# MESOPYME-IEMA SOFTWARE PROCESS EVALUATION MODEL FOR SMALL AND MEDIUM SOFTWARE INDUSTRIES

IMRAN BASHA

A dissertation submitted in partial fulfillment of the
requirements for the award of the degree of
Master of Science (Computer Science)

Faculty of Computing
Universiti Technologi Malaysia

MARCH 2014

*This Thesis Specially Dedicated to*

*My Dad "Ghouse Basha" and Mom "Amnuma"*

*My Well-wisher "Savitha Vaishnavi"*

## ACKNOWLEDGEMENT

**In The Name Of Allah, Most Gracious, Most Merciful**

Though only my name appears on the cover of this thesis, a great many people have contributed to its production. I owe my gratitude to all those people who have made this thesis possible and because of whom my graduate experience has been one that I will cherish forever. My deepest gratitude is to my advisors, **Associate Professor Dr. Wan M.N. Wan Kadir** Deputy Dean, for their guidance and support throughout my studies. They have given me the freedom to explore on my own and support when my steps faltered. Their insightful comments and constructive criticisms at different stages of my research were thought-provoking and they helped me focus on my ideas.

I would like express my gratitude to software organization *Wipro, Cognizant, Tata consultancy Services* for providing me with necessary information and technical details to complete this research. Many friends have helped me throughout my study years. Their support and care helped me overcome setbacks and stay focused on my graduate study. I greatly value their friendship and I deeply appreciate their belief in me.

Most importantly, none of this would have been possible without the love and patience of my family. My family, to whom this thesis is dedicated to, has been a constant source of love, encouragement, concern, support and strength all these years. I would like to express my heart-felt gratitude to my family.

# ABSTRACT

The Software Industry plays a prominent role in the economy. During the last few years, many (SPI) methods have been presented to increase the quality of products and services provided by software industries. SPI is generally associated with large scale software organizations because large scale software industries have the capacity to get funding for programs to improve the software process activities widely. Small and Medium (SMI) software industries do not have the same financial opportunities, but still in need of software process improvement programs, to strengthen these small and medium-sized businesses we need to improve current software process in industries. This research will lead to a recommendation of how to conduct the software process evaluation that a SMI can be used to implement improvements and see the benefits at a short time. This research presents a new software process model called Mesopyme-IEMA with the main focus of to reduce effort and time on the SPI implementation and to find a way for SMI to improve the quality of the final product. New model focuses on the improvement in the implementation stage, which is based on a concept called Action Package. The results obtained from SMI by using this new Mesopyme-IEMA action Package model in five industries is also presented in this thesis which proves significant improvement in software process as well as the final products delivered with quality.

# ABSTRAK

Industri perisian memainkan peranan penting dalam ekonomi. Dalam beberapa tahun kebelakangan ini, ramai (SPI) kaedah telah dibentangkan untuk meningkatkan kualiti produk dan perkhidmatan yang disediakan oleh industri perisian. SPI secara umumnya perhubungan dengan organisasi perisian berskala besar kerana industri perisian berskala besar mempunyai keupayaan untuk mendapatkan dana untuk program untuk meningkatkan aktiviti proses perisian secara meluas. Kecil dan Sederhana (IKS) industri perisian tidak mempunyai peluang kewangan yang sama, tetapi masih memerlukan satu program pembaikan proses perisian , bagi mengukuhkan perniagaan kecil dan sederhana kita perlu meningkatkan proses perisian terkini di dalam industri . Kajian ini akan membawa kepada syor bagaimana untuk menjalankan penilaian proses perisian bahawa IKS boleh digunakan untuk melaksanakan penambahbaikan dan melihat manfaat pada masa yang singkat. Kajian ini membentangkan model proses perisian baru yang dikenali sebagai Mesopyme - IEMA dengan fokus utama untuk mengurangkan usaha dan masa pelaksanaan SPI dan mencari jalan untuk IKS untuk meningkatkan kualiti produk akhir. Model baru memberi tumpuan kepada peningkatan dalam peringkat pelaksanaan, yang berdasarkan kepada konsep yang dipanggil Pakej Tindakan. Keputusan yang diperolehi daripada IKS dengan menggunakan Mesopyme - IEMA model Pakej tindakan baru ini dalam lima industri turut terkandung di dalam tesis ini yang membuktikan peningkatan yang ketara dalam proses perisian dan juga produk akhir yang dihantar dengan kualiti.

# TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

## LIST OF ABBRIVIATIONS

| | | |
|---|---|---|
| CMM | - | Capability Maturity Model |
| GSPIM | - | General software process improvement |
| IEMA | - | Iteration Evaluation Model Approach |
| ICT | - | Information & Communication Technology |
| IAP | - | Improvement Action Plan |
| IEMA | - | Iteration Evaluation Model Approach |
| QFD | - | Quality Function Deployment |
| SPI | - | Software Process Improvement |
| SMI | - | Small Medium Industry |
| SDLC | - | Software Development Life Cycle Model |
| SPM | - | Software Process Matrix |
| SPICE | - | Software Process Improvement and Capability dEtermination |
| SPI | - | Software Process Improvement |
| SMI | - | Small Medium Industry |
| SQA | - | Software Quality Assurance |
| TQM | - | Total Quality Management |
| VSE | - | Very Small Entities |

# LIST OF APPENDICES

# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

Software plays an important role in our everyday lives since more and more products in the market incorporate software that drives the product's functionality into their operation. With this importance, the software engineering discipline and the study of the processes involved in software development have started to gain more popularity among researchers and practitioners in industry. One of the common research areas in software engineering is in the field of Software Process Improvement (SPI).

SPI involves the understanding of the software processes as they are used within an organization and suggests areas for improvements in achieving specific goals such as increasing product quality, operational efficiency and cost reduction. Software industry plays an important role in the economy. In the late nineties, the spire (Software process improvement in the areas of europe) program spice model applied to various small and medium industries.

However, studies indicate that only a small percentage of software development industries implemented a formal methods evaluation SPI people. The study confirms that one of the programs of these industries do not want to participate in the official estimates for SPI because of high costs and resources involved.

### 1.1.1 SMI Features

Small and medium software companies exhibit many special features that give reason for a dedicated approach to process improvement. They often cannot afford implementing maturity models or quality standards both in terms of time and money. Instead, they expect simpler solutions that can allow running projects in more systematic and repeatable way, increasing quality and knowledge management. Small and medium industries (SMIs) with less than 250 employees and, in particular, very small entities (VSEs) with less than 25 employees explore their advantages such as flexibility, innovativeness, market reaction and managerial agility to achieve their specific key business goals.

According to a Malaysian study by (Saleh and Ndubisi, 2006) SMIs in manufacturing category have employees less than 150 or have annual sales turnover less than $78 million. SMIs in services mainly Information & Communication Technology (ICT) have full-time employee's less than 50 and annual revenue less than $15.6 million. Many SMIs compete with big organizations for project from prospective clients. Many small and medium software development organizations have recognized the need to improve their software product and evaluating the software product alone seems insufficient since it is now that its quality is largely dependent on the process that is used to create it. Therefore, these organizations are looking for evaluation of their software processes and products.

### 1.1.2 SPI Adoption and Evaluation

Many small industries are not aware of the existing models and standards for assessing software development processes. There is often an assumption that standards and conformity assessment of these models can be expensive and time-consuming, and therefore it is difficult to perform in small industries. Smaller indus-

tries also recognize the models and evaluation criteria including documents and formalize the practice of targeting large institutions such as.

These measures have been criticized as inappropriate for small businesses, which usually have informal processes and organizational structures that focus primarily on the fact that the product to stay in business. Transparent model of software development dates back to the nearest large software development project system in. In general, the purpose of the life cycle model of a software system early in the concept of rational management of software systems development. This project can serve as a basis software development planning, organization, staffing, coordinating, budgeting, and directing activity.

Software life-cycle model or specification is required, or a description of how it is or should be developed. Descriptive model that describes how a specific date software system was developed. This model can be used to understand the description and improve the software development process.The way it should be done and re-organizing software development activities, and any systems. Usually, it is easier and more common to express the life-cycle model of instruction, how to develop software systems. This is possible because most of the models of sensory and has also been argued.

This means that many of the specific details that describe how the program built-in system can be neglected released or is postponed for consideration at a later time. However, it has concerns about the health and viability of the model life cycle .The development of a variety of applications in a variety of development settings, using different programming languages with a differential of skilled personnel. The software industry has had problems during a long time with projects over the budget or/and products with wrong functionality.

As software becomes increasingly important to all aspects of the industry, and there is a need to encourage practitioners to adopt best practices so as to improve

the process of software projects, and achieve goals related to time, budget and quality. Currently unknown levels of adoption of best practices among small and medium software industries for software development. Software process improvement (SPI) is generally associated with large scale organizations.

Large scale software organizations have the capacity to get funding for programs to improve the software process activities widely. Small Medium Industries (SMI) do not have the same financial opportunities but still in need of process improvement programs. Often these programs do not show improvement progress until sometime has elapsed.

## 1.2 Problem Background

Problems in the software industry over a long period of time with the project or budget and the product were faulty. Two known Capability Maturity Model and CMM model for software process improvement and reporting skills SPICE models are discussed in literature review Chapter 2.

Those models were real standards for measuring and improving software processes and enables organizations to control many of the problems associated with software development. It is recommended to improve the software development process as a means to improve the effectiveness of cost and schedule performance, quality, and increased competition (Ibáñez,1998)(Yamamura,1997). There are many calls for increased recognition of the importance of small business, the small business sector, and develop appropriate policies to meet the needs of small business (Dunlop, Johns 1989). Recent research has raised doubts about whether the SPI standard models suitable for small software development organization.

This study responds to demand for more research to assess the effectiveness of programs based SPI on small development firms (Brodman & D. L. Johnson,1994).Despite improvements in the management of software projects over the past few years, it is still disappointment software projects fail, Most often major projects have failed. This research investigates the reasons for this failure to consider and questions to looking to improve your organization's performance on a large scale software projects.

Implement CMM or SPICE model in a large organization and the most demanding parts of the model for a small industries, this can be a problem for small industries because the implementation requires more time, resources and budget. Today very promising software-scale small medium industries (SMI) are striving to unite its operations and software development. They do but not optimization processes appropriate set of processes. There are a limited adoption, assimilation, adaptation and absorption modelling software to improve the process in the small and medium-sized companies because of the lack of resources available in terms of know-how and money and time and the expected benefits and quality focus.

To strengthen these small and medium-sized businesses and we need to improve software process in the organization that has been adapted to the size and type of business. Process improvement is the operation of putting in place measures to strengthen processes which have been identified as sources of defects or risks to quality, cost or schedule performance. Process improvement is based on the premise that product quality is highly dependent upon the processes used in its creation (ISO/IEC JTC1/SC7 N944R 1992 n.d.).

The process improvement program is defined as all the strategies, policies, goals, responsibilities and activities concerned with the achievement of specified improvement goals (Moore,1998).The software industry is a very most important activity which was formed during the last two decades. There are programs organizations whether on a small or medium-sized or large wish to succeed in the market by providing high quality programs along with related services, support, communicate

with customers. The focus of the evaluation is to find SPI model for software process improvement through the enhancement.

This thesis is concentrated for enhancing one established software process model which has constraints need to solve. The enhancing collaborates with some phases which are related to requirement phase and design phase. Another objective of this thesis is to validate the enhanced model in the real life.

## 1.3 Problem Statement

Although there is a claim that the software crisis had passed (Ramesh *et al*, 2004), there are still reports of abandoned projects and software errors cause problems (Yardley,2002). In addition, the development of local industry, the need to adopt international standards to compete (Howarth,2004). In many small organizations and software development processes and the way to realize the chaotic (Batista & Figueiredo,2000) is not defined.

Various technical innovations have been introduced in recent decade's CASE tools for example and different programming models, formal methods and so on. In accordance with these issues, the research questions that are related to this research are as follow:

**Research question 1**: Why is it difficult to manage software projects and various administrative systems and procedures?

**Research Question 2:** Why do we need to enhance the software processes model in software industries?

**Research Question 3**: How to conduct the enhancement process for SMEs software industries?

**Research Question 4**: Do the current software process models work as it is supposed to do?

**Research Question 5**: How to evaluate the proposed enhanced software process evaluation model in the context of small and medium software industries.

## 1.4 Research Objectives

This research aims at enhancing the existing SPI model in the evaluation of the software process for small and medium industries (SMI). Therefore the research questions for the dissertation are:

i. To identify software process improvement model issues that needs to be addressed in software process evaluation in SMI.

ii. To enhance the existing software process model that may reduce the action plan errors and maintain the organization commitment in the context of SMI.

iii. To validate and analyse the enhanced model by conducting questionnaire survey with software industries for enhanced model.

Evaluation of the software project process model is an essential step towards improving organization process to overcome from software failure. A small organization can then define sub goals of the SPI model and strive to reach those sub goals in their own software improvement process.

## 1.5 Research Scope

- The study focus on enhancing the assessment stage of the software process model.

- To find a way for small enterprises to improve the quality of the final product and delivery is done through improving the process by using (MESOPYME-IEMA) process model for developing quality software in a short period of time by improving the software techniques for successful software.

- And this research mainly focuses on small medium software industries because larger industries typically have the necessary funding for the implementation of large models SPI.

A small industry grows (hopefully) and if there is set to focus on improving operations in early, and the cost will be less with the passage of time when you do to improve the process.

## 1.6 Research Significance

- Small industries will delivered the final products with quality and this is done through by enhancing the one established software process model which has constraints.

- The enhanced model will work as general and it is made that way, so that it can be used and adopted for any small software organization.

- The enhanced model is concerned with small software organizations thus only focusing on one software process improvement at a time and one software life cycle.

- Improvements can be implemented and monitored with a simplicity well suited for the small organization using enhanced model.

- The strength of the enhanced model will be low cost and simplicity of implementing it in small medium software industries.

## 1.7 Research Outline

**Chapter 1** provides a brief background of the software process in software industries. The concepts of best practice and process improvement are introduced, the research problem is stated, the justification of the research presented. Delimitations of the scope of the research and key assumption are discussed.

**Chapter 2** reviews the literature relating to the underlying theories of process improvement and SPI models are reviewed. Current research about software process improvement is summarized, highlighting the gap in research relating to the adoption of SPI by small industries. Finally, the literature is used to formulate to develop the new model for software industries according to the crises.

**Chapter 3** design frameworks that how research methodology is conducted in achieving the thesis objectives and scopes details the methodology used, it contains describing the research paradigm, approaches and validation methods have been derived.

**Chapter 4** defines and designs the new model of evaluation which is integrated with the Mesopyme model with IEMA as proposed one model.

**Chapter 5** will do data analysis and discussion were made by using questionnaire data which is filled by the software industry experts to find the result of enhanced model

**Chapter 6** will give conclusion and study limitations were discussed and future suggestion.

## 1.8 Summary

This chapter lays the foundation for the thesis. Presented the research problem and research questions. The study methodology described is justified for a brief period and justified, and was scheduled to be presented the definition and delimitation of view of the thesis. On this basis, the thesis will continue with a detailed review of the literature on the basic theories to improve the process in general and improve the software process in particular.

# REFERENCES


Abrahamsson, P., 2001. Rethinking the concept of commitment in software process improvement. *Scandinavian Journal of Information Systems*, 13, pp.69–98.

Agarwal, R. & Prasad, J., 2000. A field study of the adoption of software process innovations by information systems professionals. *Engineering Management, IEEE Transactions on*, 47(3), pp.295–308.

Ahern, D.M., CLOUSE, A.A. & TURNER, R.A., 2004. *CMMI distilled: a practical introduction to integ* Survey *rated process improvement*, Addison-Wesley.

Allen, P., Ramachandran, M. & Abushama, H., 2003. PRISMS : an Approach to Software Process Improvement for Small to Medium Enterprises.

Anacleto, A. et al., 2004. Experiences gained from applying ISO/IEC 15504 to small software companies in Brazil. In *4th International SPICE Conference on Process Assessment and Improvement, Lisbon, Portugal*. Citeseer, pp. 33–37.

Anderson, M. & Sohal, A.S., 1999. A study of the relationship between quality management practices and performance in small businesses. *International Journal of quality & Reliability management*, 16(9), pp.859–877.

Anderson, M & Sohal, A., 1998. A Study of the relationship between quality management practices and performance in small business, Dept of Management Working Paper Series 77/98, Faculty of Business and Economics, Monash University.

Ares, J. et al., 2000. A more rigorous and comprehensive approach to software process assessment. *Software Process: Improvement and Practice*, 5(1), pp.3–30.

Attewell, P. & Rule, J.B., 1991. Survey and other methodologies applied to IT impact research: experiences from a comparative study of business computing. *The Information systems research challenge: survey research methods*, 3, pp.299–315.

Azuma, M., 1994. Towards the 21st Century's Software, State of the Art and International Standard in JTC1/SC7. In *Software Quality and Productivity: Theory, practice and training*. Chapman & Hall, Ltd., pp. 3–9.

Barron, J.M. & Gjerde, K.P., 1996. Who adopts total quality management (TQM): theory and an empirical test. *Journal of Economics & Management Strategy*, 5(1), pp.69–106.

Basili, V.R., 1997. Evolving and packaging reading technologies. *Journal of systems and software*, 38(1), pp.3–12.

Batista, J. & Figueiredo, A., 2000. SPI in a Very Small Team: a Case with CMM. *Software Process: Improvement and Practice*, 5(4), pp.243–250.

Bollinger, T.B. & McGowan, C., 1991. A critical look at software capability evaluations. *Software, IEEE*, 8(4), pp.25–41.

Brodman, J.G. & Johnson, D.L., 1994. What small business and small organizations say about the CMM: experience report. In *Proceedings of the 16th international conference on Software engineering*. IEEE Computer Society Press, pp. 331–340.

Bucci, G., Campanai, M. & Cignoni, G.A., 2001. Rapid Assessment to Solicit Process Improvement in Small and Medium-Sized Organizations. *Software Quality Professional Magazine*, 4(1).

Butler, K., 1997. Process lessons learned while reaching level 4', Crosstalk: The Journal of Defense Software Engineering, May, pp. 1-6.

Cater-Steel, A. & Tan, W.-G., Implementation of IT Infrastructure Library (ITIL) in Australia: Progress and success factors.

Chiles, T.H. & Choi, T.Y., 2000. Theorizing TQM: an Austrian and evolutionary economics interpretation. *Journal of Management Studies*, 37(2), pp.185–212.

Crosby, P.B., 1979. *Quality is free: The art of making quality certain*, McGraw-Hill New York.

Curtis, B., Krasner, H. & Iscoe, N., 1988. A field study of the software design process for large systems. *Communications of the ACM*, 31(11), pp.1268–1287.

Davis, C.J. et al., 1992. A survey of approaches to software quality within the United Kingdom. *Occasional Paper, University of Sunderland*, 92(5), pp.1–74.

Dean, J.W. & Bowen, D.E., 1994. Management theory and total quality: Improving research and practice through theory development. *Academy of management review*, 19(3), pp.392–418.

Debou, C. & Kuntzmann-Combelles, A., 2000. Linking software process improvement to business strategies: experiences from industry. *Software Process: Improvement and Practice*, 5(1), pp.55–64.

Dekleva, S. & Drehmer, D., 1997. Measuring software engineering evolution: A Rasch calibration. *Information Systems Research*, 8(1), pp.95–104.

Deming, W.E., 2000. *The new economics: for industry, government, education*, MIT press.

Dunlop, Johns, W.& S., 1989. *Small Business in Australia: Problems and Prospects, 3rd edn, Allen and Unwin, Sydney.*

Dunn, RH & Ullman, R., 1994. TQM for Computer Software, McGraw-Hill, New York.

Dutta, S., Lee, M. & Van Wassenhove, L., 1999. Software Engineering in Europe: A study of best practices. *Software, IEEE*, 16(3), pp.82–90.

El-Emam, K., Smith, B. & Fusaro, P., 1999. Success Factors Barriers for Software Process Improvement: An Emperical Study.

El Emam, K. & Birk, A., 2000. Validating the ISO/IEC 15504 measure of software requirements analysis process capability. *Software Engineering, IEEE Transactions on*, 26(6), pp.541–566.

El Emam, K. & Madhavji, N.H., 1995. A field study of requirements engineering practices in information systems development. In *Requirements Engineering, 1995., Proceedings of the Second IEEE International Symposium on*. IEEE, pp. 68–80.

Fayad, M.E., Laitinen, M. & Ward, R.P., 2000. Thinking objectively: software engineering in the small. *Communications of the ACM*, 43(3), pp.115–118.

Fenton, N., 1993. How effective are software engineering methods?' paper presented to 2nd International Conference on Achieving Quality in Software, Venice, Italy, 1993.

Fitzgerald, B. & O'Kane, T., 1999. A longitudinal study of software process improvement. *Software, IEEE*, 16(3), pp.37–45.

French, WL & Bell, C., 1995. Organization Development: Behavioral Science Interventions for Organization Improvement, 5 edn, Prentice Hall International, Englewood Cliffs.

Glass, R.L., Vessey, I. & Ramesh, Venkataraman, 2002. Research in software engineering: an analysis of the literature. *Information and Software technology*, 44(8), pp.491–506.

Goldenson, D et al., 1999. Empirical studies of software process assessment methods.

Goldenson, D.R. & Herbsleb, J.D., 1995. *After the Appraisal: A Systematic Survey of Process Improvement, its Benefits, and Factors that Influence Success*, DTIC Document.

Goode, S., 2001. Organisational size metrics in IS research: a critical survey of the literature 1989-2000.

Graham, S.J.H. & Mowery, D.C., 2003. *Intellectual property protection in the US software industry*, Washington, DC: The National Academies Press.

Gray, L., 1998. Why coaches are needed in software process improvement. *Crosstalk: The Journal of Defense Software Engineering*.

Graydon, A.W., Nevalainen, R. & Drouin, J., 1998. The reference model. *SPICE: the theory and practice of software process improvement and capability determination, IEEE Computer Society*, pp.75–97.

Grover, V. & Teng, J.T.C., 1992. An examination of DBMS adoption and success in American organizations. *Information & Management*, 23(5), pp.239–248.

Hackman, J.R. & Wageman, R., 1995. Total quality management: empirical, conceptual, and practical issues. *Administrative science quarterly*, pp.309–342.

Hall, T., Rainer, A. & Baddoo, N., 2002. Implementing software process improvement: an empirical study. *Software Process: Improvement and Practice*, 7(1), pp.3–15.

Hammer, M. & Champy, J., 1993. Reengineering the corporation: a manifesto for business revolution", Harper Collins. *New York*.

Hansen, B., Rose, J. & Tjørnehøj, G., 2004. Prescription, description, reflection: the shape of the software process improvement field. *International Journal of Information Management*, 24(6), pp.457–472.

Hauck, J.C.R. et al., 2008. Process Reference Guides – Support for Improving Software Processes in Alignment with Reference Models and Standards.

Henry, J. et al., 1994. Improving software maintenance at Martin Marietta. *Software, IEEE*, 11(4), pp.67–75.

Herbsleb, J. et al., 1994. *Benefits of CMM-based software process improvement: Initial results*, DTIC Document.

Hersh, A., 1993. Where's the return on process improvement? *IEEE Software*, 10(4), p.12.

Holmes, S. & Gibson, B., 2001. Definition of small business. *Retrieved September*, 3, p.2002.

Horvat, R.V., Rozman, I. & Györkös, J., 2000. Managing the complexity of SPI in small companies. *Software Process: Improvement and Practice*, 5(1), pp.45–54.

Howarth, B., 2004. SOFTWARE CRISIS BREWING Tough accreditation standards will make it hard-maybe impossible-for small software developers to compete. *BRW-MELBOURNE-*, 26(1), pp.28–31.

Humphrey, W.S., 2000. *Introduction to the team software process (sm)*, Addison-Wesley Professional.

Humphrey, W.S., Kitson, David H & Gale, J., 1991. A comparison of US and Japanese software process maturity. In *Proceedings of the 13th international conference on Software engineering*. IEEE Computer Society Press, pp. 38–49.

Ibáñez, 1998. Balanced IT Scorecard Milagros Ibáñez. , (May).

ISO/IEC JTC1/SC7 N944R 1992, The Need and Requirements for a Software Process Assessment Standard, Study Report, Issue 2.0.

ISO/IEC TR 15504, 1998. Information Technology -Software process assessment, Parts 1-9, ISO/IEC TR 15504:1998(E).

ISO/IEC TR 15504-2, 1998. Information technology -Software process assessment - Part 2: A reference model for processes and process capability, ISO/IEC TR 15504-2:1998(E).

Johns, BL, Dunlop, WC & Sheehan, W., 1989. Small Business in Australia: Problems and Prospects, 3rd edn, Allen and Unwin, Sydney.

Johnson, A., 1994. Software process improvement experience in the DP/MIS function: experience report. In *Proceedings of the 16th international conference on Software engineering*. IEEE Computer Society Press, pp. 323–329.

Jung, Ho-Wan & Goldenson, Dennis, 2003. CMM-Based Process Improvement and Schedule Deviation in Software Maintenance.

Kaltio, T. & Kinnula, A., 2000. Deploying the defined SW process. *Software Process: Improvement and Practice*, 5(1), pp.65–83.

Kautz, K., Larsen, E.Å. & Galliers, R., 1997. Diffusion Theory and Practice: Disseminating Quality Management and Software Process Innovations. In *Conference Proceedings*. Cork Publishimg Limited, pp. 224–238.

Kautz, K, Hansen, HW & Thaysen, 2001. "Applying and adjusting a software process improvement model in practice: the use of the IDEAL model in a small software enterprise", in RB Hunter & RH Thayer (eds), Software Process Improvement, IEEE, pp. 463-70.

Kitchenham, B.A. et al., 2002. Preliminary guidelines for empirical research in software engineering. *Software Engineering, IEEE Transactions on*, 28(8), pp.721–734.

Kitson, D H, 1996. Relating the SPICE framework and SEI approach to software process assessment. *Software Quality Journal*, 5(3), pp.145–156.

Kitson, David H & Masters, S.M., 1993. An analysis of SEI software process assessment results: 1987–1991. In *Proceedings of the 15th international conference on Software Engineering*. IEEE Computer Society Press, pp. 68–77.

Komiyama, T., Sunazuka, T. & Koyama, S., 2001. Proposal on Library–Centered Software Process Assessment. *CROSSTALK The Journal of Defense Software Engineering*, 14(8), pp.22–28.

Laudon, K.C. & Laudon, J.P., 2004. Managing the digital firm.

Lawthers, I., 1999. Spire European Analysis Report: Esprit-ESSI Project 23973.

Likert, R., 1967. THE HUMAN ORGANIZATION; ITS MANAGEMENT AND VALUE.

Lowry, G.R., Morgan, G.W. & FitzGerald, D.G., 1996. Identifying excellence in leading Australian-owned information technology firms: Five emerging themes. In *Australasian Comference on Information Systems (ACIS'96)*. pp. 419–429.

Massey, C. & Ingley, C., 2004. The New Zealand Policy Environment for the Development of SMEs.

McGibbon, T., 1999. A business case for software process improvement revised. *DoD Data Analysis Center for Software (DACS).*

McKerlie Consulting, 1996. *Needs Analysis for Enhancement for Software Development Capability within Australian Industry, DIST.*

Meehan, B. & Richardson, I., 2002. Identification of software process knowledge management. *Software Process: Improvement and Practice*, 7(2), pp.47–55.

Milgrom, P.R., 1988. Employment contracts, influence activities, and efficient organization design. *The Journal of Political Economy*, pp.42–60.

Mintzberg, H., 1995. Structure in fives: Designing effective organizations. 1983. *Nederlandse vertaling*.

Mishra, D. & Mishra, A., 2009. Software process improvement in SMEs: A comparative view. *Computer Science and Information Systems*, 6(1), pp.111–140. Available at: http://www.doiserbia.nb.rs/Article.aspx?ID=1820-02140901111M [Accessed April 25, 2013].

Moore, J.W., 1998. *Software engineering standards*, Wiley Online Library.

Natwick, G., Draper, G. & Bearden, L., 1999. Software mini-assessments: process and practice. *Crosstalk: october*, pp.10–14.

Niazi, M., Wilson, D. & Zowghi, D., 2006. Critical success factors for software process improvement implementation: an empirical study. *Software Process: Improvement and Practice*, 11(2), pp.193–211.

O'Regan, N. & Ghobadian, A., 2004. Testing the homogeneity of SMEs: The impact of size on managerial and organisational processes. *European Business Review*, 16(1), pp.64–77.

Paulish, D.J., 1993. *Case studies of software process improvement methods*, DTIC Document.

Paulk, M.C., 1995. How ISO 9001 compares with the CMM. *Software, IEEE*, 12(1), pp.74–83.

Pfleeger, S.L., Fenton, N. & Page, S., 1994. Evaluating software engineering standards. *Computer*, 27(9), pp.71–79. Available at: http://ieeexplore.ieee.org/lpdocs/epic03/wrapper.htm?arnumber=312041.

Powell, T.C., 1995. Total quality management as competitive advantage: a review and empirical study. *Strategic management journal*, 16(1), pp.15–37.

Radice, R.A. et al., 1985. A programming process architecture. *IBM Systems Journal*, 24(2), pp.79–90.

Rainer, A. & Hall, T., 2003. A quantitative and qualitative analysis of factors affecting software processes. *Journal of systems and software*, 66(1), pp.7–21.

Ramesh, V, Glass, R.L. & Vessey, I., 2004. Research in computer science: an empirical study. *Journal of systems and software*, 70(1), pp.165–176.

Richardson, I. & Ryan, K., 2001. Software process improvements in a very small company. *Software Quality Professional*, 3(2), pp.23–35.

Richardson, I.R., Software Process Improvements in a Very Small Companyhttp://www.iscn.at/select_newspaper/process-models/limerick.html.

Rigby, C.& T., 2004. SMEs: A World View, viewed 29 May 2004,.

Robey, D. & Zmud, R., 1992. Research on the organization of end-user computing: Theoretical perspectives from organizational science. *Information Technology & People*, 6(1), pp.11–27.

Rout, T.P. et al., 2007. SPICE in retrospect: Developing a standard for process assessment. *Journal of systems and software*, 80(9), pp.1483–1493.

Shewhart, W.A., 1931. Economic control of quality of manufactured product.

Smith, D.J., 2011. *Reliability, maintainability and risk: Practical safety-related systems engineering methods*, Butterworth-Heinemann.

SPICE, 1998. Project Team , SPICE Phase 1 Trials Report, viewed 27 Oct 2004.

SPICE, 1995. SPICE Project,Software Process Assessment Parts 1-9, June.

Stambollian, A. et al., 2006. OWPL : A Light Model & Methodology for Initiating Software Process Improvement. , pp.1–9.

Stelzer, D. & Mellis, W., 1998. Success factors of organizational change in software process improvement. *Software Process: Improvement and Practice*, 4(4), pp.227–250.

Sweeney Research, 2003. What's Bugging Australia's Software Industry: 2003 Report Summary, SEA National, viewed 6 Jan 2004, <http://www.seanational.com.au/articles/files/What_s_Bugging_the_Australian_Software_Industry_Report.pdf>.

Tan, M. & Yap, C.Y., 1994. Impact of organisational maturity on software quality. In *Software Quality and Productivity: Theory, practice and training*. Chapman & Hall, Ltd., pp. 231–234.

Team, C.P., 2002. CMMI for Systems Engineering/Software Engineering/Integrated Product and Process Development/Supplier Sourcing, Version 1.1, Continuous Representation. *CMU/SEI*.

Thinktank, 2001. SME E-Commerce Roundtable,Definition of Small Business: A Small Business Coalition Initiative, <www.setel.com.au/smeforum2002/tp/BP01.htm>.

Thomson, H.E. & Mayhew, P., 1997. Approaches to software process improvement. *Software Process: Improvement and Practice*, 3(1), pp.3–17.

Thong, J.Y.L., Yap, C.-S. & Raman, K.S., 1996. Top management support, external expertise and information systems implementation in small businesses. *Information Systems Research*, 7(2), pp.248–267.

Tully, C., Kuvaja, P. & Messnarz, R., 1999. Software process analysis and improvement: a catalogue and comparison of models. *Better Software Practice for Business Benefit: Principles and Experience*, pp.51–106.

Varkoi, T., 2004. SataSPIN-a network for software companies to improve processes. In *Software and Systems Standards for the Real World Seminar, Brisbane*.

Voss, C. et al., 1998. Made in Europe: small companies. *Business Strategy Review*, 9(4), pp.1–19.

Weber, K.C. & Do Nascimento, C.J., 2002. Brazilian software quality in 2002. In *Software Engineering, 2002. ICSE 2002. Proceedings of the 24rd International Conference on*. IEEE, pp. 634–638.

Wiegers, K.E., 1998. Software process improvement: Eight traps to avoid. *CrossTalk, The Journal of Defense Software Engineering*.

Wilkie, F.G. et al., 2007. A Low-overhead method for software process appraisal. *Software Process: Improvement and Practice*, 12(4), pp.339–349.

Wohlwend, H. & Rosenbaum, S., 1993. Software improvements in an international company. In *Proceedings of the 15th international conference on Software Engineering*. IEEE Computer Society Press, pp. 212–220.

Wruck, K.H. & Jensen, M.C., 1994. Science, specific knowledge, and total quality management. *Journal of Accounting and economics*, 18(3), pp.247–287.

Xydias-Lobo, M. & Jones, J.T., 2003. *Quality Initiatives and Business Growth in Australian Manufacturing SMEs: an Exploratory Investigation*, School of Commerce, Flinders University.

Yamamura, G.& W., 1997. SEI CMM Level 5: for the right reasons', Crosstalk: The Journal of Defense Software Engineering.

Yardley, D., 2002. Successful IT Project Delivery:Learning the Lessons of Project Failure. *Addison Wesley, Harlow, UK*.

Zhang, Z., 2000. Developing a model of quality management methods and evaluating their effects on business performance. *Total Quality Management*, 11(1), pp.129–137.