

An Overview of Software Process Improvement Initiatives Promoting to the Growth of an Organization

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Abstract: Software development firms need to develop strategies that demand systematic changes in creating and delivering reliable, safe, efficient, secure software at low cost, consistently. Continuous and stepwise improvement of either product or process results in innovation. Software development firms need to adopt a somewhat low risk approach towards bringing innovation and improvement in meeting the challenges of today's competitive world. Therefore, Software Process Improvement (SPI) initiatives must be streamlined to the business objectives and are inevitable in carrying out key practices in software development firms. This study presents an overview of SPI initiatives followed by software development organizations to achieve their objectives, promoting to the growth of these firms.

Key words: Software, software process improvement, organization, overview, growth, India

INTRODUCTION

Software engineers follow an organized sequence of software processes to develop and maintain software and associated products consistently on time. It involves a collection of activities, actions, practices and tasks and a systematic application of a set of people, procedures and tools. A process model describes the processes that are performed to meet the objectives of an organization. The performance, returns and maturity of a software development firm can be improved defining and following the right processes. SPI initiatives are concerned with the efforts to improve not only processes but also cost, plan, efficiency, quality and customer satisfaction. The various Software Process Improvement (SPI) Models and standards are Capability Maturity Model Integration (CMMI), ISO 9001, SPICE (ISO, 15504), Six Sigma, total quality management, IDEAL etc.

Literature review: Many research studies indicate the scenario of software industry and SPI initiatives in software development firms. It helps to identify the existing approaches and policies adopted in software firms.

Thapliyal and Dwivedi (2010) discusses the key issues in SPI paradigm and compares the existing process in India and the globally used standard models. This research by Thapliyal and Dwivedi (2010) also suggests that Indian small and medium software companies need a software process practice framework for to transform their current scenario into a significant one. This quantitative

study, based on questionnaires and interviews of Indian small and medium software organizations have identified some features of SMEs and challenges to them in implementing SPI such as:

- Lack of both time and money prevents firms in conducting formal SPI appraisal
- Shortage of human resource in SMEs and they play numerous roles affecting the quality of work and project
- As these SMEs have to compete with big organizations for project, they lack process assessment or process improvement activities that are carried out in big organizations
- Extensive requirement of resources, specific practices, documentation and formal procedures
- Lack of proper guidance in the software process improvement efforts

According to a report from Associated Chamber of Commerce and Industry in India, ASSOCHAM (2015), a major factor behind the lag in India's performance globally has been the poor performance of software firms. Unfavorable regulatory requirements, multiple formal procedures and high capital to start a new business discourage the growth of small firms in India. As a result, 94% of SMEs are currently unregistered. They are struggling with issues and challenges such as shortage of skilled workers, limited market exposure and financial constraints. So, they have limited technology and resources leading to poor systems reducing national productivity.

Baruah (2012) has conducted a survey of 18 Indian software development firms for finding software development scenarios and tools used to automate and integrate software development process and project management.

The annual report of NASSCOM (2016) considers startups and SMEs as torchbearers of a young and confident new India and shows its efforts in promoting the start-up eco-system. The Indian start-up ecosystem maturing-edition 2016 (NASSCOM, 2016) published by NASSCOM reports that, India harbors over 4750 start-ups and 140+incubators/accelerators. This report goes into the length and breadth of the Indian tech start-up scenario covering funding, geographical clusters, market developments, trends and best practices. Badra *et al.* presents startup India as the flagship initiative of the government. A survey was conducted to express the expectations of respondents on startup initiatives.

The study by Unterkalmsteiner *et al.* (2016) focuses on software development in startups. The research agenda described in this study is one of the first attempts to establish the software startup as a nascent, yet, fast growing research area and to depict its landscape by emphasizing the interesting research topics and questions to explore.

The study by Sutton (2000) gives guidelines for a start-up's relationship with the software process. This study also throws light on the characterization of software startups and its challenges such as:

- Little or no working experience in development processes and organization management
- Limited resources
- Pressure from external environment in quickly delivering the product

Paternoster *et al.* (2014) provides the first systematic exploration of software development work practices in startup research. This systematic mapping study conducted on startups indicate that if sound Software Engineering work practices are chosen and modified properly, then the challenges and constraints in the startup context can be faced.

The importance of very small entities is described by Laporte *et al.* (2015) and presents the results of early trials of ISO/IEC 29110 standard applied in two small firms. Wiegers (1996) describes ten common traps that can destabilize software process improvement efforts.

The barriers for very small enterprises to process improvement given by Larrucea *et al.* (2016) are financial

constraints, impact of organizational culture, change resistance, skills of people and complexity of the reference model.

A pilot survey conducted on Jordanian small software development firms by Yousef *et al.* (2009) present information about firm's profiles, employee's profiles, firm's characteristics and the problems faced by the firms through software development stages. The results identified are:

- Most of the small software firms in Jordan do not have long experience and are under development
- Average of number of employees about 10-30
- Scarce participation of software process improvement in these firms.
- Problems during software development

It has been concluded that the Jordanian small software development firms need to have suitable software process improvement framework to manage and improve their software processes that enable these firms to implement the suitable SPI.

The study, Wong and Hasan (2006) focus on the key issues in software process improvement standards and compares the current process practices in Bangladesh with the global standard models. The exploratory research has identified some problems such as:

- Lack in setting targets for software process and improvement
- Infrastructure problem
- Fiscal problem
- Knowledgeable human resource problem
- Lack of marketing channel and unstable political situations

Shelpar and Malhotra (2013) presents an introduction to different software process improvement models. Sugnaya *et al.* (2016) presents a brief description about process improvement as well as suggests a new sequential model-SMSPI (Sequential Model for Software Process Improvement) designed for software process improvement for small and medium enterprises. The steps in the model are initialization, diagnosis, analysis, group discussion, implementation, monitoring and progress and documentation.

MATERIALS AND METHODS

Evolution of Software Process Improvement (SPI): The research of Walter Shewhart (Oberoi *et al.*, 2016) on Statistical Process Control (SPC) in the 1930's was the

initial attempt in the SPI field. In SPC, statistical methods are employed to monitor and control the quality of a process. Shewhart is often called the father of modern quality control. His philosophy is based on the motto “the better the quality, the lower the cost”. Later W. Edwards Deming, Philip Crosby and Joseph Juran (O'Regan, 2014) continued and refined the research of Shewhart emphasizing that stability of the software is exclusively dependent on the practices and processes used to develop it. They applied these principles to software in their research at IBM (International Business Machine) and Software Engineering Institute (SEI).

The Software Engineering Institute (SEI) helps firms to become stable and enhance their capabilities to develop or acquire the right, defect free software at low cost (Humphrey, 1989). The contributions of Humphrey (1989) led to the growth of SPI. In Humphrey's book, “Managing the Software Process” (Humphrey, 1989) emphasis is placed on the basic principles and priorities of the software process.

The Capability Maturity Model (CMM) of SEI, released in the early 1990's played an instrumental role in supporting firms in enhancing their goals and practices to achieve consistent results and high quality software (Paulk *et al.*, 1995). Capability Maturity Model Integration (CMMI) tries to integrate multiple CMMs. CMMI Models are a suite of fine practices that help organizations to improve their software processes. The CMMI Version 1.3 product suite was released in 2010.

Six Sigma is a statistical approach to detect the defects and reduce the defects to 3.4 defects per million opportunities (Pressman, 2010). It was developed by Motorola in the early 1990's. In 1993, a working group was formed to draft the joint International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) standard ISO/IEC 15504 and used the acronym SPICE (Software Process Improvement and Capability Evaluation) (Pressman, 2010). It defines the requirements for assessing software processes for process improvement and maturity determination.

Software Engineering Institute (SEI) (Claude *et al.*, 2015) published another SPI Model named IDEAL in 1996 for firms that begin improvement efforts for the first time and even for those that are continuing an already established standard. The IDEAL Model contains 5 stages initiating, diagnosing, establishing, acting and learning. Laporte *et al.* (2015) present ISO/IEC 29110 systems engineering standard developed specifically for very small enterprises.

RESULTS AND DISCUSSION

Future trends in software process improvement: Software development firms have attempted to improve their

Software Engineering practices by applying software process improvement framework to effect growth and innovation but there are challenges. Software process improvement initiatives aims to assess the current software process of the organization and establish and execute an improvement plan to gradually reduce the gap between the existing process and to-be process.

Based on the review of related works and the existing challenges, some future trends in software process improvement can be noted as follows:

- SPI models must follow less costly and less time consuming approach
- SPI frameworks must be significantly more agile
- SPI efforts should focus on project level
- Complex framework models must give way to simpler models to achieve better and fast results
- Emphasize only on pivotal organizational practices
- Collaboration of software process improvement models
- Web based training on SPI targeted at pivotal organizational practices rather than expensive and time consuming classroom courses
- Proper support and commitment from the management
- SPI success can be achieved through basic project management activities
- Continuous process improvement can be achieved through metrics and feedback from the process

Based on the above trends in software process improvement, the following steps can be adopted in designing an efficient software process improvement model:

Collect data and assess the current software engineering practices in firms to uncover both strength and weakness. Educate, train and guide the practitioners and managers on concepts, methods, technology and quality related topics for process improvement. Select the pivotal process characteristics and tools that best suits the organization. Redesign and develop a new software process improvement framework by identifying, applying and refining new techniques to significantly improve and transform software processes in view of the existing process (“as-is”), transitional process (“here-to-there”) and target process (“to-be”). Evaluate or review the degree to which changes have been introduced and adopted.

CONCLUSION

As software processes and methods are continuously refined to address the challenges of software development firms, the scope of research is

broadened in the software process improvement area. Since social, cultural, economical and demographic differences exist between the small and medium software development organizations of different countries and regions, for India to reach its goals, it will have to follow a new path. So, it can be concluded that SPI efforts are required to maximize returns and to cover the final lap of software development without which the end targets cannot be met.

REFERENCES

- ASSOCHAM, 2015. Innovation-driven growth in India. ASSOCHAM, India. https://www.pwc.in/assets/pdfs/publications/2015/innovation_driven_growth_in_india_final.pdf.
- Baruah, N., 2012. A survey identifying trends on use of software development tools in different Indian SMEs. *Intl. J. Software Eng. Appl.*, 3: 31-38.
- Claude, Y., R.V. Laporte, R.H. O'Connor and J. Marvin, 2015. ISO/IEC 29110: Systems engineering standards for very small enterprises. MSc Thesis, Superior Technology School (ETS), Canada.
- Humphrey, W.S., 1989. *Managing the Software Process*. Addison-Wesley Longman, New York, USA., Pages: 512.
- Laporte, C.Y., R.V. O'Connor and L.H.G. Paucar, 2015. Software engineering standards and guides for very small entities implementation in two start-ups. *Proceedings of the International Conference on Evaluation of Novel Approaches to Software Engineering (ENASE)*, April 29-30, 2015, IEEE, Barcelona, Spain, ISBN:978-1-4673-8411-7, pp: 5-15.
- Larrucea, X. and R.V. O'Connor, R. Colomo-Palacios and C.Y. Laporte, 2016. Software process improvement in very small organizations. *IEEE. Software*, 33: 85-89.
- NASSCOM, 2016. Indian start-up ecosystem maturing-2016. NASSCOM, India. <http://www.nasscom.in/knowledge-center/publications/indian-start-ecosystem-maturing-2016>.
- Oberoi, E.H.S., M. Parmar, H. Kaur and R. Mehra, 2016. SPC (Statistical Process Control): A quality control technique for confirmation to ability of process. *Intl. Res. J. Eng. Technol.*, 3: 666-672.
- O'Regan, G., 2014. *Introduction to Software Quality*. Springer, Berlin, Germany, ISBN:978-3-319-06105-4, Pages: 351.
- Paternoster, N., C. Giardino, M. Unterkalmsteiner, T. Gorschek and P. Abrahamsson, 2014. Software development in startup companies: A systematic mapping study. *Inform. Software Technol.*, 56: 1200-1218.
- Paulk, M.C., C.A. Weber, B. Curtis and M.B. Chrissis, 1995. *The Capability Maturity Model: Guidelines for Improving the Software Process*. Addison-Wesley Pub. Co., Reading, MA.
- Pressman, R.S., 2010. *Software Engineering: A Practitioner's Approach*. 7th Edn., McGraw-Hill, New York, USA., ISBN:9780071267823, Pages: 895.
- Shelpar, M. and S. Malhotra, 2013. Software process improvement model. *Intl. J. Adv. Res. Comput. Sci. Software Eng.*, 3: 313-315.
- Sugnaya, K. Alagarsamy and S. Gavaskar, 2016. Software process improvement model for small and medium enterprises-a new sequential design. *Intl. J. Res. Emerging Sci. Technol.*, 3: 14-20.
- Sutton, S.M., 2000. The role of process in software start-up. *IEEE. Software*, 17: 33-39.
- Thapliyal, M.P. and P. Dwivedi, 2010. Software process improvement in small and medium software organisations of India. *Intl. J. Comput. Appl.*, 7: 37-39.
- Unterkalmsteiner, M., P. Abrahamsson, X. Wang, A. Nguyen-Duc and S. Shah *et al.*, 2016. Software startups-a research agenda. *E Inf. Software Eng. J.*, 10: 89-123.
- Wieggers, K.E., 1996. Software process improvement: Ten traps to avoid. *Software Dev.*, 4: 1-9.
- Wong, B. and S. Hasan, 2006. Software process improvements in Bagladesh. *Proceedings of the International Conference on Software Engineering Research and Practice Volume 1*, June 26-29, 2006, CSREA Press, Las Vegas, Nevada, USA., pp: 367-374.
- Yousef, M., M.S. Abdullah and A.B.M. Ali, 2009. Software development process in Jordanian small software development firms. *Small*, 60: 40-40.