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A Lean Software Process Improvement Model for Small and Startup Software Development Firms

Smitha Anu Thomas [1], Bindu V. R [2]

School of Computer Sciences, Mahatma Gandhi University, Athirampuzha, Kottayam District, Kerala, India [1]
School of Computer Sciences, Mahatma Gandhi University, Athirampuzha, Kottayam District, Kerala, India [2]

Abstract: There are several Software Process Improvement (SPI) models for software development firms. But the implementation of these models is a challenge to small and startup software development firms and the effort for research to examine these challenges can assist in producing high quality software. This paper has a two-fold objective: first to review and summarise the benefits of SPI approaches; second to determine the critical barriers in implementing different approaches to SPI in small and startup firms. This paper also seeks and identifies the requirements for an SPI model to propose a lean SPI model for these firms. A set of software engineering practices has been suggested as the components of the lean model that were required to exist in small and startup software firms.

Keywords: Startups, software process, Software Development Life Cycle

I. INTRODUCTION

Software development firms follow a Software Development Life Cycle (SDLC) to design, develop, modify and maintain software applications or components. It begins from recognizing the problem and culminates in a work product. These firms specialize in creating solutions for the needs of customers. Software engineering is the systematic, disciplined approach to identify problems, conceive, design, document, test and re-engineer software components. To deliver fast, transparent and efficient solutions, software firms need to streamline the software process. Software development firms can be classified in different ways. In paper [1], an industry classification for software product industry is done as business function software, industrial software and consumer software. Depending on the number of employees, software firms can be large, medium, small and startups [2]. Startups have usually fewer than 10 employees, small enterprises with 10 to 49 employees, medium-sized enterprises with 50 to 249 employees [3]. Large enterprises employ 250 or more people.

Small and startup software firms are able to deliver software products with a strong impact on the fast growing IT market, significantly contributing to the global economy. Small software development firms and startups typically use cutting-edge technologies and create innovative deliverables [4]. These firms need to select the right blend of software development practices to build stable software, adaptquickly to new demands, while being constrained by limited resources [5][6]. The launch of small software development firms and startups is extremely popular and plays a critical role in the economy of a nation. These types of firms are created all the time while software development is in constant evolvement. The maintenance of quality and stability in the work products created by these firms is necessary to improve the return on investment. This is a quite challenging and uneasy task. There are several models [7][8] for Software Process Improvement (SPI) such as CMMI(Capability Maturity Model Integration), ISO, SPICE etc. But small firms and startups face challenges and barriers in executing these models to achieve quality. The Critical Barriers (CB) faced by these firms are:

- Adhoc and uncertain Software Development Life Cycle (SDLC)
- Processes are new often undocumented

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- Limited competent resources for software development
- No clearly defined software process and iterations
- Difficulty in tackling fast growing markets
- Inadequacies in requirements engineering
- Little experience in organization management and process improvement

II. REQUIREMENTS OF THE SPI MODEL FOR SMALL FIRMS AND STARTUPS

The ultimate purpose of the study was to understand the characteristics of small and startup software firms. For this exhaustive study data was collected from employees of small and startup software development firms using a questionnaire. The purpose was to understand the nature of these firms, role of employees, software development practices followed and SPI initiatives in these firms. A systematic literature review on software engineering and the current scenario of IT industry also helped in this study [10]. The case study approach seeks to understand the relevant software processes being investigated and gives a rich in-depth study of these firms. It also provides the opportunity to ask penetrating questions and to capture data that reflects the richness of organizational behaviour.

Based on the analysis of the data collected from these firms, they require an appropriate, lean, efficient, generic software process improvement model. These firms should plan of short/medium term milestones of achievement, reviewing the Software Development Cycle (SDLC) to find areas of improvement. Integrating CMMI and other advanced methodologies such as agile practices will also reap potential benefits like more predictable deliveries, early return on investment, quick response to changes in customer needs and risk mitigation. Simulation can also be observed as an attractive tool to evaluate issues related to the chaotic software process strategy, improvement, methodology adoption, project management in small and startup software firms. The small and startup software firms need to establish sound software engineering practices

- that are agile and dynamic to accommodate changes
- to achieve software process improvement as small increments
- that focuses on most important processes at project level
- that is reliable and cost effective
- to achieve the organization's business goals and quality
- to measure the effectiveness of improvement efforts

III. STEPS IN BUILDING A PROPOSED SPI FRAMEWORK

Small and startup software development firms require organisational change technology transition and continuous improvement to keep in pace with industry standards. These firms follow adhoc practices to speedup software development [11]. There are obstacles to these firms in creating innovative products [12][13], but an integrated framework can be proposed to achieve quality and agility. They are comprised of highly reactive small teams that rely on a single product [14]. It is difficult to initiate the standard software process improvement models in small and startup software firms such as CMMI [15].

The steps for building an SPI framework for startups and small firms are:

1. Conduct Case Study on small and startup software organizations and its process areas.
2. Analyse the data collected from case study to facilitate the construction of software process improvement framework or model.

The case study on startups and small firms was conducted through systematic literature review and data collection using questionnaire. The questionnaire considered different software engineering practices. Each practice consisted of various sub-practices for which the data was collected. A 5 point Likert scale [9] was given for the minor software practices allowing the respondent to express how much they follow a particular sub practice. The data collected from these firms were statistically analysed to extract the software practices that form the components of the model as shown in Figure 1. Each software practice was analysed separately to extract a set of sub practices that are critical for small and startup software firms. The components of the lean model need to be implemented in these firms through continuous learning and sub-practices serve as guidelines for organising SPI activities. The practitioners of these firms can follow the guidelines to manage and synchronise SPI events as a project, achieving milestones and allocation of resources. The sub-practices are the drivers that enhance performance and benefits to small and start-up software firms with the involvement and collaboration of stakeholders. So workshops, training sessions and seminars may be beneficial to the software practitioners of these firms. The awareness on SPI initiatives will facilitate the conduct of gap analysis

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and process assessment based on the reference model. The business strategies and organization-specific issues are also considered while designing the lean model. All SPI activities focus on the fact that organizations need more guidance to conduct SPI, suggesting solutions for different aspects of challenges they face.

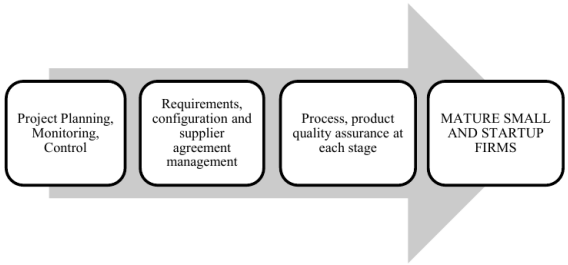

Fig. 1. Components of the lean model for small and startups

A set of sub-practices for each component of the lean model is given in Table 2. These sub-practices were identified based on Principal Component Analysis (PCA) of the data on software development phases. The significant software engineering practices and umbrella practices that contribute to enhance performance were extracted.

TABLE I
SOFTWARE PRACTICES IDENTIFIED FOR SMALL AND STARTUP SOFTWARE FIRMS

Sl.No	Appearance (in Time New Roman or Times)	
	Software Practice	**Sub practices/ Components**
1	Configuration Management	Version control Tools for configuration management
2	Project Monitoring And Control	Work Breakdown Structure (WBS) Multiple iterations
3	Project Planning	Scope document Describe deliverables and major objectives
4	Process and Product Quality Assurance	Check that process defined is followed Record variances
5	Supplier Agreement Management	Feasibility of the proposed idea
6	Requirements Management	Recording requirements of stakeholders Business Requirements Document

Software process improvement (SPI) has a profound effect on both academia and industry as it aims to improve the effectiveness of the software development process [16]. A rimary solution to the problems of meeting deadlines, managing schedule, planning budget and satisfying requirements in software development is configuring, controlling and improving the process for software development (software process). The following are the characteristics of the framework developed for small and startup software firms for improving the software development process.

- More simple and agile rather than dozens of key software practices and supplementary practices
- Lean software practices that focus on customer requirements for the continuous delivery of new functions
- Focus on pivotal practices at project level to achieve quality
- Helps in precise monitoring of deliverables as small increments
- Easy to follow, implement and cost effective model with limited resources
- Helps to deliver stable and frequent release of work products by guiding the improvement process

The analysis of the literature study and the components of the proposed lean model show that small and startup enterprises using processes based on SPI models and standards can produce higher quality software, reduce development cost and time, and increase efficiency[17][18]. There is academic and industrial interest in research on small and startups as these firms contribute to the economic growth of a nation. Research shows that SPI models like CMMI is difficult to apply to (SMEs), due to distinguishing characteristics of SMEs. Due to these distinguishing characteristics and challenges, it is important to analyse the impact of SPI approach on SMEs [19][20]. This is because SMEs may need to know that SPI is proven before they may be drawn to complex issues of SPI which require lot of resources of funds, expertise and

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management support. An initial step toward process improvement is identifying the strengths and weaknesses of the software processes of these organizations to determine effective improvement actions. An assessment can help to examine gaps in its processes against a reference model to determine the processes' capability or the organization's maturity, to meet quality, cost, and schedule goals. A set of twenty one factors are considered from SPI literature to develop a prioritization-based taxonomy of the SPI success factors using the Multi-Criterion Decision Making (MCDM) fuzzy AHP approach [21]. The data on software development based on the goals of the project or firm suggests an Optimum Measures Set Decision (OMSD) Model, an extension of the well-known Goal Question Metric (GQM) paradigm using a heuristics approach [22]. The study in [23] uses dynamic capability theory with Potential Absorptive Capability (PAC) and Realized Absorptive Capability (RAC) in order to investigate empirically the capability of a firm to absorb external knowledge and achieve SPI. The SPI initiatives and assessment examined from the industry perspective [24] illustrate the success of implementation.

IV. CONCLUSION AND FUTURE WORK

Quality assurance is a significant factor in the success and stability of small and startup software development firms as they are newly created companies with little or no history of facing high volatility in computing technologies and markets. It can be concluded that the lean SPI model offers a finite suite of practices to be followed in these firms for maturity. The key to the survival of these firms is to develop, optimise and deliver high quality software products at low cost. This can be achieved by following the key software development practices proposed in the lean software process improvement model. The outcomes of this study might be used for future research in small and startup context in relation to SPI implementation. The following areas can be considered for study in future:

- Validity of the proposed lean model through empirical study in small and startup software industry.
- Identification of additional success factors and barriers from industry and compare them by conducting empirical and literature study.

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