1.3 Research Question

Research questions will form the core for the development of thesis for establishing contents and direction. The following research questions have been formulated. These are based on discussed background and problem domain.

RQ1: What are the most common critical success factors (CSFs) that have a positive impact on implementing SPI?

RQ1a: What are the most common factors that are frequently cited in the literature studies?

RQ1b: What are the factors that are found through the empirical study?

RQ1c: What are the differences between the factors identified in RQ1a and RQ1b?

1.4 Structure of Thesis

The structure of thesis is as follows. *Chapter 1* (Introduction) comprises of description of the problem domain, background of prior research in SPI domain. *Chapter 2* (Method) contains the research method and research process followed by *Chapter 3* (Software Process Improvement) presents definition of SPI, selection of process improvement methods, guidelines for selecting process improvement methods and description of CMM model and its five stages. *Chapter 4*

(Critical Success Factors) presents description of top ten CSFs identified through literature. Chapter 5 (Research findings) comprises of the literature review and empirical study results, a brief description of the results along with professionals remarks that obtained from the empirical data is also discussed, followed by Chapter 5 (Discussion) that contains the details descriptions and comparisons of the findings with the prior research. Also contains the suggestions and recommendations on the ground of analysis of empirical data. Chapter 7 (Conclusion) wrap-up of the outcomes of the study and possible future work.

2 Research Method

This section describes the methodology used for this study (thesis). The main parts of this section are research approach followed by a detail research process.

2.1 Research method

In the research method comprehensive literature review and empirical study was conducted and further detail is mention in section 2.2.1 & 2.2.2.

2.2 Research process

The research for this study (thesis) has been carried out in two phases. *In first phase extensive literature review* was undertaken; this was *followed by empirical investigation*. The empirical investigation focused on the qualitative aspect of the data collection only. In the second phase of the study, theme based questionnaire was designed and structured interview conducted. On the basis of collected information from the literature review most common factors of SPI was identified appropriately and, then these factors were compared with the result achieved through the empirical study.

2.2.1 Literature Review

A detailed and comprehensive literature review was conducted that included research articles and papers, books, case studies and web references to answer the Research Questions and to understand the topic in more depth. This method of literature review helps to further explore the area that provide extended helps and support in gathering information about the SPI role, implementation problems and initiatives. Further, it helps to identify the key CSFs that have positive impact on implementation of SPI.

2.2.2 Empirical Investigation

For Empirical Investigation, qualitative approach was used to examine the respondents' point of views. The adopted method aided to support our findings that were closely examined from the outcome of the first phase.

The Empirical study aim is to create awareness in the researchers and respective research community in the practice of SE and its different activities. Its emphasis on effective use of scientific knowledge and, the level of abstraction, that guide and help them for the development of new SE technologies. The vision of Sjøberg, Dyba & Jørgensen (2007) helps to overcome the challenges which are considered hurdle and affect goals i.e. building new theories that help in improving existing technologies in terms of tools, methodologies, languages etc. It also helps in best practice in the field of SE domain. The relevance and synthesis factors identified among the key issue, which needs to be dealt with appropriately. (Sjøberg, Dybå & Jørgensen, 2007)

The qualitative research refers to *"what, how, when and where of thing"* (Berg, 2006). Due to its complexity and diversity, this method was criticized by number of researcher like Mike and Huberman (1994, p.40). Further referring to it researcher Fred Kerlinger said, "*There is no such thing as qualitative data, everything is either 1 or 0*". D.T. Cambell was argumentative on the

above definition and said that "*all research ultimately has qualitative grounding*" quoted by Berg (2006).

Nevertheless, large number of research has been conducted in this regard and unlimited numbers of articles have been published in this domain. These focus and examine qualitative studies and roles in SE domain. (Sjøberg, Dybå. & Jørgensen , 2007 ; Taipale & Smolander , 2006 ; Oza, 2009) and (Berg, 2006). These studies focused on the role of qualitative research in SE different activities such as requirement, development, process, testing, and evaluation.

For empirical study, a structure interview was conducted by the help of well-designed questionnaire to find the answer of the Research Questions (RQ1B) and to understand the topic in more depth. This method empirical study helps to further explore the area that provide extended helps and support in gathering information about the SPI role, implementation problems and initiatives. Further, it helps to identify the key CSFs that have positive impact on implementation of SPI. The further detail is available in subsequent section.

2.3 Data Collection

For this study (thesis) almost 70 plus research articles, case studies, reports and the books were analyze in detailed. Some of the above mention materials categories (such as case studies, articles, reports etc.) although found interesting but, not reflected the relevant information that we searched and hence those articles were excluded from the research. To further refined the quality and relevance of material for the research finally selected around 50 cases studies, research articles, reports etc that's helped a lot throughout the research and hence a major contribution in writing this study (thesis). However, to identify the CSFs in the literature review seventeen articles were finally been selected that contained a high quality articles in terms of the authors and the method of collection empirical data. The overall inspiration of the data collection is been taken from the Niazi et al. (2006) and the classification of data is done in three major categories.

Firstly, the case studies that describing lessons learned from SPI implementation were carefully analyzed. In those articles, it is quite easy to pick the CSFs, obstacles, and motivators as it was mention in summary in terms of 'lesson learn'. Secondly, in some of the case studies the detail SPI initiatives and implementation efforts were described steps by steps nothing was found like lesson learned in those cases studies. Therefore, in those cases studies to get the obstacles, motivators, and CSFs is much difficult. So, those articles were very carefully analyzed to get the desirable information. Finally, some of the articles and research papers listed the CSFs, motivators and obstacles that were identified in their empirical studies were watchfully determined. The main issue found in this category were describes in detail in section 5.3.4 of this study (thesis). Additionally, only those CSFs were chosen from the literature review that was mentions in abstraction or where authors emphasis on the specific factors in the descriptions otherwise, among the listed CSFs in the papers only top ten in terms of ranks or percentage was selected in order to determined the top ten CSFs from the literature review .

Selection of Respondents

Initially it was difficult to found the appropriate SPI personals as our aimed to interview those professionals who had vast experienced and expertise in SPI domain. Thus, the selection of respondents was done on the bases of method of convenience i.e. all the SPI practitioners were initially contacted by the references that obtained from the IT university professors and the personals working in the respective organization. The respondents of ours study is represented fours different countries namely Sweden, Pakistan, Norway and Denmark.

The major of the SPI practitioners are belongs to managerial levels and represented the multi-national organization see table 2.1 and hence we have trustworthy in our findings and the comments they provided about the SPI.

The response rate was quite attractive and positive as initially twelve people were contacted and those belongs to project manager, manager, QA, developer and the consultant. Some of SPI practitioners turn down the request as they responded that they are not appropriate persons to interviewed, but they recommend their other colleagues who more suited according to the thesis topic. However, finally we able to interviewed eight SPI personals that have a sound knowledge and expertise in the domain. Please see the table 2.1 that describes the demographic data of the interviews (i.e. basic information about the respondents and the organization they represents) and table 2.2. Further describes the medium of interviews conducted in respected of the countries.

Interviewer	Job title	Experience	Industrial Sector	Primary Business	Established	Location	Company Name
1	Head of Application development	13	Financial/Capital market	Shares depository	11	Pakistan	CDC
2	Manager Application development	9	Financial/Capital market	Shares depository	11	Pakistan	CDC
3	Technical Specialist	15	Automobile	Manufacturing and development of Cars	100	Sweden	Volvo Car
4	Software developer and QA	10	Automobile	Manufacturing and development of Cars	100	Sweden	Volvo Car
5	Asst Manager	20	Telecommunication	development of communication device	100	Sweden	Ericsson
6	Project Manager	9	Telecommunication	development of communication device	100	Sweden	Ericsson
7	Quality Assurance	1.5	Software Consultancy	Software development	26	Norway	Visma Software
8	Software Engineer	7	Software Consultancy	development and consultancy	10	Denmark	Commentor A/S

Table 2.1: The demographic data of the Respondents

Countries	Face to Face	Telephonic	Email	Total respondent
Sweden	4		4	4
Pakistan		2	2	2
Norway		1	1	1
Denmark		1	1	1
Total	4	4	8	8

Table 2.2: The interview type and the respondent's countries representation

Structure of Questionnaire

The questionnaire was structure in well-organized manner and the inspiration is been taken from (Niazi et al., 2006 ; Rainer & Hall, 2002). The interview questionnaire was divided in two parts (see Appendix A). In the first part of the questionnaire, the basic demographics information of the respondents and the organization was assembled. While in second part of the questionnaire , was about the SPI initiatives and implementations and in the middle & last part of the questionnaire, the respondents experienced & expertise and their preferences and suggestion about SPI related data is collected. Additionally, practitioner's perspective and priorities regarding selection of respective CSFs and motivators & obstacles from two perspective i.e. (management & employee) data was also collected.

Empirical Interviews

Eight quality CSFs interview were conducted. The respondents who participated in the interview were QA, developers, assist. /project manager, consultant, and head of development (see figure 2.1 and 2.2 for more details). Out of eight qualitative interviews, four interviews were face to face while rest of the interviews were conducted on the phone due to geographical displacement of the respondents. The duration of the interview was set forth minutes by the consent of respondents for both the interview types' i.e. face-to-face and telephonic interview. The interview request was sanded through email along with the questionnaire and, the respondents determined the interview time and place.

The purpose of sending questionnaire well in advance was to get the quality information from the interview and the respondents do not need to guess or brainstorm during the interview about the questions. All the interviews that were conducted been recorded whether it is face-to-face or telephonic and the notes were taken during the interviews that were documented later on. The windows vista sound recorder was used for recording the interview for both the interviews types i.e. face-to-face and telephonic. The purpose of taken notes was to validate the interview themes and really helped while in the actual transcription of the interviews that did later at analysis of interviews.

Before the actual interview started, a brief introduction of the aims and purpose of the thesis and personal background is given to the participants. In the first part of the interview, demographic questions were asked in order to determine some key information of the participants and their company background. While in second part of the interview, questions that were asked merely belong to interview experienced and knowledge about the SPI implementation. Additionally, respondents asked throughout the questions to provide some real time examples, professional comments or tell the success/failure stories about the SPI and the CSFs. At the ends of interviews, participant's consent were taken for contacting them again in case of ambiguity or further information/clarification required and were contacted as when required.

2.4 Data Analysis

The data was gathered in the shape of selected articles, literatures, case studies, and empirical interviews. These were analysed by using the Content Analysis Method. In the available literatures and studies different authors and researchers have recommended different useful approaches and methods for data analysis such as Grounded Theory. However, for this research study we followed the Niazi et al. (2006) Data Analysis Mechanism.

Content Analysis
According to Michael and Lewis (cited by Niazi et al, 2006) Content Analysis is a research method that helps to generate valid conclusions from text by using a set of procedures. (cited by Niazi et al, 2006), thus defined Content Analysis Method: "*content analysis is a research technique for making replicative and valid inferences from data to their context*".

Empirical Data
Empirical data was obtained in the shape of interviews from the companies' personals through transcripts to form the common factors (step 1 to 3 followed) and interviews from different actors involved in SPI i.e. senior manager, developer, QA and testers etc. was conducted.

1. *Identify themes from transcript*

   - The interview transcripts were read very carefully to identify major themes for SPI implementation. These themes were noted down and compared to the notes taken during the interview to make sure that transcripts being analyzed are the true reflection of the actual CSFs interviews. These two steps give us assurance that the transcription process has remained the same as per the original data generated in the interviews. (Niazi et al, 2006)

2. *Generate categories*

   - All the interview transcripts were read again to form the categories from the responses. Different themes that belong to same categories were grouped together. For example budget, funds, finance, capital, money, etc. were put in a group under "resources" category. (Niazi et al, 2006)

3. *Frequency analysis*

- Coding in empirical research helps to extracting quantitative data from the qualitative data. In this thesis, research data from the literature and CSF interviews were categorized and coded in order to perform frequency analysis and comparative analysis of CSFs and SPI implementation. (Niazi et al, 2006)

- Frequency Analysis method helps in organizing the qualitative data into respective group item scores/values into frequencies. The statistical information such as number of occurrences and percentages of each variable can be represented in the shape of frequencies tables or graphs. These frequencies later helps in contrasting and comparing variables within or across the groups. (Niazi et al, 2006)

In this research, we used frequency analysis. Firstly, we recorded the episode of CSFs, motivators & obstacles found in each articles of survey studies in a matrix structure that is further used to calculate the priority, percentages and number of occurrence of CSFs, motivators & obstacles. Secondly, we recorded the occurrence of CSFs, motivators & obstacles that were found in the empirical studies interview transcripts. We further used it to generate priority, percentages of CSFs, according to practitioner's points of view. Finally, in results, we presented discussions and conclusions for comparative analysis.

3 Software Process Improvement

3.1 Definition of SPI

IEEE defined process as "a course of action to be taken to perform a given task (IEEE Std-610, 1990) while, IS0 9000-1 defines a process as "a set of interrelated resources and activities which transform inputs into outputs. ... Resources may include personnel, finance, facilities, equipment, techniques and methods" (Stelzer and Melis, 1999). Likewise, a software process can be defined as "a set of activities, methods, practices, and transformations that people use to develop and maintain software and the associated products (e.g., project plans, design documents, code, test cases, and user manuals)" (Paulk et al, 1993). The Authors Paulk et al (1993) thought that the software process improvement aims is to:

- Improve software product quality
- Enhance productivity
- Cut-down the cycle time for the development

Thus, a SPI aim is to produce economical, enhanced and better quality products. Different groups of practitioners across the world use different approaches to implement the SPI. North American companies are comfortable in using CMM; Japanese companies prefer TQM and European firms use ISO 9000 family to improve their organizational capabilities. CMM is designed entirely for software processes, while TQM and ISO 9000 family standards are not specially for software manufacture. (Stelzer and Melis, 1999)
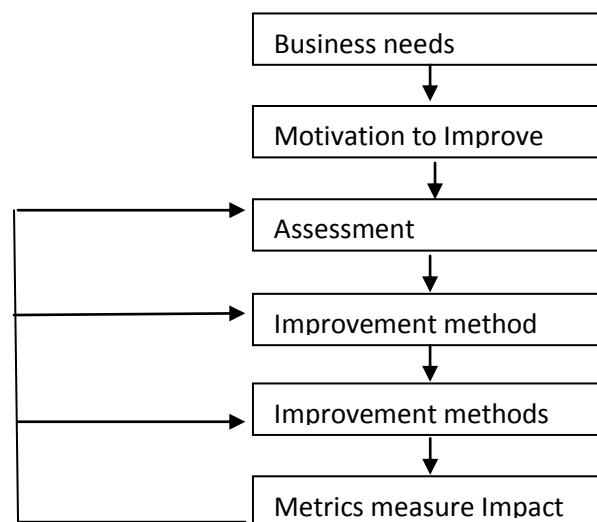

Figure 3.1: Process Improvement Approach

Siemens (Mehner et al., 1998)

3.1.2 Software Process Improvement Method

Mehner et al. (1998) defined process improvement method as *"an integrated collection of procedures, tools, and training for the purpose of increasing product quality or development team productivity, or reducing development time"*. Through this software process methods process mangers or engineers can improve the efficiency of current practices within the key process areas or get support in the implementation of KPAs of Capability Maturity Model. These methods usually required lot of resources. Therefore, before the deployment of the software process methods in the organization, it is necessary to provide significant training and make reasonable efforts at the time of introducing these methods. For successful implementation of process methods management needs to overcome barriers that come across at the time of adoption so that positive impact on process improvement can be monitored and evaluated.

3.1.3 Needs for Process Improvement

The enthusiasm towards software process improvement depends upon the business need and different approaches can be adopted depending upon the organization existing practice and the maturity (see the Figure 3.1.). Consequently, appropriate methods will be recommended and implemented that fits organization current practices and business goals (see Figure 3.2. contain the list of methods according to KPAs). It is not easy to determine the impact and forecast about the success of any improvement methods because this depends upon organization environment variables such as staff skills and training effectiveness, process implementation efficiency and acceptance. *"The selection and successful implementation of the SPI methods are dependent on many variables such as the current process maturity, skill base, organization, and business issues such as cost, risk, implementation speed, etc".* Few questions, given below, appear after the process is in place to ensure the successful process implementation:

- What is the next step that should be taken?
- Whether the existing method implemented successfully or still need to go?
- What is the maturity of the current process?
- Whether the implemented process is mature enough and appropriate for use or any new methods needs to introduce? Siemens (Mehner et al., 1998)

The Organizations that produce software's wants to improve their software development process for business competitiveness and profitability; this is achieved through:

- Improving product quality
- Improving team productivity
- And reduce product development cycle time

3.2 Selection of process improvement methods

No doubt, most of the organizations are motivated to improve their development process but to do them best only few know. This is because the numbers of improvement methods available create problem and confusion for the process and software engineers/ managers, to determine,

which methods to adopts and at what points of their process evaluation (see Figure 3.2. depicting the appropriate methods according to KPAs and process maturity). The process and software engineering mangers who rightly estimate and calculate the assessment methods, can only guarantee implementation success. (Stelzer and Melis, 999)

There are lot of success and failure cases studies that were published, where authors mention their success stories, challenges, issues and reasons for implementation failure in terms of lessons learned. Some case studies were IBM (Nichols & Connaughton, 2005), NASA (Basili et al., 1997), Raytheon (Dion, 1992), Siemens (Mehner et al., 1998), NAVAIR (Wall et al, 2005) and SIS (Capell, 2004). While going through these studies it becomes pretty clear and understandable that how selections of appropriate methods identified the area where that process evaluation method is used and can help in successful process implementation and initiatives.

Method	Key Process Areas	CMM Level
Estimation	Software project planning	2
ISO 9000 certification	Software quality assurance Organization process def.	2 3
Software process assessment (SPA)	Organization process focus	3
Process definition	Organization process def.	3
Formal inspection	Peer reviews	3
Software measurement & metrics	Software project planning Software project tracking & oversight Integrated software mgt. Quantitative process mgt. Software quality mgt. Process change mgt.	2 2 3 4 4 5
Computer aided software engineering (CASE)	Software configuration mgt. Software quality assurance Software project tracking & oversight Organization process def. Software product engr.	2 2 2 3 3
Interdisciplinary group methods (IGMs)	Intergroup coordination	3
Software reliability engineering (SRE)	Quantitative process mgt.	4
Quality function deployment (QFD)	Software quality mgt.	4
Total quality management (TQM)	Organization process focus Quantitative process mgt. Software quality mgt. Process change mgt.	3 4 4 5
Defect prevention process (DPP)	Defect prevention	5
Cleanroom software development	Quantitative process mgt. Software quality mgt. Defect prevention	4 4 5

Figure 3.2: Software Process Methods and KPA (Siemens (Mehner et al., 1998)

3.3 Guidelines for selecting process improvement methods

Mehner et al. (1998) recommended a guideline for selecting software improvement methods. This guideline was based on the observation of case studies sites. The approach mentioned for selecting and implementing software process improvement methods are given below and they provide help to those organizations which like to implement the process improvement methods successfully.

1. *Establish improvement goals*

   The SPI goals (e.g. Improved performance goals: improved quality, enhanced productivity, reducing cycle time and better schedule etc.) needs to be constituted so that it reflect the overall business goals of the organization and should be

described according to organization environment and it further requires to efficiently communicate across each and every level of the organization.

2. *Identify improvement key process areas (KPAs)*

The KPAs need to indentify and this usually is done at the time of software process assessment (SPA). It is essential to choose right method for process improvement (see the list of methods and KPAs they support in Figure 3.2) that is appropriate for organization process maturity levels as identified in CMM (Paulk et al, 93 **;** Herbsleb and Goldenson, 1994 & Hughes (Humprehy, 1991).

3. *Select process improvement methods*

It is recommended not to choose more than three or four SPI methods of interested KPAs, following points should be keep in consideration while selecting the methods.

- o Target KPAs and the maturity level
- o Organization goals consideration
- o Sound benefits
- o Earlier Investment
- o Implementation problem
- o Organization resistance

The tool that assists in identifying the selection criteria for each process improvement method is matrix (see the Figure 3.4 and 3.2) .The matrix contains the appropriate methods according to KPAs, benefit, difficulty and level of process maturity options.

4. *Establish responsibility*

Next step that should be taken after chosen the process improvement methods is to establish responsibility for the SPI program. Specific improvement methods need to be assigned for implementation to responsible action teams.

5. **Communicate the process improvement plan**

The SPI plan need to be communicated to the entire organization .This helps in understanding and accepting the process improvement program.

6. *Train*

The process improvement methods require certain skills, specialized training needed to transfer those special skills to the staffs so that "quality culture" is established and the process improvement program become accepted practice throughout the organization.

7. *Define progress tracking measures*

It is essential to define measure (see the Figure 3.5) that aid in tracking the progress of the software process improvement methods. In some of the cases, the training provided for suggested measures. The Figure 3.5 list "measure" and the unit of the measure that may prove useful .The authors Mehner et al (1998), referred a McAndrews (93) study that also has a suggestion for implementing a measure.

8. ***Implement the process improvement methods***
   After carefully going through above steps, the methods needs to implemented so they will become a part of the standard work practices and corporate culture of the organization. If the methods are complex pilot project implementation is recommended.

9. ***Collect and analyze tracking data***
   When a methods implementation is initiated/ taken and the measures are defined, the tracking data can be collected and analyzed. The collected data helps to observe the impact of the method and implementation effectiveness.

10. ***Adjust the process improvement plan***
   Careful investigation of tracking data will help to look into the effectiveness of the implementation of the software process improvement program. These examinations help in identifying the required adjustments; and, as required, appropriate adjustments should be done in SPI plan.

Method	Potential Benefit	Initial Investment	Implementation Difficulty	Anticipated Organizational Resistance
Estimation	2	1	1	1
ISO 9000	1	3	2	1
Software process assessment (SPA)	3	3	3	1
Process definition	3	3	4	2
Formal inspection	4	2	1	1
Measurement	4	2	4	4
Computer aided software engineering (CASE)	3	4	4	2
Interdisciplin. group methods	3	2	3	3
Software reliability engineering (SRE)	2	3	4	2
Quality function deployment (QFD)	3	2	3	2
Total quality management (TQM)	3	3	4	3
Defect prevention process (DPP)	5	4	4	3
Cleanroom	5	5	5	5

Figure 3.4: Example of Matrix criteria for selection of process improvement methods Siemens (Mehner et al., 1998)

Measure	Units of Measurement	Primary Data Used
Defect detection distribution	% Defects found per phase	Defects
Defect rate	Defects/KLOC per phase	Defects, product size
Project productivity	LOC/Staff-hour	Product size, effort
Schedule cycle time	Months	Schedule duration time, actual
Schedule adherence	%(Estimated Actual)/ Estimated	Actual and estimated schedule duration times

Figure 3.5: Organization performance measures Matrix
Siemens (Mehner et al., 1998)

3.4 CMM model

CMM model is specially designed for process improvement and numerous authors Paulk et al (93), Herbsleb and Goldenson (1994) & Humprehy (1991) emphasised on the importance of CMM and argument on its suitability for the process improvement methods. Further comments about model flexibility and support for different organization process maturity levels. The CMM identifies and support five levels of maturity (see the Figure 3.3).
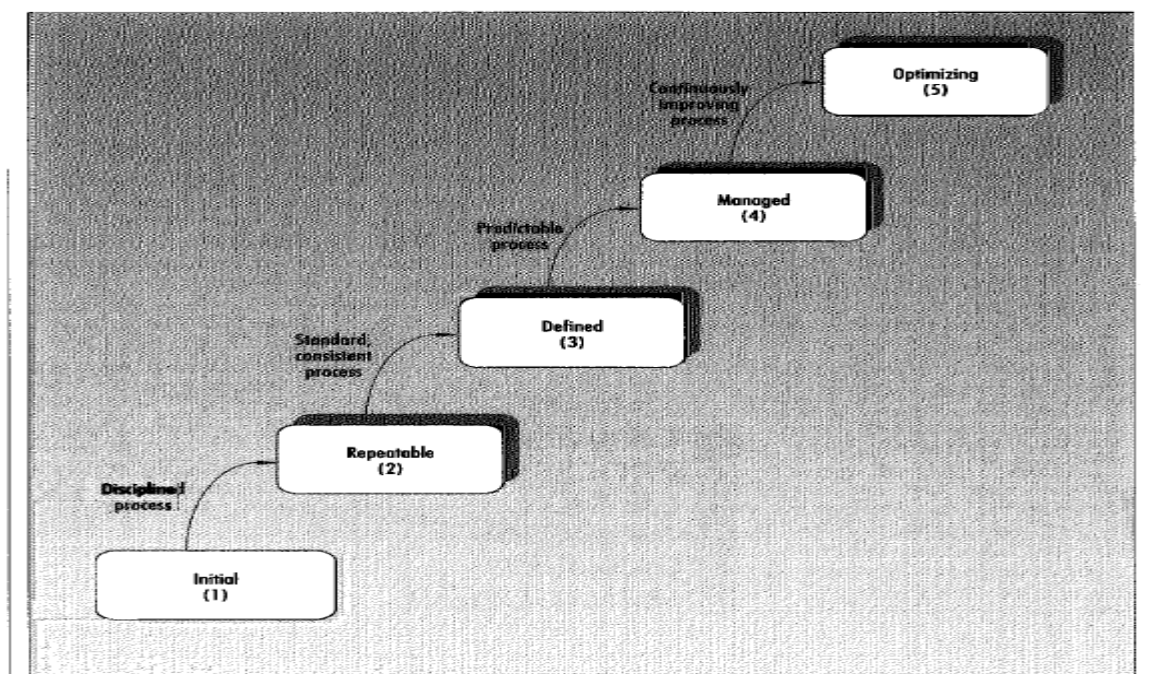

Figure 3.3: Maturity framework with five levels, each one is the foundation for next
(Paulk et al, 93)

1. *Initial.*
   - At this point or the level, the organization does not have a steady development environment for software's. In addition, the organizations adopt adhoc and chaotic processes and developed products are over budget and behind schedule. Such organizations are not consistence with the decision making and success merely depends upon the individuals who are champion, and seasonal and adhoc teams. If the process manger, who is champion, leaves the organization then, the impact of his absence will create a serious project management problem and issue in the organization. (Paulk et al, 93)

2. *Repeatable*
   - Organization at level 2 has established policies, standards for managing the projects and sets the procedure for implementing them but processes may vary among different projects. Basic software management controls has been installed in the organization and new project planning and management is repeated on the based on the earlier project success and previous learning experience. Processes are stable and a project manager well in control of the budget and schedule. The communication of the identified problem is done appropriately as arise in the project. (Paulk et al, 93)

3. *Defined*
   - At this level of an organization, documented processes categorically are used across the organization for the development and maintenance of the software. These processes also integrate into coherent whole of the processes of Software engineering and management processes and CMM as "organization standard software processes". A software engineering process group (SEPG) has facilities for the organisation process improvement efforts. To enhance the product quality peer reviews is in place and the Organization also launch training program to ensure that entire employee holds necessary skills that helps to perform their duties efficiently. (Paulk et al, 93)

4. *Managed*
   - At the managed level, Software products are of high quality and management sets quantitative and quality goals for product and process. There are well-defined consistence mechanism for evaluating process and product. Under Organizational measurement program, the productivity and quality of the key process activities of all the projects across the organization are measured. The organization also maintains the process database which use, collect and analyze the data accessible for "projects defined processes" (Paulk et al, 93).

5. *Optimizing*
   - At this level, the organization goals are to preventing defects and main focused on continuous process improvement. The organization has the channel to identify the weakness of the process and make them stronger to processes. A cost analysis of new technologies is performed, on the basis of process effectiveness and appropriateness changes and suggestion is provided to the process. The modernization that use best software engineering practices are identified and shifted all over the organization. (Paulk et al, 93)

4 Critical success factors (CSFs)

While in comprehensive literature reviews i.e. based on case studies, experience reports, research articles and books. We identified ten critical success factors (see the table 4.1) for details

Categories	Priority	Percentage, N=17
Senior Management Commitment	**1**	88%
Staff Involvement	**2**	71%
Exprience Staff	**3**	53%
SPI awareness and Implementation	**4**	53%
Training and mentoring	**5**	41%
Allocation of Resources	**6**	35%
Communication and Collaboration	**7**	35%
SPI goals and Objective	**8**	29%
Organization Culture	**9**	29%
Organization Politics	**10**	29%

Table 2.1: List of CSFs identified through literature review

The above identified CSFs are describes below in details,

Senior Management Commitment

Senior management commitment is most cited factors in the available literature (Niazi et al , 2006 ; Dyba, 2005 ; Rainer and Hall, 2001 ; Stelzer and Melis, 1999 ; El Emam et al, 2001 ; Rickart, 1979 ; Montoni and Rocha, 2007 ; Woong, 2004 ; Goldenson and Herbslebs , 1995 ; Badoo and Hall , 2002) & Dorenbos and Combelles , 2004). These researchers use different key words to define the "management commitment" term, for example, higher management commitment, executive support, top down commitment etc. However, all of researchers tried to

share their findings about the role of senior management commitment and its importance in Software process Improvement. Different group of practitioners belonging to industries with best practice concepts and approaches for successful implementation of SPI and initiative taken, is highlighted in their empirical studies results and, how truly commitment and involvement of senior management abled them for successful implementation of SPI initiative program was pointed out.

The management commitment is the degree of interest for process improvement and the extent to which the resources make available for SPI by the management. (El Emam et al, 2001; Stelzer and Melis, 1999). Management commitment and support is one of the most important factors that can play a vital role in successful implementation of SPI and initiative program (Niazi et al, 2006). Without management support, progress cannot be granted. It is the level of commitment which higher management ensures to support at all the operating levels of the organization that sponsors the change in order for successful implementation of SPI assessment and, it is also very essential to overcome barriers which are set by staffs and groups against this change .(Stelzer and Melis, 1999)

Leadership operate at different level in organization should need to be truly committed and must enthusiastically be willing to take part in SPI because, SPI success is directly associated with the involvement of the leadership (Dyba, 2005). According to Rockart (1979) managers of different levels have different viewpoints, preferences and focuses, they take appropriate tactical and strategic set of actions according to the levels in which they operate to assure that they meet the organisation mission or gaols.

To be successful in the SPI process the senior management should have a broader picture of their resources required to conduct the process improvement assessment initiative, and appropriately need to plan, sponsor, provide funding and accomplish the actions plan (Stelzer and Melis, 1999). The Goldenson and Herbslebs (1995) study shows that almost 100% create actions plans and 90% for Process Action Team (PAT) to assure the implementation of actions plans. This study also confirmed that the monitoring of the progress by higher management is the most vital factor in successful implementation of SPI.

Staff Involvement

Staff involvement is among a key factor which helps to facilitate successful SPI program. This is agreed by many researchers such as (Niazi et al, 2006 ; Dyba, 2005; Rainer and Hall, 2001 ; Stelzer and Melis, 1999 ; Hall et al, 2002 ; Montoni and Rocha, 2007; Woong, 2004 ; Goldenson and Herbslebs, 1995 ; Badoo and Hall, 2002 ; Dorenbos and Combelles, 2004). These authors explore different aspects of staff involvement CSF in their studies and provide some in-depth knowledge and idea about how the staff participation and involvement leads us to successful implementation of SPI and in the evaluation process; and assessment of its initiative in change management. The Dyba (2005) defined staff involvement factor as "*the extent to which employees use their knowledge and experience to decide, act, and take responsibility for SPI and this is positively associated with SPI success*" while, Stelzer and Melis (1999) defined staff involvement as " *the degree to which staff members participate in the improvement activities* ".

So, in the light of above researchers definitions it can be said that staff involvement is the amount of interest taken by the employees in the adoption of responsibility to participate in SPI initiative where they use their skills, experience and knowledge for successful implementation of SPI program and initiative.

For successful SPI program, staff involvement is extremely essential that all the personnel belonging to software development should be encouraged for participation in the change process and this can be achieved by forming workgroups. The software organizations require promoting, engaging and maintaining collaboration within the workgroups and between Project teams. The involvement of the group's members should be administered properly so that every staffs feel the improvement in their work and sense of responsibility of contributing towards the organization goals (Dyba, 2005 ; Goldenson and Herbslebs, 1995; Stelzer and Melis, 1999 & Guerrero, 2004). The workgroup address is the Key Process Area and, the scheme for the design enhancement under the guideline of SEPG. These motivated workgroups facilitate to move on the road that leads towards rapid and smooth improvement. (Guerrero, 2004)

According to Moitra (1998), in the SPI process most of the organizations are not able to adopt integrated approach and people related processes are totally ignored, which have significant impact on the organization to change program. To be successful in the process improvement program, high morale of the employee and their continuous involvement is really essential. People- CMM model can be supportive and useful in this regard. Dyba (2005) quoted Mayo's studies at Western Electric Howthrone plant, that brings revaluation in management thinking. results from this study shows that if people are treated with respect then this change of behavior can even improve routine individual's job performance and output. He further quoted the Social Technical Model (STM) model purposed by Tavistock that hold a strong position in Scandavian countries and UK.

 Stelzer and Melis (1999) *stated that "to ensure grass root staff involvement successful implementation initiative have established local process team, special interest groups, training scheme, forum for the exchange of ideas and for coordinating effort among project team."* Some of the organizations are not able to understand the integrated approach and split the development project and the process improvement activities. While staff member should need to be involved in the improvement initiative as they used these processes in daily job routine and hence they have better understanding and strong knowledge of weakness and strength of current processes". (Stelzer and Melis, 1999)

Staff Training

A review of the CSFs literature reveals that the concept has been employed in great extent on the topic of SPI implementation and the   importance of training factor is recognised by different researchers such as (Niazi et al, 2006 ; Dyba, 2005 ; Rainer and Hall, 2001 ; Goldenson and Herbslebs, 1995 & Rainer and Hall, 2002). These researchers and practitioners highlighted its different crucial aspects on the basis of their samples data and successful stories of SPI that provided valuable information. This helps us to understand how this factor can play a key role in successful implementation of SPI program during change.

Rainer and Hall (2001) quoted Paulk et al, who stated that "… *the most effective transfer occurred with the reassignment of people possessing the dynamic knowledge about how to apply mature processes and improvement methods*." In order to make SPI assessment and change program successful, it is almost mandatory to provide essential training to personal involved in improvement and change process. Organization need to have a must-continued training and evaluation program to keep track of the training of the personals that sponsor the change. The importance of these factors is not just because it has been recognized by most of researcher's studies sample but, also due to, reasons that it also recognized by set of companies who successfully implemented the SPI. (Rainer and Hall, 2001)

All the software development staff involved in process maturity improvement need to provide training according to their roles; for example, Technical workgroups personnel like developer, QA staff, and configuration manger belonging to same processes can be trained in a single training room. The large or young organization cannot provide this type of detail training to all the staffs and processes as it's too expensive so, instead, they should select an individual staffs and provide the specific processes training that s/he will execute. (Guerrero, 2004)

At Hughes aircraft case studies the assessment for CMM maturity level 2 to CMM maturity levels - 3 based on SEI process maturity 1-5, was conducted in collaboration with SEI. This study results shows that, how Hughes software engineering division jumped to maturity level 3 successfully? During assessments teams found that Hughes had a well sponsor and comprehensive training program but certain training categories were either not available or were not used sufficiently such as assistant project managers, review leaders, and requirement specifications. So, the assessment team in the report based on the review suggested; in exiting training program, according to current training needs, to improve the effectiveness in the jobs. Hughes and SEI selected the team members and SEI trained them for assessment methods. This program was for two-day duration and held at SEI. SED also maintain training records database to record the status of each employee at the time of performance appraisals. Also, form a committee that will periodically review the training requirement and effectiveness at Hughes. (Humphrey et al, 1991)

Software process methods need specialized training for their implementation. These trainings help to transfer methods to organization so that it is accepted and become part of practice by the organization. For the software engineering staffs it is important to have general training to SPI that helps in addressing the environmental issues. This leads organization towards a "Quality culture" such as that of Siemens. (Mehner et al., 1998)

Software organization face serious problem maintaining their capabilities in terms of both efficiency and flexibility. Dyba defined two broader categories and concepts of learning strategies i.e. "exploitation" and "exploration". *"Exploitation involves improving existing capabilities by refining, standardizing, routinizing, and elaborating established ideas, paradigms, technologies, strategies, and knowledge. In contrast, exploration involves learning through discovery and experimenting with ideas, paradigms, technologies, strategies, and knowledge in hope of finding new alternatives and untapped opportunities that are superior to current practice."* (Dyba, 2005)

Experience Staff

The number of authors on the basis of their collected sample studies data, emphasis on how a software process skills, experience and staff expertise can play a key role in successful implementation of SPI program. In experienced staffs, practitioners consider hurdle in SPI and emphasize to equip them with the necessary training that transfers the right SPI skills that enable them to mastery it in use. This training should make awareness in the in-experienced staff about the critical technologies that is required for SPI initiatives. The main goal for this training should be to transfer the knowledge of SPI inter-related activities with business objective and organization goals. (Niazi, 2009)

Nonetheless, some of the authors defined lack of experienced staff as a barrier in SPI:

- In the organization different staffs treat differently, some of them give more priorities and importance than others this is due to reasons based on their experience and expertise. The organization lacks experienced staff and due to these reasons, they recruit people who have just graduated from the universities and don't have previous experience. This skills and expertise continuously need to be improved and increased by means of training. (Rainer and Hall, 2003)

- Due to lack of prior significant development experience of the change agent, who is engaged in SPI, their resulted approach towards process improvement is unrealistic and impractical. When such change agents try to implement a particular process, model or approach fails to tailor it that is suited to organization culture and aligned with organization business goals. Because, they don't understand themselves, the software development process and in what context they used it. This leads towards failure and the results, which are achieved through the process, is neither accepted nor followed. (Moitra, 1998)

To enhance the capabilities of the working team, the right balance between IT and business skills should be maintained between cross functional project teams. The projects teams should have the capabilities and required skills so that diverse requirements can easily be accommodated that is aligned with the business goals. (Woong, 2004)

SPI practitioner said that process initiative could only be successful if the staff involved in the process has detail and comprehensive understanding of SPI process and related to business. Experienced staff should need to be involved in SPI initiative because, they have all the necessary skills, experience, knowledge and firsthand experience with SPI implementation. By involving them, we can avoid re-documentation and real issues can be resolved on the spot. Below mention are some of the guidelines suggested by the practitioner for successful implementation of SPI.

- Only those people need to be selected for the SPI activities that have good record of accomplishment of different SPI projects.

- Organization should need to develop a well-written training policy according to their needs for SPI training.

- Responsibilities of each member should be clear and the member should be assigned SPI implementation activities.

- A mechanism for monitoring the SPI progress against the each staff members should be established and maintained. (Niazi ,2009)

SPI awareness and Implementation methodology

According to Niazi (2009) to fully understand the benefits of SPI, there is need to sponsor the SPI awareness program i.e. "ROI and impact", practitioner belief that SPI implementation is basically taking on board the organization best practices. Consequently, it is essential to address the SPI awareness activities and transfer the share knowledge among different groups who are actively engaged in process activities (Niazi, 2009). The author Guerrero further elaborate on SPI awareness and implementation as small teams needs to form, which should be guided by the SEPG to recommend and execute improvements. SPI initiatives should be measured in terms of success or failure of whole groups of software development unit rather than of individual members of teams (Guerrero, 2004). SPI awareness is really important because SPI is an expensive and long-term approach and its concrete benefits visible in terms of results take much longer time to appear. Therefore, it is crucial to provide adequate awareness of SPI in organization in order to get continuous support from both management and the practitioner for successful continuation of SPI initiative. (Niazi et al, 2006)

Stelzer and Melis (1999) stressed on how to successfully implement SPI methodology procedure that should be adopted. The authors stated that different teams and departments have certain strengths and weakness, which need to take the improvement initiative. This tailoring increase the well-matched improvement plan that is truly reflected on the basis of existing organization true needs. This aids to implement a realistic organization process improvement infrastructure. The lacks of project management in improvement process move towards adhoc and, inefficient chaotic practices and need to avoid this bottleneck situation. (Stelzer and Melis, 1999)

SPI implementation should be well planned, managed and controlled. For successful process initiative, it should be run like software development projects; that they use project management standards, set objectives, monitoring mechanism, milestones, and measurement for success. In addition, there is need to establish return on investment (ROI) or cost benefit analysis. (Stelzer and Melis, 1999 & Niazi, 2009)

According to Dyba (2005), clear defined SPI program are designed according to inspiration of business objectives and the process orientation; as process improvement plays a vital role in business excellence (Dyba, 2005). Niazi quoted Herbsleb and Goldenson that defined SPI implementation as a critical factor and to which considerably less attention has been paid for effective implementation of SPI initiative. "*Studies show that 67% of SPI managers looking for guidance in SPI implementation rather, then on what SPI activities really implemented*".

In the SPI initiatives process program all the stakeholders should get involved and, comprehensive awareness and its benefits should be communicated to them. Because, the SPI

implementation cannot be successful if adequate awareness was not provided to all the stakeholders in advance.

In order to avoid barrier in SPI implementation, practitioner suggested below awareness guidelines

- The benefits achieved through SPI implementation need to be communicated before the implementation process.
- Higher management needs to be informed about the resource required and the amount of long benefits received.
- The role and responsibilities of staff members should be clear before implementation and, proper planning should be completed in order to manage and carry on SPI awareness events within the organization.
- Planning is also required to make SPI an organizational culture

    In order to avoid barrier in SPI implementation, practitioner suggested the following guidelines:

- Technologies (such as tools for planning, monitoring and reporting projects) should be used while developing SPI implementation methodology
- In the pilot projects, SPI implementation methodology should be tested and staff member should be convinced with the performance of methodology.
- Necessary training should be provided that transfers the appropriate skills and understanding that provide surety of successful use of methodology.
- Methodology needs to be continuously evaluated with the aim to implement in the whole organization. (Niazi ,2009)

Communication and Collaboration

Communication and Collaboration are considered to be amongst the most influential factors, which affect the SPI process. Dyba defined these factors as:

"Degree to which communication efforts precede and accompany the improvement program (communication) and degree to which staff members from different teams and departments cooperate (collaboration)"

Business executives and Software has required effective communication in order to understand the communication mechanism between these two groups. Researchers and practitioner should need to significantly understand the "share domain knowledge" and "best practices" for effective communication between these groups. In order to establish effective communication between these two groups firstly, each group must understand the importance and the role of other group in their problem domain and also respects the experienced and expertise of other group. Secondly, the each group should have detailed information about other groups e.g. (the roles and the responsibilities of the group members) and it also need to be clear how problems need to be communicated effectively to other groups. (Dyba, 2005)

The lack of effective communications occurs when the change agent and the management are not able to communicate effectively the benefits achieved from the process improvements. Consequently, staffs involved in the mechanism don't have clear information about their contribution, roles and the achievements. When the change initiative happen, people who are involved in the process always want clear answers of "the reasons for change" and "benefit they get" from the process initiative (Guerrero, 2004). The problem of inadequate cooperation among the teams and divisions occur in software companies like QA teams that are not suitably well involved in the development process. Thus, conquering process improvement activities stresses collaboration and, the collaboration project includes:

"*Joint process descriptions, workshops, and special interest groups. Joint activities help staff members discover unexpected similarities in products and processes.*"

The winning SPI initiatives create the well establish interface between the various teams that provides a platform to exchange expertise, experience among the staffs doing same tasks in different division across the organization (Stelzer and Melis, 1999). The successful SPI initiatives promote the multichannel communications. Author Hall quoted Schlumberger study that SPI produces better communication between and among different departments. (Hall et al, 2002)

Allocation of Resources:

According to El-Emam et al., the management commitment can be determined by the degree to which management seem ready to make available the resources for SPI and it is considered one of the strong indicator of management commitment towards SPI. (El Emam et al, 2001). Senior management sponsorship is essential for the assessment and recommendations; that means, higher management must show their strong commitments in developing, financing and implementing the actions plan. This again means that senior management should have a broader picture of the resources and time required in order to conduct the SPI initiatives. (Stelzer and Melis, 1999)

Majority of SPI practitioner's belief that inadequate supply of staffs, time and other resources are the major barriers in successful SPI implementation (Hall et al, 2002). Management often fails to understand the real investment of the resources required for process initiatives and often agree without having a clear-cut picture of the resources required. In practical terms, some of the management does not consider SPI as an actual or separate project. Thus, they hesitate to allocate resources.

Niazi quoted some Authors and studies given below who consider that lack of resources is the main barrier in SPI implementation:

- Florence discuss in the lesson learned , MITRE Corporation succeeded to achieved CMM level 3 due to adequate level of resources provided but, fails to achieve CMM level 4 due to the reasons that the resources were not provided as required.

- Kautz and Nielsen discussed SPI implementation and thought that it did not succeeded because the project managers are not willing to provide resources for their own projects and, for others improvement activities.
- Laporte and Trudel in *Lesson learned from Oerlikon Aerospace* described that it is important to estimate and provide resources. Otherwise, announce end of project and discontinue adopting SPI program. (Niazi , 2009)

SPI objectives and goals

It is necessary for organization to set realistic & relevant objectives and goals for SPI. These objectives need to be crystal clear and, SPI managers need to communicate to all the actions groups within the organization.

Establishing the realistic objectives means that goals seem to be achieved in the near future and its objectives and goals are not too ambitious. It demand that the expectations should be clear and the expected results need to be communicated at all the levels of the organization (Stelzer and Melis, 1999 ; Becham, 2003). "….Therefore, successful SPI program is one, in which SPI goals and policies have been clearly aligned with business goals, identifying the nature and direction of any SPI actions" (Dyba, 2005). The result of this combined effort towards the "common objectives", "to focus energy" and "to motivate people". These factors citied 44% of the ISO cases and 87% of the CMM cases. Mangers who don't set the realistic objectives or too much goals merely dishearten their subordinate staff. The organizations that while taking the process initiatives do not defined relevant objectives and goals basically, in the long term, end up on fuzzy goals. This approach neither help fully to motivate the staffs nor for successful improvement efforts. (Stelzer and Melis, 1999)

Organizational Politics

Several authors consider politics as barrier in SPI implementation because SPI aim is to bring a change in the organization and people do often resist the change. This is because SPI initiatives goals may suit to one group's goals but collide with other groups or teams goals. The reason is that the organization comprises of different groups and they have different priorities and goals that do not match with the SPI initiatives goals and this leads to oppositions from those people. "There are many factors that can trigger organization politics, such as reallocation of the resources, promotions opportunities, low trust, times pressure, and role ambiguity." (Niazi, 2009). The authors Goldenson and Herbsleb (1995), El-Emam et al (2001) and Becham (2003) also found that organizational politics is very common in the organization and create hurdle in successful process implementation activities. Author Moitra also identified the underlying problems and difficulties of SPI change management process and stated that politics is one of the main cause in change management efforts and a strong barrier in successful process improvement initiatives (Moitra, 1998).

Organizational Culture

Culture difference exists between different countries that are not necessarily suited or accepted by people living in other countries. Moreover, specific cultures adopt, without considerations of

that organization, original values from these countries customs and practice. These may be found as a problem in existing organization's cultures (Becham, 2003). Organizations will continuously face problems in implementation and deploying of best practices; majority of these problems belong to *"people, group, team and community culture and behavior"* (Dorrenbos and Combelles, 2004). All these needs to be considered when SPI improvement initiative steps should be taken. So that any suggestion, implementation and deployment activities do not adopt any such change of management methods which oppose the culture. The failures in consideration of culture impact while designing the change management program, leads towards process adoption by the groups or people in unproductive manner or, totally neglect the adoption. This consequently affects the process improvement program and overall productivity (Guerrero, 2004). According to Moitra neglecting to anchor change in corporate culture is main reasons for failure in process improvement related change efforts. (Moitra, 1998)

5. Research findings

The research findings in this section are wrapped/folded in three core themes to explore the role of CSFs in successful implementation of SPI. The first aspect was to investigate the CSFs that were identified through literature reviews and empirical study. Second aspect was identified as the "common factors" that were common in both the methods (literature and empirical study), 30% and above criteria was applied to came up with the final factors. Finally, we investigated the reasons for SPI initiatives, the motivators and, the obstacles in the software implementation process.

In this section of the Results, we are reporting our findings and we discuss the reported findings related to the research questions RQ1A, RQ1B and RQ1C.This sections shows the CSFs that have been cited in the literature and empirical study, and the frequency at which they occurred. The percentage shows the proportion of the literature and practitioners that cited a particular CSF.

5.1 CSFs identified through literature

In order to answer the research questions RQ1A, Table 5.1 shows the list of CSFs that were identified through the literature review. In the literature review method, we identified top ten CSFs that were cited by the author's (see Table 5.1). The most repeatedly citied factor in the literature is senior management commitment; i.e. 88%. This suggested that, in the practitioner's opinion, management commitment could play a vital role in implementation of SPI programs. Other frequently cited factors in the literature are staff involvement (71%), experienced staff (53%) and SPI awareness and implementation (53%). It shows that practitioners of the literature consider staff involvement & experience, and SPI awareness and implementation as a vital requirement for successful implementation of SPI programs along with training and mentoring, allocation of resources etc.

Code	Categories	Priority	Niazi et al.,(2006)	Dyba,(2006)	Rainer and Hall.,(2001)	Stelzer and Melis,(1999)	El Emam et al.,(2001)	Montoni and Rocha,(2007)	Woong,(2004)	Hall et al,(2002)	Rainer and Hall.,(2002)	Badoo and Hall,(2002)	Goldenson and Herbslebs,(1995)	Mathiassen,(2005)	Moitra,(1998)	Dorenbos and Combelles,(2004)	Felipe Guerrero,(2004)	Bechams,(2003)	(Niazi,2009)	Frequency	Percentage ,N=17
1	Senior Managment Commitment	1	√	√	√	√	√	√	√	√	√		√	√	√		√	√	√	15	88%
2	Staff Involvement	2	√	√	√	√				√	√		√	√	√	√	√	√		12	71%
5	Exprience Staff	3	√		√			√		√		√			√		√	√	√	9	53%
7	SPI awareness and Implementation	4	√	√		√		√		√	√						√	√	√	9	53%
4	Training and mentoring	5	√	√	√					√		√					√	√		7	41%
3	Allocation of Resources	6	√		√	√				√		√						√		6	35%
10	Communication and Collaboration	7		√	√					√					√		√	√		6	35%
9	SPI goals and Objective	8		√	√					√		√						√		5	29%
13	Organization Culture	9										√			√	√	√	√		5	29%
15	Organization Politics	10	√	√		√									√				√	5	29%
16	Visiblity success/value/process			√								√				√	√			4	24%
17	Process Champions					√									√	√	√			4	24%
6	Reviews				√					√		√								3	18%
8	Clear vision													√	√	√				3	18%
12	Tools and Technology								√		√							√		3	18%
11	Reward Schemes											√						√		2	12%
14	Process Ownership				√							√								2	12%

Table 5.1: List of top ten CSFs, identified through the literature

5.2 CSFs identified through Empirical study.

In order to answers the research questions RQ1B, Table 5.2 shows the list of top ten CSFs that were identified through the empirical study. Table 5.2 shows the similarities in the literature review. The most repeatedly cited factors in CSF interviews were: Senior management commitment and staff involvement (88%) and, Staff Training and Allocation of the resources (50%). Some other frequently cited factors were experienced staff, SPI goals and objective and change management (38%). For more detail, please see the Table 5.2.

Critical Success Factors (CSFs)	Priority	Respondent1	Respondent2	Respondent3	Respondent4	Respondent5	Respondent6	Respondent7	Respondent8	Frequency	Percentage N=8
Senior Managment Commitment	1	√	√		√	√	√	√	√	7	88%
Staff Involvement	2	√	√	√	√	√		√	√	7	88%
Training and mentoring	3	√		√	√					4	50%
Allocation of resources	4	√		√		√	√			4	50%
Exprience Staff	5	√	√				√			3	38%
SPI goals and Objective	6			√	√	√				3	38%
Change management	7				√	√		√		3	38%
SPI awareness and Implementation					√		√			2	25%
Communication and Collaboration		√		√						2	25%
Culture						√				1	13%
Politics						√				1	13%
Detail Action Plan						√				1	13%
Review						√				1	13%
Unclear results					√					1	13%
Process measurement					√					1	13%
Team management								√		1	13%
Leader/Champions							√			1	13%
Align business objective with process							√			1	13%
Tools support			√							1	13%
Learning from Experience			√							1	13%

Table 5.2: List of the top ten CSFs, identified through empirical studies

5.2.1 Comparison of the two data sets & practitioners comments

In order to answers the research questions RQ2C, Table 5.3 and Figure 5.2 shows list of 7 common CSFs that were identified through the literature and empirical study and same =>30% criteria was applied to get the common CSFs; which were: Senior management commitment, staff involvement, experienced staff, SPI goals and objective, Training and mentoring and, change management. The new CSFs Identified in the empirical studies that were not found in the literature review and is frequently cited top CSFs in empirical studies i.e. change management.

In the Figure 5.2 on the X-axis, we defined the percentage whereas, on Y-axis respective CSFs is listed. In the Figure 5.2 the bar in blue color on X-axis shows the 'empirical study' CSFs while the bar in red color shows 'literature review' and their respective percentage is labeled on top of

the those bars. The results show that there are slight changes in the proportion of CSFs in terms of percentages while 'senior management commitment' CSFs proportion in terms of percentage, remains the same in both the studies i.e. empirical and literature review.
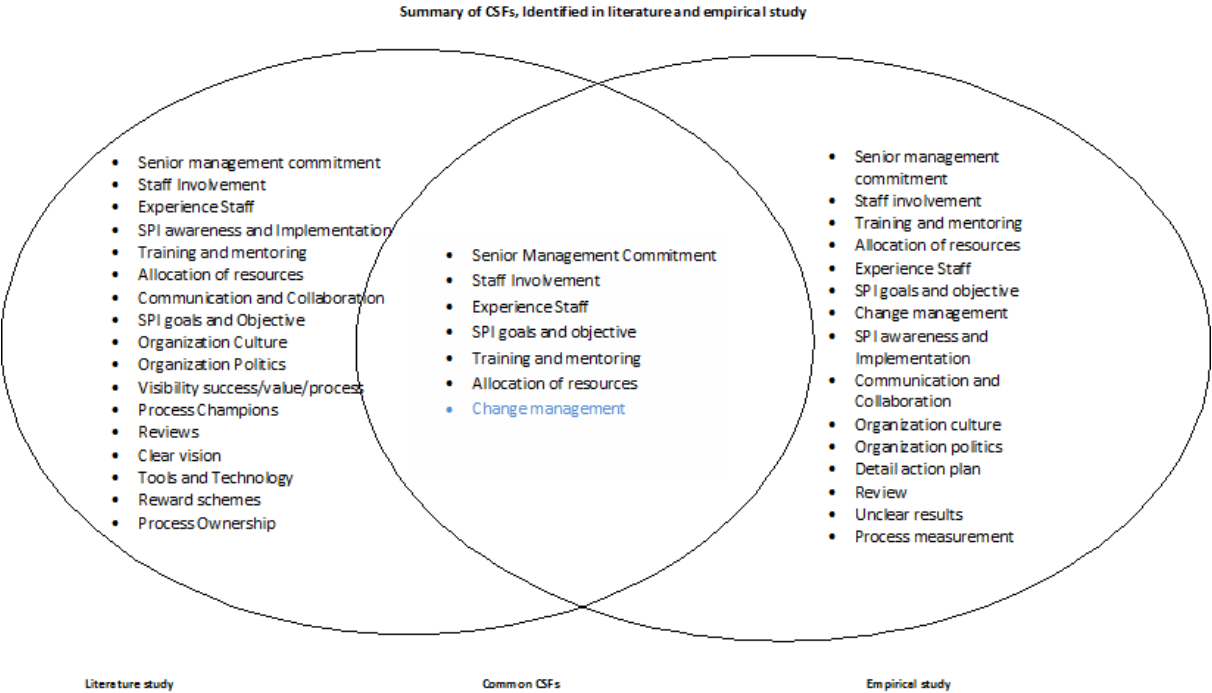
Summary of CSFs, Identified in literature and empirical study

Table 5.3: Summary of CSFs, The area where both the categories overlap represents the common factors found in two data sets.
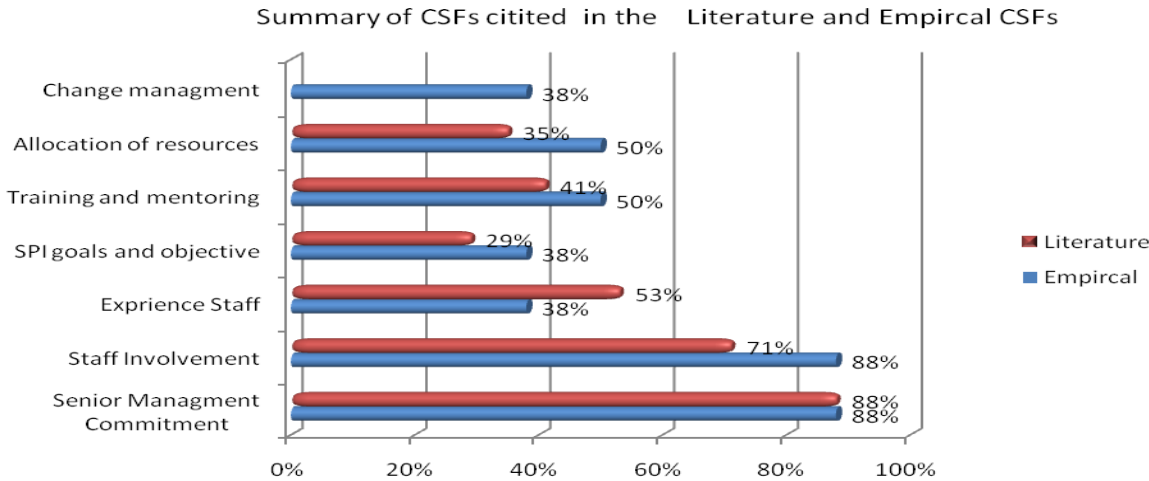

Figure 5.2: Detail summary of of CSFs citied in the Literature and Empircal CSFs and the proportion of the changes in findings b/w two data sets.

When the respondent selected the CSFs from the list and when next questions we asked: why you think the above choosen CSFs is important? Almost 100% of the respondents said that ,this is usual way and is based on our experience that choosen factors is commonly required for

successful projects . Some of the responses from the practitoners based on their experienced and expertise were:

According to Assit and Project Manager,

> "....Normal way and there is no difference between the normal development project and the SPI project,you should handle SPI in same way..."

In the practitinors view, thier is no difference between handling normal software development projects and SPI projects. Even though some of the organization is parallel running the two projects i.e. routine develpment activites and process improvement activites which, produce some time, overburden or extra workload on the staffs; some of the remarkable comments about the Project Manager (PM) was :

> "In our world ....In the assignments you also accomodate process improvment in terms of test case , test tools, reviews. If your PM tells you guys to do that process improvements activities then, you should make sure that this should get formally assign activites to avoid the problems..."

In our empircal data some of the practitinoiers discussed about the inter-dependcy of different CSFs and comments about them, that how these factors are closely related to each other and helps in succesful process implementation program,

According to Head and Manager Application development,

> "It is important as the seriousness of adopting the change is always driven by the senior management, and timely and lasting decisions will be guaranteed during the course of SPI. Also staff involvement is important because of overall better change management."

> "Strong consistent support from senior management is crucial to obtain resources for process improvement activities. For any change strategy to get successful, rewards for improvement and additional hardworking is dependent on management's buy-in. Further, without the involvement of staff no change can be successfully institutionalised".

In the light of the our empirical professinal comments on CSFs, we have trustworthy conviction that CSFs such as management commitment, staff skills & expertise and their involvement, change mangement, allocation of resources is really crucial for implementing and running software development and SPI projects.

5.3. Description of Emprical findings & praticitiners comments.

5.3.1 CSFs

Senior management commitment

No one can deny the role of management commitment for successful implementation of SPI. It is the degree of interest and supports that ensures all the levels of management that sponsors the change. Without management commitment and continuous support, project progress cannot be guaranteed and lacks of commitment from the management become major obstacles that may be key hurdles in successful implementation program. An illustrative quote from Technical Specialist, in our empirical interview was:

> *"We not assume everything working fine...around 2 years we monitor our supplier SPI activities.... as from some of the suppliers we expecting higher expectation. One of our suppliers we do second SPICE assessment this was worst then first, eventually we found in the meeting that higher management of supplier don't aware of our so higher expectation from them. So, they promise to do formal SPI assessment and we schedule more frequently SPI activity improvement reviews. So we went to Japan every three four months in next year's. Significantly, suppliers move dynamically up in a process maturity levels in the duration of one and half years. This happen due to our proper management attention and commitment initially this company not took it seriously but due to our attention they go from very low level of software process to very high level"*

Management commitment is not only necessary to motivate and monitor & control organization internal staffs and teams but sometimes need to convince the external supplier and their management too, in a case where an organization productivity and efficiency is integrated with the external processes. In empirical interviews with one of the Assistant Manager, he marked the CSFs but not selected the management commitment although he talked lot about it throughout his interview. We asked him about the reasons why he wasn't selected the 'management commitment from the list' he answered:

> *"I don't see management commitment as a separate critical factor but for me for any successful projects it is adopted by default by the managements. My experience said that the commitment is required at all the levels from higher, middle and lower management without them success not guarantee. CSFs such as allocation of resources or staff involvement etc cannot make available for the projects if the management is not having a commitment ".*

Through our empirical data, we can confidently say that management commitment is crucial for successful projects and the 'commitment' should be from the management of all the operating levels of organization. The absence of the high commitment from the management leads the projects at failure or not match with the specification or unfinished

projects. The results of these are: spoil of cost, staffs effort, time and other effective resources.

Staff involvement

Staff involvement is one of the most crucial factors that cannot be ignored in SPI program and without full support and commitment from the staff there is lack of chances in SPI success. To ensure that the grass root of staff involvement in process initiatives, necessary measure is need to be taken such as formation of local process team etc. that ensures individual staffs and team's interests, cultures and align individual goals with the business and process goals. A practitioner's points of views about it were:

Project Manager,

> "IT Management commitment and staff involvement in continuous improvement for software development processes is resulting in better accomplishing business needs and objectives"

Our empirical data shows that staff involvement along with commitment aids the organization to better achieve the business goals & objectives that may not be met authentically when there is lack of user involvement in the development process.

Assistant Manager,

> "...functionality is implemented in software and complexity is high, share the characteristic of behavior with yourself and your fellow designer..."

While in interview the respondent said that: In our organization there are hundreds of people who are engaged in the development of software and that is comprises of even 100s of modules and some of modules developed across different countries .The requirement which is received from the user are also pre mature, that changes quite often and, it is really necessary for manger to first understand the system behavior and exact working of the functions/modules/processes. Then share the desired documents details that need to be modified or adopted with the all the necessary teams and staffs who are actively engaged in development or designing of the process. If we do not involve all the peoples who are engaged in development or deployment process then there is very little chance that our new or modified process is accommodated by the peoples in their ongoing activities. Moreover, our implementation process or the product that we produced has very low chance of meeting the required specification or with the set objectives & goals.

Experience staff

The staffs skills, expertise and experience is essential and crucial factors for SPI implementation .Lack of prior significant process experienced of change agent leads towards approach that is unrealistic and impractical. An illustrative comment in this regard by a Technical Specialist was:

> "It is hard for "outsiders", like people from SEPG, to be able to do the complete job themselves. Experienced staff, knowing by best practice, is usually crucial to get

involved in SPI tasks. They are normally hard to get since they are always stuck in product project with higher priorities..."

According to practitioners, experienced staffs are hardly available within the organization as they are already engaged in different projects ongoing activities and their demands are relatively high within the organization. For successful SPI implementation, it is essential to get involved experienced staffs because they are equipped with appropriate skills and expertise that are required for the process initiatives and without them, even the people from SEPG, cannot guarantee the implementation success.

Allocation of resources

Management commitment can be determined by the degree it makes available resources for the project initiatives. Inadequate supplies of the resources such as staff, technology, time etc. are main problem in the successful implementation of SPI program. An illustrative quote by a Manager Application development was:

> *"Strong consistent support from senior management is crucial to obtain resources for process improvement activities. For any change strategy to get successful, rewards for improvement and additional hardworking is dependent on management's buy-in. Further, without the involvement of staff no change can be successfully institutionalised".*

SPI goals and objective

It is mandatory for organization to set realistic & relevant goals and objective for SPI. These should also be communicated properly to all the staffs' teams and at all the levels who are engaged in process improvement program. For successful implementation of SPI program, it is duty of process engineer to align the SPI goals and objectives with the business objective. Some of the remarkable comments of the practitioners were:

Technical Specialist comment,

> *"SPI projects dies without them. At the same time they are rather difficult to define if you don't have anything to measure against, e.g. a detailed SPICE assessment report with well-defined gaps and related improvement actions. If you can't measure progress against your goals you are lost."*

Mangers comment,

"SPI should be taken as a Project, Targeting achievable goals that can show benefit to organization within short time, Aligning Business objectives and Process improvement"

Assistant Manager,

> "...you have methodology and tools and technical things and you can 30% for right method and 70% helps in deployment and people to understand, motivate why this introduced...."

A SPI program should be considered as a project, and need to set appropriate objective along with the respective measure that helps process manager to evaluate the desirable results. If management cannot see the desired results, then, there is not much meant to continue SPI programs.

Training and mentoring

In order for SPI program to succeed, it is essential and mandatory that staff who are involved in process initiatives and change should be trained and equipped with necessary skills; in particular KPAs specially those individuals who are involved. Significant comments about some of expertise in the domain were:

Technical Specialist comments,

> *".... successful SPI project, so to be able to have an successful implementation phase, e.g. rolling out a new/modified process, involved personnel must be trained and having some support from senior staff, process, QA, etc. If this doesn't work they will most likely get back to where they started using the old way of working instead."*

Assistant Manager comment,

> "*IT management understands the importance of Software process improvement under such conditions and it is therefore the management plan/works accordingly to improve/mature technical and managerial processes. Also the training and mentoring of resources, in particular, in one of the focused area*"

According to empirical data, without an appropriate training in chosen focus areas SPI programs dies. Staff training is essential for any successful implementation program. These training should and need to be focused on KPAs. If necessary skills and expertise is not supplied to the staffs who are engaged in SPI then there will be chance that we will reach at same point where we started the process improvement program.

Change management

To be succesful in SPI program organization should need to well manage and control the change. Usually people resists and are reluctant to change because they think that they are doing their job at their best and management needs to convince staffs about the mutual interest to get full supports from them and also to win the heart of thier people. Lack of handling of change management agents leads towards resistance from the staffs for adoption of new process or activites. A practitiners comments about it :

According to Technical Specilist,

> "*If employees cannot see the benefit of working in a different way they will not change. I guess it is always possible to force a new procedure upon employees but that takes a lot of extra efforts from others, like control mechanisms, QA follow up, reporting, etc. and that will make the complete SPI initiative not worthwhile. We must mainly trust the practitioners of the different processes to do their job with not too much monitoring around them.*"

Change management needs proper mechanism and good planning to implement changes. There will always be resistance from the staffs. It is change agent duties to inform all the people who are involved in change that mutual benefit are achieved rather than forcing them for adoption of new procedure without enough motivation that may result in poor adoptions of the procedure. A remarkable comment from the domain specialist was:

According to Manager Application development,

> "*Strong consistent support from senior management is crucial to obtain resources for process improvement activities. For any change strategy to get successful, rewards for improvement and additional hardworking is dependent on management's buy-in. Further, without the involvement of staff no change can be successfully institutionalised*"

No change management programs can succeed without truly involvement of all the staffs in change program. So, people who are working on different change activities need to properly guide and to train in their KPAs. Additionally, all the doubts and problems need to be resolved well before process implementation is started in order for the successful implementation of SPI program.

5.3.2 SPI Initiatives awareness

SPI awareness refers to the knowledge and understanding of process improvement or change agent. Successful SPI implementation programs dependant upon the process engineeres or manager skills. In this regards, if the process manager is equipped with the process skills and good awareness of SPI then, there is more chance of SPI implementation success and adoption in the best practice of domain. Otherwise, the implementation programs ends with failure and frustration or no change and is not able to meet the real objectives of the business. Failure to provide adequate understing leads as a major obstacles. Some siginifcant remarks by the SPI practitiners in this regards was :

According to Technical Specilist,

> "*For us it is 'win win' situation ,continous improvement in our higher and higer demand because, we need to assure that when we introduced new or complex function in car we need to make sure that our process and software supplier process working well. If the process on the both sites are efficient and working well is the way of saving money, car with less error and in time.....*"

According to Project manger and Asst. PM ,

> *"General idea is continous improvement in all aspcts, continously questions why things not going according to improvement plan . So, to have learning organization ,continously working with group, cost analsysis etc. Its is very improtant ....important thing is always make sure you have learning orgainzation who encourporate improvement in early projects"*

> *"SPI is how you improve your process of developing softwares.......and i am very convienced that you need to something written down..... sepcially when you have 75 or 100 peopls, you need well defined hand over milestone and activities. It where you you effect the proces , how things be done and define the quality output by using process description and also checklist and guidelines"*

Accordg to Head and Manger of application development,

> *"......SPI should be done suited to one's evniroment,including people skills, culture and nature of work. Also, Software process improvement is continous process"*

> *"SPI in nutshell is a set of activities an organization performs to modify processes so that it can more effectively meet business needs and objectives. For a software organization , SPI is essential to eliminate inefficiencies in software development"*

According to empirical data, different domain specilists have different understaning and point of views about the SPI awareness that may be due to the basis of their prior experience, education and industries they belong. But, generally saying all belived that continous improvement in the KPAs is essential and processes should be efficient to eliminate the inefficienies to meet the basis of projects attributes (costs ,cycle time and quality) and the organization should be learning organization, meaning that it should always learn from their mistakes. Professinals also emphasise that well defined processes also helps in simplified complexity of software systems which is realtively high in some of the big organizations.

5.3.3 Reasons of embark for software process improvement

While through the empirical interview, it was found that management need sound reasons to take SPI initiatives and, they only think seriously if they found any problem in their ongoing process in terms of quality, deduction in cycle time or to cut down the cost etc. Reasons attributable are that SPI is a long term and costly mechanism, that it required lot of dedication, that it demanded patient and support from the management & the staff. So, it is quite essential for taking SPI initiatives that the management needs to do lot of homework in terms of calculation of ROI before the initiatives is taken. Organizations that have not done there initial work for their process improvement program, end up on failure.
Figure 5.3 below shows the sound reasons for introducing SPI programs:

- improving software quality
- shorten development time

- reducing development costs
- increase productivity and management visibility

Figure 5.3 also shows that few companies introduced SPI due to meeting the client requirement and market purposes.
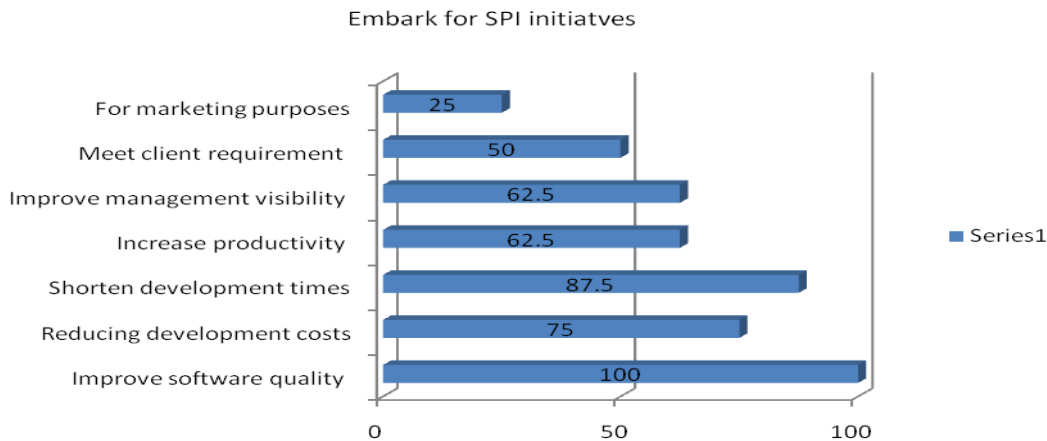

Figure 5.3. List of SPI initiatives reasons citied in the empircal studies

5.3.4 Motivator & Obstacles in SPI Implementation

For successful SPI program, it is required to understand some of the major obstacles and motivator for SPI implementation program. No process program will be successful if their major obstacles, in terms of barrier and potential motivator in implementation, are not considered well. It is the duty of process manager to estimate the hurdles and take necessary steps to overcome the barrier that is held in successful implementation. He also needs to know estimates of what are the basic motivators that help in the process implementation. Appropriate barriers and motivators may put in action plan and respective policy or mechanism should also need to be developed to tackle them. These actions list later aids the process manger to overcome barrier or get support from motivator in the ongoing process program respectively. In this part of findings, we presented the results that were obtained through our empirical data .The major obstacles and motivator in SPI implementation is described by both the management and employee points of view. For details see the Figure 5.4, Figure 5.5, Figure 5.6, and Figure 5.7 respectively. From the empirical interview, we came to know that the some of the obstacles and motivators might be different from two aspects: management and staffs viewpoint. Therefore, it really helps to understand two different viewpoints and appropriate action is useful in the process improvement.

Obstacles

Employee perspective

In this part of our findings, we found that the major obstacles from the employee perspective is 'employee reluctant to change habit', 'lack of management commitment' and 'lack of SPI understanding' 63% ,63% and 38% respectively, and other less important obstacles is lack of experience ,lack of staff involvement ,excess workload and lack of measure mechanism etc.
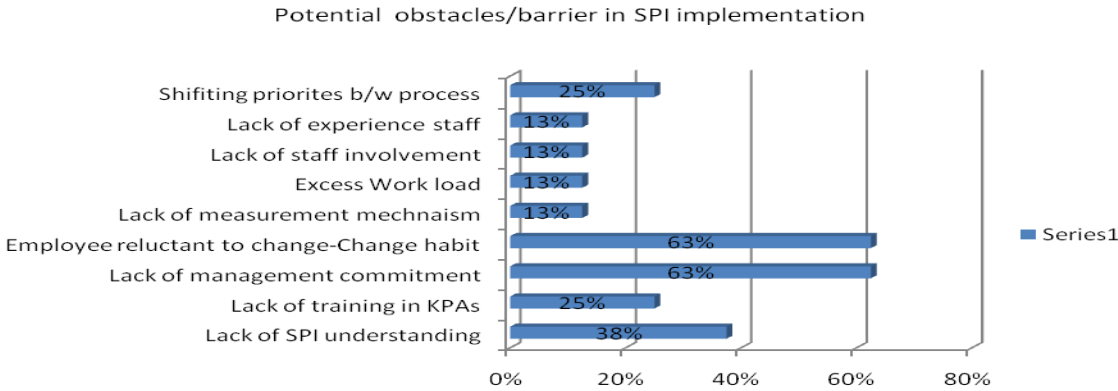
Potential obstacles/barrier in SPI implementation

Shifiting priorites b/w process	25%
Lack of experience staff	13%
Lack of staff involvement	13%
Excess Work load	13%
Lack of measurement mechnaism	13%
Employee reluctant to change-Change habit	63%
Lack of management commitment	63%
Lack of training in KPAs	25%
Lack of SPI understanding	38%

■ Series1

Figure 5.4: List of potential obstacles/barrier in SPI implementation in Employee point of views.

Management perspective

In this part of our findings, we found that the major obstacles from the management perspective is 'SPI activity can increases overhead' and is citied 38%,other less important obstacles is visibility/unclear results, cost and issue of resources.
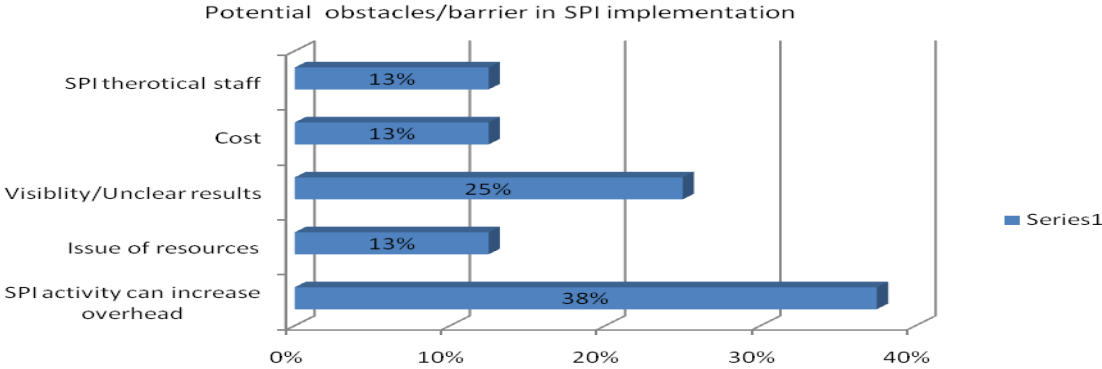
Potential obstacles/barrier in SPI implementation

SPI therotical staff	13%
Cost	13%
Visiblity/Unclear results	25%
Issue of resources	13%
SPI activity can increase overhead	38%

■ Series1

Figure 5.5: List of potential obstacles/barrier in SPI implementation in Management point of views.

Motivators

Employee perspective

In this part of our findings, we found that the major motivator from the employee perspective is 'customized process that suit people", "doing things right", "understanding system behaviors

(activities)" and is citied 38% respectively, Other less important obstacles are: things happen quicker, new tools and visibility of individual work etc.

Major Motivator in SPI implementation

Figure 5.6: List of potential Motivator in SPI implementation in Employee point of views.
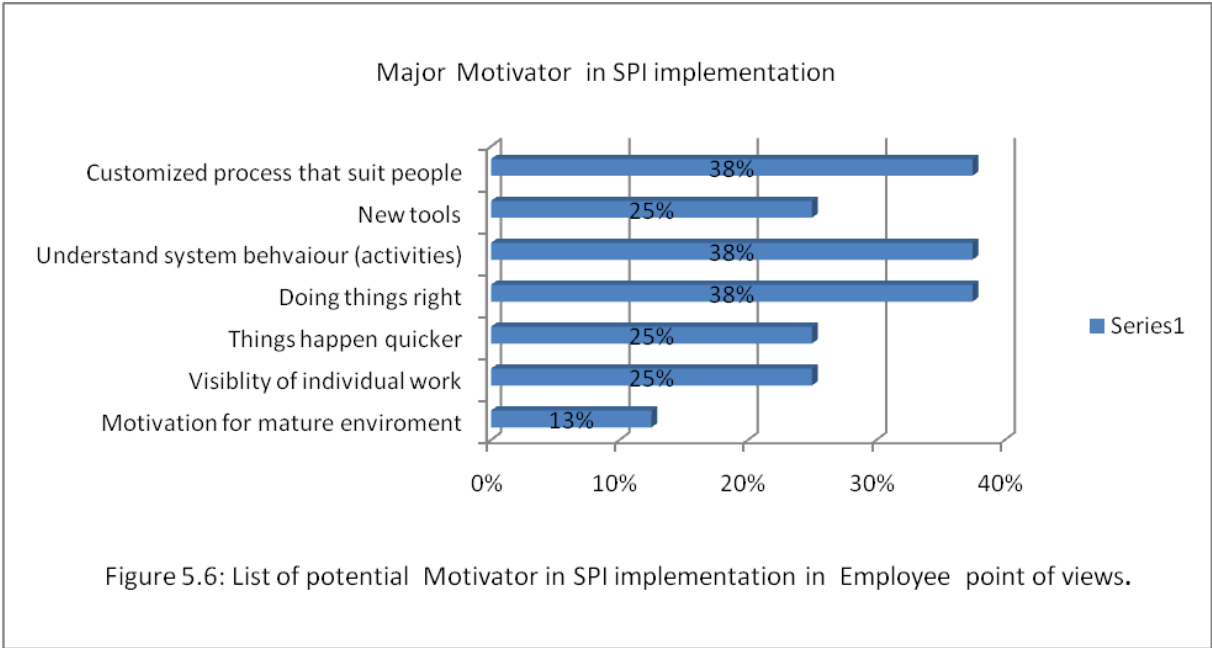
Management perspective

In this part of our findings, we found that the potential motivator from the management perspective is 'ROI', 'competitors /market edge' and is citied 68% & 38% respectively, other less important motivators are: quality product, employer of choice, quick way of review, development efforts decreases and achieving control etc.
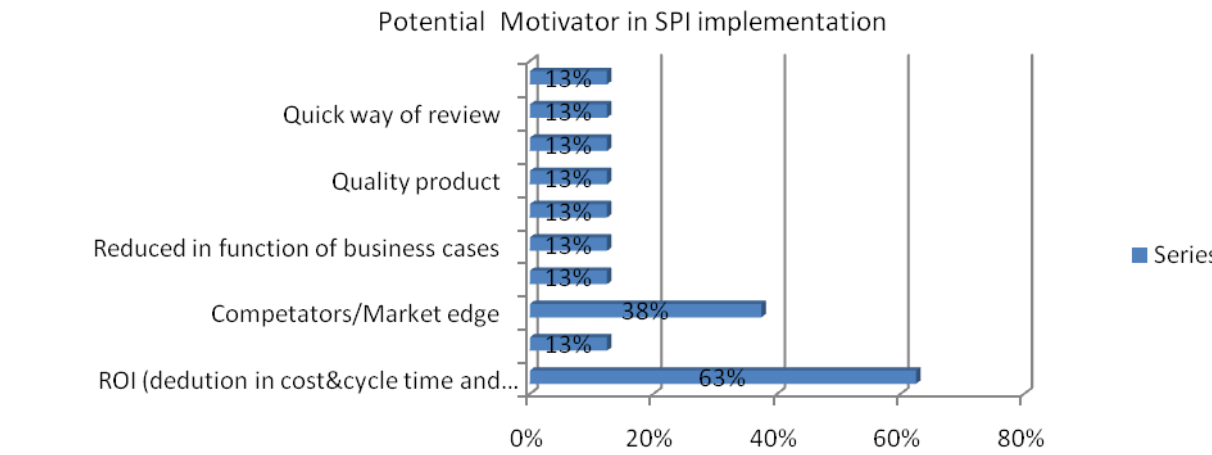

Potential Motivator in SPI implementation

Figure 5.7: List of potential Motivator in SPI implementation in Management point of views.

Summary of Major motivator and obstacles in form of matrix

Summary of major motivator and obstacles in form of matrix

	Motivator	Obstacles
Management	• Return on Investment (ROI) • Competitor /Market edge	• SPI activities can increase overhead
Staff	• Customized process • Doing things right • Understanding system behaviour (Activities)	• Reluctant to change • Lack of management commitment • Lack of SPI understanding

Figure 5.8. Matrix of major motivator and obtacles from management and staff view points.

The Figure 5.8 provides the list of potential motivator and a major obstacle that we got after we applied the selection criteria i.e. 30%, this criterion is used throughout this study. This matrix approach provides more visibility and understanding of two different viewpoints (management and staff). By seeing motivator and obstacles in two different ways, enables a broader or macro approach for process engineers and s/he can easily push obstacles as an opportunity by addressing more appropriately and keep focus and monitor throughout the project.

Description of Motivators & Obstacles & practitioners comments

Return on Investment

ROI means pay offs of the initial investment that is made in terms of finance, resources etc. Management is eager to know the visibility in terms of results Management may stop the issue of resources and attention if desirable level of the achievement is not achieved. According to one of the technical Specialist,

> *"When we asked our supplier to do SPICE assessment then they asked how much it cost, do we have time to do it now...we don't have budget for assessment, do we need to hire extra services or consultant or our employees to work with SEPG. This time we don't have opportunity to hand out some people to project team to help out in SPI activities."*

According to empirical data, management needs sound reasons to take the process improvement initiatives as, to start up the process program; it demanded heavy costs, resources and strong commitment. Usually management takes the SPI initiatives due the given reasons cited earlier (see Figure 5.3) and if management do not find the visibility in terms of

improvements of mentioned items in (Figure 5.3 such as decrease in cost & cycle time or quality), then, for management it is difficult to continue the SPI program.

Competitor/Market edge

The management some time takes SPI initiatives just to be the best among their competitors. This really makes them proud that we are holding the quality certification such as ISO 9000, TQM or CMM level 3 or 4, to grab the major market share or attract the clients. In this regard, one of the consultants said that:

"SPI in the sense of time to market and making sure the product is as complete and correct as possible is also a driver for success. To be able to be first with a new product on the market and at the same time knowing that the likelihood of having less major errors is good news to any one in management position".

In our empirical data professional comments that for management 'competitor/market edge' is a solid motivator for SPI. Because any management wants slight edge on their competitors and, SPI enable them to improve their product quality by cutting down the costs, cycle time and error that allows them to launch their product earlier in the market with less error and reasonable costs.

Customized process

Customized process means the process that is suited to individual staff member's capabilities and experiences. Staff is fully motivated once s/he gets surety that adopting the method will bring efficiency in their work without affecting their working style. A remarkable comment from the practitioners in this regards were:

Head of Application development,

> "Software process improvement should be done suited to one's environment, including people skills, culture and nature of work".

Assist. Manager,

> "…When I started job as 'SD' ,'Water fall' base methodology used that force to follow series of steps ....now Agile method it's much more address the work that actually done in real life. Good trends that small team solve their specific problem and process they feel comfortable. Give them requirement and form the team and let them built their own process development, this leads fast development ...People in the team belongs to different background, language expertise and experienced and if you influence them very little chance that you come best out of it ..."

Technical Specialist,

> "...There are people who working according to processes, so confirm that processes are adapted according to defined steps and also make sure the process is not too detailed; giving the people some slack otherwise following the process becomes boring."

In practitioners points of views, in our empirical data, the 'customized processes' is one of sound motivator for SPI. Because for any improvement program staffs is a key to success and if they are highly motivated then the new procedure that is going to adopt is not going to affect their actually working style; while other hand helps in improving their existing working styles; then, staffs always welcome the change and adopt the processes by their heart.

SPI activities can increase overhead

This above factors is identified among major obstacles in SPI initiatives because most of the mangers are involved in other ongoing parallel activities of different projects. Therefore, it is difficult for them to issue their dedicated resources to new process activities that cause extra workload along with the actual ongoing projects activities. Significant comments about it from the practitioners were:

Technical Specialist,

> "....Especially during SPI project definition/implementation phases. If the new process leads to less efficient process then we did something wrong to begin with, and the process need to be altered again. The overall goal for most SPI project shall be to make a process more efficient – take less time to do."

Head of Application development,

> "...We initiated the implementation of CMMi, but unfortunately, we have to defer it due to various project commitment and budgetary reasons...because our client wants our projects to be completed on the agreed time and our management gives pressure to meet the deadline for ongoing projects...."

Management shows hesitation is in taking SPI an initiative if SPI goals and objectives are not clearly defined or set. Because, SPI is run along with the normal ongoing activities and sometime its demands the changes in priorities of the routine tasks or conducting parallel tasks that is assigned by the manager to staff. If a SPI initiative is started without proper planning, staffs motivation and lack of higher management commitment, then, it may be treated as a burden because it does not rank on top priorities and the resultant SPI activities becomes frustration for middle management to monitor and shifting the priorities between different ongoing projects activities with the SPI tasks. As a result of this bottleneck, the SPI programs either hang-up for some time or if completed, not able to meets its basic objectives and goals.

Other motivators and obstacles

The rest of the motivators and obstacles, from the two perspectives i.e. management and employee, such as: understanding system behavior (activities), doing things right, reluctant to change, lack of management commitment and lack of SPI understanding concepts, was defined along with CSFs and SPI awareness in the description .As they are more relevant to those part e.g. Lack of management commitment is more appropriate to define along with management commitment and reluctant to change was defined in change management CSFs etc.

6. Discussion

6.1 The role of CSFs in software process improvement

In our findings between the two data sets (i.e. literature and empirical study) some of the factors become less critical in empirical study as compare to the literature study and vice versa and, proportion changes except the senior management commitment (see Figure 5.2) that remains the same 88%. However, all together the matching CSFs in two data sets are almost the same except that their priorities changes according to the proportion they have been cited by the practitioners.

While Comparison of CSFs from the two data sets i.e. literature review and empirical data provides confirmation that, there are both similarities and dissimilarity in two data sets. On the analytical analysis of the two data sets, we suggest the practitioners should consider both the similarities and dissimilarities as a center of attention. This adopting approach facilitate them for more broader and macro view on the CSFs and provides deeper understanding and insight of these CSFs that helps in improving the SPI implementation process. Further, by focusing on the similarities in two data sets, guides the practitioners in the overall process of SPI initiatives program that provides better mechanism to manage the SPI activities. Additionally, helps in enhancing the overall productivity and in the cost effective implementation of the process improvement program.

In the following section, we will discuss the findings of our study and compare the results with the findings of (Niazi et al, 2006).

(Niazi et al, 2006) identified 10 CSFs initially but came up with seven factors that have been cited by all the three groups of practitioners i.e. (developer, manager and sr. manager) and we would like to compare our results with their findings. Our studies also comprises of combination of respondents who belongs to diverse discipline and management levels i.e. (software engineer, quality assurance, mangers and head of application development).Our identified CSFs is 71% of the factors that were identified by their studies. In our study 'SPI awareness' and 'SPI implementation methodology' is not present in our results as compared to (Niazi et al, 2006). While, 'change management' and 'SPI goal and objectives' is identified that were not found in (Niazi et al, 2006) final listed factors. On the basic of our empirical data , we put forward arguments that 'SPI awareness' and 'define SPI methodology' factors are not of much importance if the organization properly define their 'SPI goal and objectives' and set the control mechanism that make sure that the SPI goal and objectives are aligned with the business goals and objectives . Further, these SPI goals and object should need to be communicated properly to all the levels of management and the respective staffs should be appropriately trained in their respective KPAs. Additionally, 'change management' factor is also identified in our empirical studies, this shows that if the key change agents take in confidence and make aware of the mutual benefits that obtained through the SPI initiatives program. This awareness can be done through lot of ways such as forming groups and teams of similar process and sharing of knowledge across organization between the groups as suggested by number of authors i.e.

mentioned in our literature. Then, the change agents all doubts and confusions will be cleared and they will have comprehensive understanding of the SPI methodology. By adopting this systematic approach, the management leads the SPI process program towards the road to success.

Senior management commitment plays a vital role and is one of the most important success factors of organizational changes in SPI efforts. The above factor is ranked on a top position in our findings and was cited 88% in our empirical study. In Niazi et.al study, the management commitment factor is citied 68% in their survey study and this factor rated by the individual groups was: developers 70%, managers 75% and sr. managers 25%. Their study further reported that their developers and mangers always looking for senior management support for implementation of SPI programs this is because of their past SPI experienced that realized the important of this factor.

Staff involvement is an important factor and no SPI programs can make successful if this factor is not addressed well .This factor ranked second position and was citied 88% in our empirical study. In Niazi et al study, this factor was rated 32% while this factor rated by the individual groups was: developers 50%, managers 20% and sr. managers 50%. Their result shows that sr. managers wants to involve the staffs in SPI because they belief that without staffs involvement SPI cannot be made successful and developers also want to participate in the change programs because they like to participate and are eager to involve themselves in the hope of improving their working style and chance of training opportunity.

Training and mentoring are important factors that cannot be ignored and this factor was ranked at third position and was citied 50 % in our empirical study. In Niazi et al study, this factor was citied 68% while this factor rated by the individual group was: developers 80%, managers 70% and Sr. managers 25%. Their results show that developer and manager consider training as essential part of SPI and without training of change agents in respective KPAs, the success cannot be guaranteed. On one hand while Sr. managers are little hesitated to provide training to the change agents as it is a costly process and required lot of resources to be allocated for this purpose. On the other hand, Sr. managers preferred to engage their experienced staff rather than inexperience staff, for the SPI activities who had past experience about the SPI activities.

Allocation of resources is also a core factor and this factor is ranked at fourth position and was citied 50% in our empirical study. In Niazi et al study, this factor was citied 47% while this factor rated by the individual group was: developers 70%, managers 35% and Sr. managers 50%. Their results reported that developer and higher manager consider that allocation of the resources is the key for process improvement.

Experienced staff is an important factor and plays a crucial in SPI initiatives program and this factor ranked at fifth position and was citied 38 % in our empirical study. In Niazi et al study, this factor was citied 38% while the factor rated by the individual groups was: developers 30%, managers 35% and Sr. managers 75%. Their results shows that higher manager consider that experienced staff is crucial for process improvement activities and will be productive for overall organizations too.

SPI goals and objective is an important factor and this factor is ranked at sixth position and was citied 38 % in our empirical study. In Niazi et al study, this factor is not explicitly addressed.

Instead, they emphasized on awareness of SPI and considered SPI initiatives as a critical and have understanding that it takes time to understand the real benefits of the approach. Because, SPI is rather long term and expensive approach so to get a higher management and staffs supports we need to promote the awareness through awareness events.

Change management factor is holding a seventh position and was citied 38 % in our empirical study. While in Niazi et al study, we did not find any evidence about this factor. But in our empirical data the practitioner's arguments that to change the habit of staffs member is difficult tasks and needs lot of support from higher management. There is lot of ways to overcome this problems such as by increasing SPI awareness and defining SPI goals and objectives and staff involvement etc. If the 'change management' factor is totally neglected or under estimated and proper measures in advance have not been taken then, the staffs will not go to adopt the new process or, if partially adopted, the process resultant will be that SPI initiatives will not be able to produce the results or implementation and, the program will end with frustration and failure. The reason is that people are reluctant to change and the new working style affects their normal working style. Therefore, for successful process initiatives program management should take in confidence all the changes agents. The management should also need to acknowledge the mutual benefits and gains that are going to be achieved from SPI program instead of imposing new mechanism or activities on them that is likely to be adopted and hence lead towards unsuccessful SPI implementation.

In comparison of our study findings with the Niazi et al. all the CSFs proportion in terms of percentage, it slightly varies excepts for the 'staff involvement' factors that is in the ratio of almost 1:3 (88% : 33%). This huge variation is just may be due to reasons that in our empirical data six SPI practitioners out of eight belongs to big multinationals, who reported that their software systems is quite complex and hundreds of people engaged in development of hundreds of different modules and the interdependency of this modules has a relatively high as comparable to usual software's system. Therefore, the importance of staff involvement demands is relatively high in our empirical data then Niazi et al.

Other things that also needs attention is that, in their survey study they divided the CSFs into two categories i.e.' organizational' and 'technical' and in our empirical data we do not have any evidence where the practitioners categorically differentiated the different factors or describes the importance of factors into respective categories. Therefore, all the identified CSFs have same importance in respects of the two mentioned categories and can play a crucial role in implementation of SPI.

Although the above identified CSFs in our study is very crucial and usually required for the successful implementation of SPI. However, according to our empirical data and the practitioner's comments, we can confidently say that the success demands upon the effective use of the above-identified factors. The practitioners also suggest that the success is in the hand of the process manager and if he is talented and well experienced then effective use of the identified factors in our empirical study must guarantee the project success. The practitioners further said that there is no matter whether this will be a SPI initiatives project or the normal software development projects but normally these factors always critical and plays a vital role in success of the projects.

6.2. Reasons for SPI initiatives, Motivator and Obstacles

6.2.1 SPI initiatives

The authors Stelzer and Melis (1999) and Taiple and Smolander (2006) stated in their studies that the software engineering overall aims is to reduce the development costs and enhanced the quality of software systems. In our empirical data, there is evidence that most popular reason for taking SPI initiatives is to reduced the development cost, shorten development time and improve quality along with meeting client requirement, productivity and visibility. On the basis of empirical data we have a confidence that the most popular reasons the management embark for SPI initiatives in their organization is due to facts that they are not satisfied with existing quality of the product and also feel the cost is relatively high. We argue that SPI not only enable them to improve their product quality within the reasonable costs; additionally, the productivity of the organization is improved and the visibility of the process achieved which helps management to evaluate the results of their efforts of the SPI that aid to take appropriately timely measures ignored by the above authors.

6.2.2 Potential Motivator

Baddoo and Hall (2002) conducted a research of Software Process Improvement (SPI) motivators in 13 UK software companies. Their analysis aims to provide SPI managers with some insight into designing appropriate SPI implementation strategies to maximize practitioner support for SPI. The result of their finding is discussed here and compared with our findings. In our empirical study, we had defined the motivators as two different perspectives point of views (i.e. management and employee). However, in Baddoo and Hall (2002) they defined the motivator in three different perspectives i.e. developer, manager and Sr. manager. Hence, in order to make results more comparable we grouped manager and Sr. manager motivators label as a management perspective while, developer motivator label as staff perspective.

We discuss similarities and dissimilarities between the two perspectives i.e. management and employee motivators that is reported by Baddoo and Hall (2002) and with our empirical findings. In our findings, some of the labels for motivators might not be used as in context and understanding as compared to those described by Baddoo and Hall (2002) but , in some of the cases they may reflect the same meaning and understanding as we used in our study.

Management perspective

Baddoo and Hall (2002) reported management motivator as: visible success, resources and meeting targets. Further reported that management always wants to see the outcome of SPI in terms of visibility and the resources should helps them to carry out the SPI .Additionally , if business targets is met then management is highly motivated. In our empirical data practitioners reported ROI (deduction in cycle time, error and costs), competitor/market edge as a major motivator. Although the motivators such as 'visible success' and 'meeting targets' that was reported by Baddoo and Hall (2002) is used at different labels. But, almost used in same context and can be, related with our identified motivators 'ROI' because the visible success is also achieved when the organization found that their development costs is cut down or reduction in cycle time or the products with less error i.e. the basic attributes of ROI motivators.

Consequently, due to reduction in cycle time, helps in meeting the targets. However, we have trust that 'ROI' is potential motivator that helps management to convince them, if SPI program is being introduced in the organization, that it helps them in reduction in costs & cycle time and further helps them in meeting the business targets. In our empirical data, we identified a new motivator that has not been identified by Baddoo and Hall (2002) i.e. 'competitor/market edge'. We like to make arguments that may be this motivator is over looked by the practitioners of (Baddoo and Hall, 2002) study. Therefore, need to give more attention and further exploration because this motivator aids the organization producing error less products that create a good repo in the market and secondly, helps to launch their product on time in markets that really make the organization ahead of their rivals. Finally, wants to comment that the motivator 'resources' that was identified by the authors as critical factor but we have evidence in our empirical study that, it is more a factor of the SPI rather than the motivator.

Staff perspective

Baddoo and Hall (2002) reported staff motivator as: visible success, bottom-up initiatives, resources and top down commitment. Further reported that developers also want the evidence of SPI success and wanted to occupy more resources along with top and bottom up commitment to be fully motivated. In our empirical data, practitioners reported 'customized process that suit people', 'understand system behavior (activities)' and 'doing things right'. Although the motivators such as 'visible success' and 'resources' that was reported by (Baddoo and Hall, 2002) is used at different labels. But, almost used in same context and can be related with our identified motivators 'customized process that suit people', 'understand system behavior (activities)' because the visible success is also achieved when the staff found that their understanding of the different SPI activities and their role in process improvement is visible and can relate themselves with overall project success. Customized process helps them to occupy the new tools and technology that really improved their overall efficiency and effectiveness in their work and believe in them that they are doing their job in right way. These happy feelings highly motivated them and they consider themselves an important person in the process improvement program and in confidence that a project success is their own success. So, work hard to make the process implementation program successful.

6.2.3 Obstacles

(Baddoo and Hall, 2003) conducted a research of Software Process Improvement (SPI) de-motivators in 13 UK software companies. The aim of this study was to understand the nature of the issues that de-motivate software practitioners for SPI. The result of their finding is discussed here and, compared with our findings with the same constrains, and assumptions that is mentioned above. The only difference is that (Baddoo and Hall, 2003) label it as de-motivator while in our study we used the label 'obstacles'.

Management perspective

Baddoo and Hall (2003) reported management obstacles as time pressures and lack of evidence of direct benefits, lack of resources and overall support, inertia and lack of SPI skills. Although the de-motivators that was mentioned above is reported by Baddoo and Hall (2003) is used a different labels. However, almost used in same context and can be related with our identified

obstacles i.e. 'SPI activities can increase overhead'. Because, in our empirical data there is evidence that for SPI activities management have a understanding that projects needs to be equipped with more resources ,extra efforts to convince and train staffs and provide support in order to conduct the SPI activities. Management not usually seems eager to take the SPI initiatives because they were afraid that their ongoing development activities could be affected. Additionally they were also concerned about the visibility of the results in terms of ROI if the SPI did not provide enough benefits then, there initial investment and efforts were going to be spoiled. On the comparative analysis of the data we can confidently say that management, due to some doubts of SPI activities overheads, are not eager to take SPI initiatives. But, if the management analyses the above mentioned concerns and address them properly and, the benefits in terms of motivator are properly communicated by the process manager then, there is no reason for the management to consider this as major obstacle in the SPI initiatives.

Staff perspective

 Baddoo and Hall (2003) reported staff obstacles as time pressure, budget constrain and inertia. Further reported that staffs effected by the time pressure to meet the deadlines and issue of the resources and change habit further cause major hurdle in SPI implementation. Here we like to compare our identified obstacles: 'reluctant to change', 'lack of management commitment' and 'lack of SPI understanding' with the Baddoo and Hall (2003). The two de-motivator i.e. 'time pressure' and 'inertia' mention by Baddoo and Hall (2003) can be related with our identified obstacles i.e. 'reluctant to change' because staff may think that SPI activities create the duplication of the work and hence extra load on them while the allocated time frame keep the same . These thoughts make them to resist. However, if we involved staffs in SPI activities, communicated the mutual benefits of SPI, and properly trained them in their KPAs then the de-motivator mentioned by Baddoo and Hall (2003), can be overcome. In our empirical study we did not find a 'budget constrain' as an obstacles from the staff perspective because, in practitioners perspective budget is not a major barrier in SPI implementation. However, in our empirical data practitioners consider 'lack of SPI understanding' as a major hurdle and can be overcome by providing staffs SPI awareness program in the organization, by clearly defining SPI goal and objectives and by involving staff in SPI different activities. Consequently, on the ground of our empirical data we can argue that 'reluctant to change', 'lack of SPI understanding' and 'lack of management commitment' is major obstacles/barrier in SPI implementation that can be made as a motivator if the staff take in confidence that SPI activities can increases the visibility of the individual works. Furthermore, acknowledge them that due to SPI activities, individual staffs members have the process that is created to keep in mind their natural working style and culture. This communication makes them fully committed and helps in successful implementation of SPI program.

On comparative analysis of motivator and obstacles mention in Baddoo and Hall and in our empirical study across different groups i.e. (management and staff), suggest that there are both similarities and dissimilarities in two data sets. However, the practitioners well understand the similarities that are mentioned by both the groups and will help to develop the sound SPI implementation tactic and policy. This obstacles and motivators also help the process manager in dealing real issues in day-to-day process activities.

7 Conclusion

Our study investigates the factors that have positive impact in a process of SPI implementation and offer recommendations to practitioners that promote the best practices in the software process improvements domain. In particular we focused on critical success factors, motivators and obstacles. We conducted comprehensive literature review to identified CSFs that citied most of the researchers. To authenticate our study we also conducted an empirical investigation in order to identify the CSFs that are recommends by the existing practitioners. We compared the two data sets to identify the list of the factors that is most cited in two studies. We represented our findings in the matrix structure to have a macro view for the readers of identified CSFs and for the motivators & obstacles of two group i.e. management and staff. Our findings indicates that there is seven CSFs: (1) senior management commitment, (2) staff involvement , (3) experienced staff , (4) SPI goals and objectives , (5) training and mentoring ,(6) allocation of resources and (7) change management) that is critical for SPI implementation. Five potential motivators from two different groups i.e. management and staff. Management motivators: (1) ROI, (2) competitor/market edge. Staff motivators: (1) customized process, (2) doing thing right, (3) understanding system behavior (activities). Four major obstacles from two different group i.e. management and staff. Management major obstacles: (1) SPI activities can increase overhead. Staff major obstacles: (1) reluctant to change, (2) lack of management commitment (3) lack of SPI understanding.

The purpose of this study is to imply the role of CSFs in success of SPI and offers researchers and practitioner's best practice that aid in the SPI process. Although the factors identified is most crucial in the implementation process. However, we suggest to constructs a maturity-based model of SPI implementation factors. Because different organizations is stand on different process maturity and their setup and cultures also varies. Therefore, for the selection of the right methods according to process maturity and their setup is essential and may produce better results that are more suited and valid across the organizations.

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Appendix A: Interview questions

1. What is your point of view about Software Process Improvement (SPI)?

2. What you think the major underlying problems and issues in Software development are?

3. How do you or the management address these issues?

4. What is your company's weakness and strength in the area of Software development?

5. What are the main aims and objectives of SPI in your point of view?

6. What are the main aims and objectives of SPI in management point of view?

7. What are the potential obstacles to SPI in your point of view?

8. What are the potential obstacles to SPI in management point of view?

9. What are the potential motivators to SPI in your point of view?

10. What are the potential motivators to SPI in management point of view?

11. What is your knowledge about SPI implementation?

    a. High 5 - - - - - - - - - 4 - - - - - - - - - 3 - - - - - - - - - 2 - - - - - - - - - 1 Low

    Your answer:

12. Has your company tried to improve its software development process?

    a. Yes

    b. No

    Your answer:

13. What is the approach .Is it a formal or informal approach?

    a. Formal

b. Informal

Your answer:

14. Which of the process improvement models or template or matrix does your company

use? (e.g. of model CMM,CMMI,ISO 9000 series, Spice etc)

15. Why did your company embark on process improvement?(Respondents could select

more than one motivation)

 a. Improve software quality

 b. Reducing development costs

 c. Shorten development times

 d. Increase productivity

 e. Improve management visibility

 f. Meet client requirement

 g. For marketing purposes

 Your answer:

16. What do you think are the critical success factors for the implementation of SPI

programmes?

17. What are most important CSFs among them for SPI?

 a. Senior Management Commitment

 b. Staff Involvement

 c. Experience Staff

 d. SPI awareness and Implementation

 e. Staff Training

 f. Allocation of Resources

 g. Communication and Collaboration

h. SPI goals and Objective

i. Organization Culture

j. Organization Politics

k. Any others you think_____

Your answer:

18. Why you think it the most important factors?

19. What are your most important priorities among the above chosen one. ?

20. Any additional information or comments you want to provide?
    (Please share your experience regarding ABOVE questions , any successful stories or

bad experienced you remember)

Your answer:

....The end..