REQUIREMENT ENGINEERING BEST PRACTICES FOR MALAYSIAN PUBLIC SECTOR

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DEDICATION

Dedicated to :

My beloved husband Haji Hasbullah Haji Ali,
My beloved daughters,
Ain Syazwani, Auni Syazwina, Amna Syazwana and Alya Syazihah,
My Mothers,
Hajjah Habibah Abdullah and Hajjah Misgiah Abd Hamid,
My Late Fathers,
Allahyarham Haji Haron bin Jana and Allahyarham Haji Ali Hamid,
My Brothers,
Aminduddin Haron, Azhar Haron, Allahyarham Azlan Haron and Azman Haron
My Sisters
Azizah Haron, Azurah Haron, Azila Haron and Azwin Haron,
My Best Friend,
Hafidzah Md Nadzir, Dr. Hajjah Norma Sabtu, Haji Anuar Bachik, Raja Fauziah
Raja Abdul Hamid, and Hajjah Zoraidah Ahmad,
and My Relatives especially Allahyarham Haji Ismail Jana

Thank you for your supportive and Doa.

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Amin

ABSTRACT

Although a variety of ICT standards have been developed as a guide for IT Managers, the Malaysian Public Sector is in tandem by developing new policies for them. The need of Requirement Engineering Best Practices for IT Manager is to produce an appropriate Software Requirement Specification. The proposed Requirement Engineering Best Practices aims to be a standard for the Malaysian Public Sector. The need of the standard is to resolve identified complexity during software project development. The complexity of present Requirement Engineering models and standard is either too specific or too general. These models do not meet the Public Sector's requirement and the IT Manager depends on other proposed solution or does not use any Requirement Engineering models and standard. The complexity of present software process drives the Malaysian Public Sector to create several committees for monitoring the implementation of software project. It also includes several rules and policy. The rules and policy were prepared by different or multiple agencies and is complex to understand. The proposed software projects have to go through several levels of software project approval. This process is repeated and really took times to be approved. These complexities can be overcome with a proposal of Requirement Engineering Best Practices Guideline. The development of Requirement Engineering Best Practices Guideline is implemented based on the Requirement Engineering Best Practices Guideline Research Framework. This framework used with mixed method. Qualitative techniques were used for interview, refinement and validation. Meanwhile, quantitative techniques were used for the survey. Target respondents for this research are IT Managers in the Malaysian Public Sector. The guideline also consists of identified requirement processes: Software Project Approval Process, Software Requirement Specification Approval Process, Software Requirement Specification Activity Diagram and Software Requirement Specification Development Procedure. The proposed best practices is developed using the mutation and the mapping process between defined Requirement Engineering Process, Software Project Success Factor and Requirement Engineering Critical Issues which were explained in Requirement Engineering Best Practices Framework. This guideline also aligns with the ICT standard. The Requirement Engineering Best Practices had been tested with a pilot test by selected IT Managers and the actual survey had been randomly distributed to IT Manager in Malaysian Public Sector. Furthermore, the guideline had been refined by ICT experts using Delphi techniques. The proposed guideline fulfilled the criteria: completeness, sufficiency, reliability and acceptance. This compliance was validated by selected ICT experts who have different backgrounds and experiences. The proposed guideline will guide IT Managers in implementing the requirement gathering process and will also improve the Software Requirement Specification Process.

ABSTRAK

Pelbagai piawaian ICT dibangunkan sebagai panduan kepada Pengurus IT, namun begitu Sektor Awam Malaysia juga merasakan masih ada keperluan untuk membangunkan dasar yang bersesuaian bagi mereka. Keperluan kepada Amalan Terbaik Kejuruteraan Perisian bagi Pengurus IT adalah untuk menghasilkan Spesifikasi Keperluan Perisian yang bersesuaian. Amalan Terbaik Kejuruteraan Perisian dicadangkan sebagai satu piawaian bagi Sektor Awam Malaysia. Keperluan piawaian ini adalah untuk menyelesaikan kerumitan yang dikenal pasti semasa pembangunan projek perisian. Kompleksnya model Kejuruteraan Keperluan dan Standard sedia ada, sama ada ianya terlalu khusus atau terlalu umum. Model ini tidak dapat memenuhi keperluan Sektor Awam dan Pengurus IT. Ini mengakibatkan pelaksanaan dilakukan tanpa menggunakan model Kejuruteraan Keperluan dan Standard. Kerumitan proses kelulusan perisian juga diakibatkan oleh beberapa jawatankuasa yang diwujudkan oleh Sektor Awam Malaysia bagi memantau pelaksanaan projek perisian. Ini termasuk juga beberapa peraturan dan polisi. Peraturan dan dasar yang telah disediakan oleh pelbagai agensi yang berbeza dan ianya kompleks untuk difahami oleh Pengurus IT. Projek perisian yang dicadangkan perlu juga melalui beberapa tahap kelulusan projek perisian. Proses ini berulang-ulang dan amat mengambil masa. Kerumitan ini diatasi dengan cadangan Keperluan Amalan Terbaik Kejuruteraan Garis Panduan. Pembangunan Kejuruteraan Keperluan Garis Panduan Amalan Terbaik dilaksanakan berasaskan Keperluan Rangka Kerja Penyelidikan Garis Panduan Kejuruteraan Amalan Terbaik. Rangka kerja ini menggunakan kaedah campuran. Teknik kualitatif digunakan untuk temuduga, penghalusan dan pengesahan manakala teknik kuantitatif digunakan untuk soal selidik. Sasaran responden bagi kajian ini ialah Pengurus IT di dalam Sektor Awam Malaysia. Garis panduan ini juga terdiri daripada pemprosesan spesifikasi keperluan yang dikenal pasti: Proses Kelulusan Perisian Projek, Proses Kelulusan Perisian Spesifikasi Keperluan, Rajah Aktiviti Keperluan Perisian Spesifikasi dan Prosedur Pembangunan Spesifikasi Keperluan Perisian. Amalan terbaik ini dibangunkan menggunakan kaedah mutasi dan pemetaan, di antara Keperluan Kejuruteraan Pemprosesan, Perisian Projek Kejayaan Faktor dan Keperluan Kejuruteraan Isu-isu Kritikal yang menjelaskan dalam Rangka Kerja Keperluan Kejuruteraan Amalan Terbaik. Garis panduan ini juga diselaraskan dengan piawaian ICT. Keperluan Amalan Kejuruteraan Terbaik telah diuji ke atas Pengurus IT yang terpilih dan kajian sebenar telah diedarkan secara rawak kepada Pengurus IT di Sektor Awam Malaysia. Seterusnya, garis panduan itu telah dihalusi oleh pakar ICT menggunakan teknik Delphi. Pematuhan garis panduan yang dicadangkan memenuhi kriteria: kesempurnaan, mencukupi, boleh dipercayai dan boleh diterima. Pematuhan ini telah disahkan oleh pakar ICT yang terpilih berdasarkan latar belakang dan pengalaman yang berbeza. Garis panduan yang dicadangkan akan membantu Pengurus IT dalam melaksanakan proses pengumpulan keperluan.

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LIST OF ABBREVIATIONS AND TERMINOLOGY

ICTSC	-	Information Communication Technology Steering Committee
ICTSP	-	Information Communication Technology Strategic Planning
INTAN	-	National Institute of Public Administration
JTICT	-	Government IT and Internet Committee
JUSA	-	Jawatan Utama Sektor Awam
MPS	-	Malaysian Public Sector
PTM	-	Information Technology Officer (Pegawai Teknologi Maklumat)
RCMM	-	Requirement Capability Maturity Model
RCMMi	-	Requirement Capability Maturity Model improvement
RE	-	Requirement Engineering
REC	-	Requirement Engineering Capability
REP	-	Requirement Engineering Process
REP-MPS	-	Requirement Engineering Process for Malaysian Public Sector
RES	-	Requirement Engineering Standard
RET	-	Requirement Engineering Technique
SDLC	-	Software Development Life Cycle
SPD	-	Software Project Development
SPI	-	Software Process Improvement
SRS	-	Software Requirement Specification
SWOT	-	Strength Weakness Opportunity Threat

SPAP	-	Software Project Approval Process (SPAP) is a set of processes that are required to get an approval from the management to implement software projects proposed from an organisation or agency.
SRSPF	-	SRS Process Flow (SRSPF) is a set of processes for developing SRS for software projects that have been approved in SPAP. SRS have to endorse by the Committee.
SRSEP	-	SRS Evaluation Process (SRSEP) is a component in SRSPF
SRSAP	-	SRS Acceptance Process (SRSAP) is updated from SRSEP and replace with the SRSPF.
SPIs	-	Software Project Issues (SPIs) are a group of issues that always appear during requirement gathering and faced by IT Manager. These issues were classed as SPSF.
SPC	-	Software Project Components (SPC) is component that related to the development of software projects. The determined SPC is people, process and technology.
SPSF	-	Software Project Success Factor (SPSF) contains of SPC that involved in every of SPD. The successor of a software project depends on how we manage the SPC.
SRSAD	-	SRS Activity Diagram (SRSAD) is a roles been implemented in SRSDP by key IT Personnel or related people appointed by the management for the requirement gathering.
SRSDP	-	SRS Development Procedure (SRSDP) contains of steps should follow by the key IT Personnel in order to develop the SRS. SRSDP is part of SRSPF.
RECI	-	Requirement Engineering Critical Issues (RECI) are issues related with the SPSF and REP-MPS
REP-MPS	-	The redefined REP for Malaysian Public Sector consist of Management, Elicitation, Analysis and Negotiation, Verification and Validation, and Documentation

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

The aim of the research is to create Requirement Engineering Best Practices Guideline for Malaysian Public Sector. The research gap found there is complexity during software project development. The complexity are in implementing Requirement Engineering in Malaysia Public Sector, complexity of the implemented Requirement Process and complexity of applying the Requirement Engineering model/framework/standard in Malaysian Public Sector. The problem statement has no standardization in implementing requirement engineering in Malaysian Public Sector. This research implementation is based on the research question and is to achieve the objective based on the research objective within the scope that has been defined. The significance of the research defined should align with the research contribution.

1.2 Motivation

The aim of the research is to create Requirement Engineering Best Practices Guideline as a guideline for software requirement specification for software projects.

In the development phase, the developer should refer to software requirement specification, as it is the required documentation. They can plan the user's expectation, further requirement design, do the validation of the system and meet the

original needs of the user (Saiedian & Dale, 2000). The software requirement specification is referred if there are any changes needed to update during the testing phase. Ideally, the software requirement specification is referred as a documentation checklist at the end of the software development project. The developers help a well-written software requirement specification. Software Engineering offers the structured stage in the development process. The specific field is requirement engineering which is needed in software development process. Requirement Engineering is a branch of Software Engineering concerned with the real-world goals to and constraint on software systems (Wan *et al.*, 2010). The use of Requirement Engineering Process structured the IT Personnel working style. Requirement Engineering is well established as a part of system engineering and it is also part of a feasibility study in the System Development Life Cycle.

The Requirement Engineering Process is a very complex process and requires an understanding of the stakeholders to select the right requirements. It is an ideal starting point for the software project development which can improve the decision making and its outcomes (Aurum & Wohlin, 2005). The Requirement Engineering Process, as a guideline, organized the IT Personnel task. Nevertheless, the guideline should be simple and easily understood by the reader. Its alignment with the goals of Requirement Engineering Process includes understanding the stakeholders, refining into requirements, resolving the requirements' conflicts, the requirement explanations must meet the requirements of stakeholders, and act as a foundation for system design and implementation (Castro *et al.*, 2003). In addition, the IT Personnel need the Requirement Engineering Process Activity to improve their current practice. Requirement Engineering is a continuous activity to help IT Personnel establish the Requirement Engineering Process. The Requirement Engineering Process Activity is developed based on the relationship of Requirement Engineering Process. The actor should play these activities with most appropriate Requirement Engineering techniques.

1.3 Background of the Problem

Software projects involve very high cost, but provide a good investment for high-growth industries in many countries. They also involve a costly element in improving the capability of government to serve the people (Tessler, Barr, & Hanna, 2003). The government ICT services usually are criticised, especially the counter service as poor in quality (Muhammad Rais, 1995). The quality of service delivery gave the positive impact to the public perceptions. Nowadays, the Malaysian Government combined the services in software project development as a one stop portal in improving the services. Data is the basis of a live electronic government application. Good and secure data indicate the security level of the application (Omar & Mohd. Yusof, 2006).

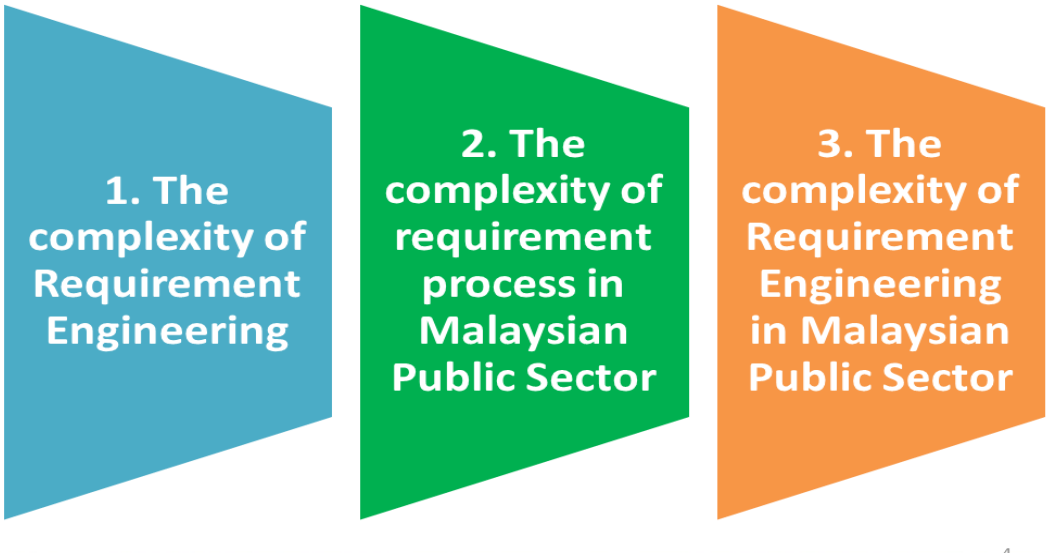

Figure 1.1 The complexity of Requirement Engineering Process in Malaysian Public Sector

The quality of software project depends of the user satisfaction. It is important to fulfil the user's satisfaction of any system with the basic requirement, there are no bugs in the systems, the consistency of the user interface, ease of use, response rates in interactive systems, coding and documentation (Omar & Mohd. Yusof, 2006). Failure to meet the users' satisfaction is the cause of the poor

communication amongst developers, stakeholders and managers (Charette, 2005). Badly defined system requirements of immature technology will give impact to the level of accessibility and availability of system application. Information will not be accurate caused by poor project managements, inability to handle the project's complexity, poor reporting of the project's status, unmanaged risks, and inaccurate estimates of needed resources (Charette, 2005).

Issues that are often overlooked is the complexity of the processes involved during the development of a software project. A proposed software project must undergo several stages of approval. In addition, it must refer to some guideline has been provided both in terms of requirements for business and ICT. The complexity has been classed into three groups as shown in Figure 1.1.

1.3.1. The complexity of Requirement Engineering

Requirement Engineering is involved in the whole requirements approaches, tools and techniques and the implementation in the software development life cycle (Dorfman, 1977). Requirement Engineering introduced general model such as for management information system and specific model such as for small medium enterprise as explained in Chapter 2-Requirement Engineering Best Practices Framework. These models are created based on certain issues or target groups. The implementation of Requirement Engineering Process in Requirement Engineering model must also depends on the understanding of researcher as explained in Chapter 2-Analysis of Requirement Engineering Process Model. The connection between the activities is also not clearly defined. The actors implement these activities also based on the Requirement Engineering Process that have been selected for their model. The difficulty of understanding the Requirement Engineering Process will lead to the actor performing the activity based on his or her experiences rather than following the stated role. Some of the implementation is based on a combination of researchers' ideas. The related Requirement Engineering standards such as ISO/IEC 122007 focus on software life cycle process, while RCMMi implemented in small medium enterprise for Malaysia as shown in Chapter 2-The differentiation between

RCMM with RCMMi. Constraints of personnel in understanding the standards made the implementation to be in an inappropriate way, and most of the outsourcing project implements the method that was proposed by the vendor consultant.

The developer is the most important personnel that must understand the Requirement Engineering Process. The requirement should define and determine the generic and specific requirement. Both requirements have their own goals to achieve in making the software project a success. A good requirement will decrease the degree of failure of software projects. However, sometimes the software project fails because of an uncompleted requirement process, no controlling of requirement changes and monitoring system design. The changes of requirement influence the changes of the business process, changes of ICT infrastructure, and cause the business process to reorganise, restructure, and react on new opportunities for improvement. The requirement is more complex and complicated especially for the large application system. The developer will need to struggle and understand the stakeholder's needs. While, the stakeholders continue gaining new insights into the problem, it will somehow lead to changes in the requirements. This problem, requirements gathering, should be resolved through the use of the guideline.

1.3.2. The complexity of requirement process in Malaysian Public Sector

This research clarified the problem based on Software Project Development scenario in the Malaysian Public Sector. The decision in implementing a Software Project Development is usually from the manager, as the decision maker. It started with a concept paper, where the idea of the software project presented among the team. The Management will appoint a consultant on behalf of the Malaysian Government to do research on the importance and the needs of the software project. The consultant will produce a "Blue Print" as a guideline during the implementation of the project. The research on process improvement will be done by the selected vendor or by the developer. Then, the consultant should assess the current situation and the particular procedure and come out with a new idea in improving the current process. This is the most crucial part where the changes of the process improvement

will affect the changes of policy of the business process. The proposed concept paper will be presented to the committees involve in ICT Steering Committee and Government IT and Internet Committee.

The proposed concept paper should align with the e-Governance. The governing organization also should align with ICT regulation or standard. The IT Personnel is responsible to ensure the conformity and accountability of the rules. Currently, the problem is lacking the appropriate guidance and support in managing within the relevant information systems. This study shows that, there is little support to manage the requirements and their relationships to various policies and regulations (Breaux, Antón, & Spafford, 2006).

The proposed software project should be advised by the IT Department and align with the role and responsibility of the IT Department such as Data Center, Network and Security. Then, the proposed papers have to get the approval from ICT Steering Committee in the organization, followed by ICT Steering Committee ministry, and finally by the Government IT and Internet Committee which is chaired by MAMPU. This process will take about three months without correction, and sometimes will go beyond six months as shown in Chapter 6–Software Project Approval Process. Besides that, the team has to follow the schedule plan of the committee, which sometimes affects the implementation schedule plan. This situation shows the complex role of the committee that should be facing by the IT Personnel. IT Personnel not only should have the technical knowledge and project management, but also need to have the soft skills in order to convince the committee. Otherwise, the proposed software project development is not important for the committee.

Several rules and guidance are being developed by organisation, ministry and treasury in order to ensure that the proposed software project development consider the management, organization and other beneficiary recipient as example in APPENDIX C. The proposed software project development should also follow and meet the international standard to ensure software project development is recognized and reliable. The government ICT framework, which is too general, also binds the

software project development and the agencies have different understanding or just use their assumption. Sometimes the vendor proposes a methodology, which needs involvements from other parties such as consultants during the implementation. The proposed methodology needs to be customised by the personnel that really have experience and supported by the training which usually is not included in the earlier plan. Otherwise, it will raise other issues such as rescheduling the implementation phase or extending the schedule planned.

1.3.3. The complexity of Requirement Engineering in Malaysian Public Sector

The Software Project Development involves many disciplines, this research identifies issues happened during the implementation of some of the Software Project Development in the Public Sector as shown in Chapter 2-Identification of Software Project Issues for ICT Project. The purpose is to ensure the problem early at the requirement gathering stage. These issues are grouped as Software Project Success Factor. Every factor is dependent on each other and the main factor is the business process. Business process directly relates to the stakeholder and the developer and finally, compacted into three main components, people, process and technology.

This research determines the complex role of the actor in between the requirement engineering process as shown in Chapter 2 - The relationship between the defined Requirement Engineering Process. Due to the constraints of people and skills, most of the software project development is outsourced. The complex role will make the conflict of task, communication and understanding between Government Project Team and Vendor Project Team. The roles of Project Director from the vendor are more difficult and messy because he has to manage different projects, which have different views, needs, goals, and objectives. Some of the issues cannot be managed urgently such as commercial issues because they involve the management's decision. A part of their task is given to the Project Manager.

The failure of Project Managers to play their roles and responsibilities give serious impacts to the schedule and deliverables of the software project

implementation. As mentioned earlier, the personnel involved in software project should have experience in software project management. Lack of the soft skills, knowledge, expertise, and decision making give impact to the software project implementation, and the capability of Project Manager will be questioned. Project Manager often lacks visibility of the project team and resources, shares team members with the other projects, depends on the third party, uses incompetent principles to resolve the issues and is not serious in meeting the project objectives.

1.3.4. Gap Analysis for the Complexity

The involvement of several committees, rules and guidelines, and the methodology in software project development raises critical issues such as constraints in applying and aligning the rules and guidelines, changes in the requirement, facilitation of ICT infrastructure, identification and understanding of needs, and decision making. Figure 1.2 shows the research gap that has been defined in Malaysian Public Sector. The gap defined is based on current Requirement Engineering Model/Practice/Standard and Current Requirement Engineering Practice in Malaysian Public Sector. The research gap is divided into three components; Requirement Engineering Model, software process and Requirement Engineering Standard.

Currently, there are many Requirement Engineering Models that have been introduced or developed. The problem is how to evaluate the best Requirement Engineering Model and which is appropriate for the software project. The owner of the software project lets the vendor proposes the appropriate Requirement Engineering Model as the solution. The impact of this solution, the developer too, depends on the vendor when applying the model, even after the software project commissioning. This working culture continues to the next software project

.Requirement Engineering also produces software process in order to guide the developer in ensuring the software project meets the software quality criteria. Again, the department should have an expert during the implementation of the

software process. The Malaysian Public Sector created several committees to review the proposed ICT project requirements before giving the approval. The role of these committees is either to evaluate the proposed software projects that have been approved or suggest some modification should be done to meet the organisation's objectives. The committee members are appointed based on their experience and expertise. The issue is to manage the ideas into one concrete solution.

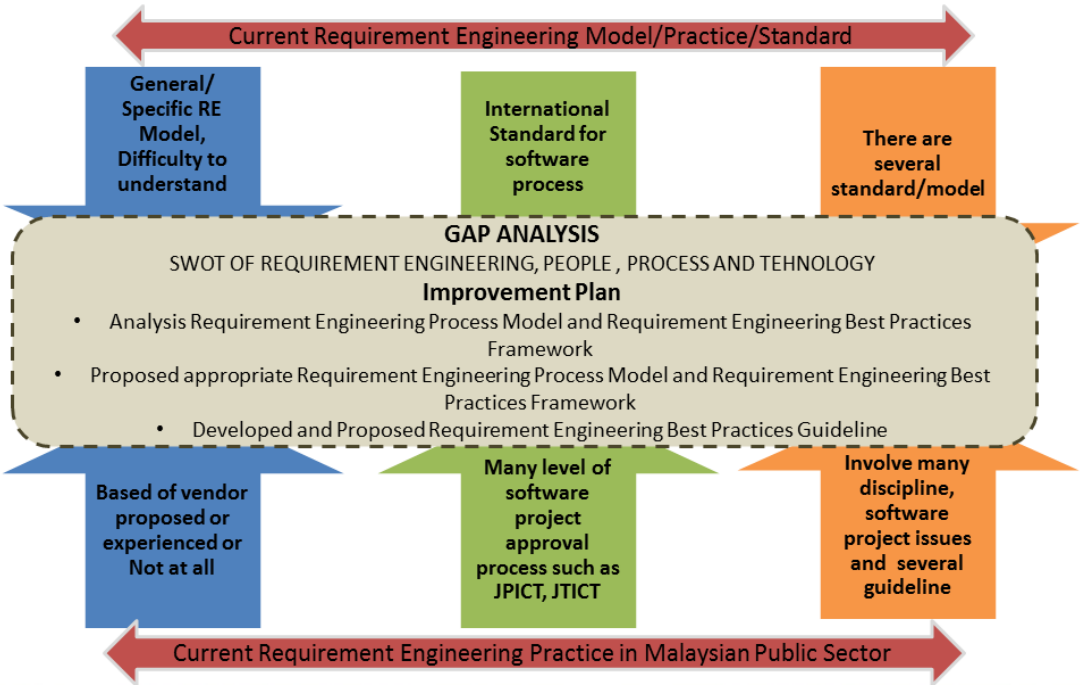

Figure 1.2 Research Gap

Requirement Engineering also developed several standard or guidelines to help the developer in selecting the right requirement. Most of the guidelines are based on special issues or certain situations. Some changes are made to adapt to the organization's objectives. Malaysian Public Sector consists of many levels of management such as ministry, department and agency which all have their own core business, customers and stakeholders. Therefore, they have different issues and problems to solve. The guidelines that have been developed cannot meet the (requirements/suggestions) of the ministry, department and agency.

The gap analysis also shows the weaknesses of people, process and technology as presented in Chapter 2-Gap Analysis of People, Process and Technology.

Table 1.1: SWOT of Requirement Engineering, People, Process and Technology

	REQUIREMENT ENGINEERING	PEOPLE	PROCESS	TECHNOLOGY
STRENGTH	▪ Need of the systems ▪ Improving the current process	▪ Training Program ▪ Business Process	▪ Circular ▪ Framework ▪ Service Delivery ▪ e-Government ▪ Expert ▪ MAMPU	▪ Application systems ▪ Workflow and Procedure ▪ Knowledge Capital
WEAKNESS	▪ Lack of RE knowledge ▪ Lack of REP element ▪ Lack of implementation of international standard ▪ Difficulty to adopt a model of RE ▪ Less exposure to RE technique	▪ Technical Skill ▪ Business Skill ▪ Movement of people	▪ Change Management ▪ Vision and Mission ▪ R&D ▪ Awareness	▪ RE ▪ REP ▪ Maturity Standard ▪ RE Maturity ▪ ICT Infrastructure
OPPORTUNITY	▪ Model/technique of RE ▪ Literature from Journal	▪ Local Training ▪ Attachment Program ▪ Certification ▪ Abroad Training	▪ Innovation ▪ Competition	▪ Guideline ▪ R & D ▪ Consultation
THREAT	▪ Type of the self-system application	▪ Management ▪ Security	▪ Restructure ▪ Rebranding ▪ Different	▪ Tools ▪ Techniques ▪ Methods

1.4 Statement of the Problem

Generally, Requirement Engineering is implemented in the Malaysian Public Sector. The implementation of Requirement Engineering in organisations is different from the Malaysian Public Sector, even though in the same section. This situation happens because of the constraints that will be discussed in Chapter 2.The project team has to depend on the method proposed by the vendor.

The software project development in Malaysian Public Sector involves several committees. The software project development should have the approval from the IT Department, followed by ICT Steering Committee Organisation and Ministry. Some of the software project development has to go through the

Government IT and Internet Committee. And, most importantly, Software Project Development has to be approved in the Cabinet Meeting.

The current standard that has been developed for the Malaysian Public Sector or International Standard cannot be adapted directly to the software project development. A lot of tailoring or customisations have to done to the standard. This process needs expert personnel that understand the standard or method. The International Standard such as RCMMi developed for the SME, ISO/IEC 122007 focuses on software life cycle process.

The Malaysian Public Sector needs a standard regulatory guideline for IT Personnel in order to guide them in the software project development approval process, followed by the activity after getting the software project development approval, and the development of the software requirement specification. The proposed guideline is to ensure that the technical specification proposed for acceptance is aligned with the Public Sector ICT's Vision.

1.5 Research Question

Our research study is based on the following research question:

i. What are the activities involved in determining requirements of software project development? The researcher lists the related activities based on literature and fieldwork.
ii. What is the most appropriate guideline for software project development in the Malaysian Public Sector? The researcher makes a comparison of requirement engineering process model, standard and requirement engineering practice framework.
iii. How to evaluate the proposed Requirement Engineering Best Practices for the appropriate Software Project development in the Malaysian Public Sector? The researcher had done the evaluation and validation for the proposed Requirement Engineering Best Practices Guideline with experts.

1.6 Objectives of the Research

The research objective was determined based on the problem statement as follows:

i. To evaluate the current practices of requirements for software project development;
ii. To develop the Requirements Engineering Best Practices as an appropriate guideline in developing software projects in the Public Sector; and
iii. To evaluate the proposed Requirement Engineering Best Practices for requirements using Software Project Development in the Public Sector as case study.

1.7 Scope of the Research

The following statement covers the scope of this research:

i. Business: Focuses on related ICT fields for the software project that is implemented in Malaysia's Public Sector. The respondents will be selected among software practitioners (Pegawai Teknologi Maklumat, Level F48 and above) in Malaysian Public Sector;
ii. Sandard: This research is based on several standards namely Requirement Engineering Process, Requirement Engineering Standard and Requirement Engineering Capability.

1.8 Significance of Research

The significances of the study are as follows:

i. Gap Analysis: Analysis of Requirement Engineering Practices implement by the IT Managers during the requirement gathering. Analysis includes the determination of methodology and standard that is usually referred by the IT Manager. In making it reliable to the organisation, the analysis should involve SWOT analysis of people, process and technology. The software project issues are a part of the requirements in this research.

ii. Requirement Process: There are several processes involved during the acceptance of Software Requirement Specification. The proposed Software Requirement Specification is gathered by the Project Team, managed by Project Manager, and lead by the Project Director. And, this process is controlled by the ICT steering committee and management of the organisation.

iii. A proposed guideline for software requirement specification: This research proposesa guideline for software requirement specification which is Requirement Engineering Best Practices Guideline in the Malaysian Public Sector. This Requirement Engineering Best Practices Guideline must be understood by IT Personnel and can be implemented in requirement gathering. A model/method/tools and technique that is suitable in this research.

1.9 Thesis Organisation

This thesis is organised into seven chapters as detailed below:

i. Chapter 1 Introduction. This chapter compresses the whole content of the thesis. The introduction of Requirement Engineering, background of the problem, statement of the problem, research question, research objectives,

scope of the research, significance of the research, and finally, thesis organisation.

ii. Chapter 2 Literature Review. This chapter elaborates the literature of Requirement Engineering, the related issues to Requirement Engineering such as a Requirement Engineering Process, Requirement Engineering Techniques Requirement Engineering Standard, and Requirement Engineering Capability. This chapter also describes the Malaysian Public Sector, the Requirement Engineering in the Malaysian Public Sector and the comparison Requirement Engineering Best Practices Framework in the Public Sector.

iii. Chapter 3 Research Methodology. This chapter describes the methodological aspects of the research for the development of Requirement Engineering Best Practice Guideline, a process flow of Requirement Engineering Best Practices Guideline. This chapter also presents how we conduct the research study for Requirement Engineering Best Practices Guideline based on the Requirement Engineering Best Practices Guideline research framework, and describes the research procedure.

iv. Chapter 4 The development of Requirement Engineering Best Practices. This chapter starts the deriving of Requirement Engineering Best Practices, the mapping process of the Software Project Success Factor, Requirement Engineering Process Model and Requirement Engineering Critical Issues. The reviewed and redesigned Requirement Engineering Best Practices and also presents the summary of the practices based on the Requirement Engineering Process.

v. Chapter 5 The development of Requirement Engineering Best Practices Guideline. This chapter explains the development and provides results of Requirement Engineering Best Practices Guideline. The Requirement Engineering Best Practices Guideline consists of the Requirement Process and Requirement Engineering Best Practices. The Requirement Process is Software Project Approval Process, Software Requirement Specification Acceptance Process, Software Requirement Specification Development

Procedure and Software Requirement Specification Activity Diagram. This chapter also describes the reliability of Requirement Engineering Practices.

vi. Chapter 6 Refinement and Validation of Requirement Engineering Best Practices Guideline. This chapter explains the refining and validating of Requirement Engineering Best Practices Guideline. This chapter provides results of the proposed Requirement Engineering Best Practices Guideline, which is done through the Expert Review Process.

vii. Chapter 7 Discussion and Conclusion. This chapter discusses the journey of the research with the summarization diagram, research objective and the achievement, discussion on research contribution. Finally, this chapter also presents the limitation and future work.

1.10 Summary

This chapter focuses on the background of the problem, problem statement of the research, research question as guidance to this research, research objective that this research should achieve, the research boundaries, the significance of the research, and how the research is organised.

REFERENCES

Abd Manan, A., & Mohd Yusoff, M. S. (2006, October 1). E- Learning for the Malaysian Public Sector. National Institute of Public Administration (INTAN) Malaysia.

Abd Rashid Zaharah. (2006). E-Perolehan- A Breakthrough for E-Commerce in the Malaysian Government. *Public Sector ICT Management Review*, *Vol.1 No.1*(Implementation of Electronic Government (EG) Project).

Alawneh, L., Debbabi, M., Hassaine, F., Jarraya, Y., & Soeanu, A. (2006). A unified approach for verification and validation of systems and software engineering models. In *Engineering of Computer Based Systems, 2006. ECBS 2006. 13th Annual IEEE International Symposium and Workshop on* (pp. 10–418).

Altendorfer, S., Aschauer, T., Dauenhauer, G., & Pree, W. (2010). Alignment: a new software architecture approach to support streamlining business processes.

Antón, A. I., Earp, J. B., Potts, C., & Alspaugh, T. A. (2001). The role of policy and stakeholder privacy values in requirements engineering. In *Proc. Fifth IEEE Int. Symposium on Requirements Engineering* (pp. 138–145).

Aurum, A., & Wohlin, C. (2005). Aligning requirements with business objectives: A framework for requirements engineering decisions. In *Proceedings of Requirements Engineering Decision Support Workshop*.

Azevedo, L. G., Santoro, F., Baião, F., Souza, J., Revoredo, K., Pereira, V., & Herlain, I. (2009). A method for service identification from business process models in a SOA approach. *Enterprise, Business-Process and Information Systems Modeling*, 99–112.

Banica, L., Rosca, D., & Stefan, C. (2009). A software for project management process. *Munich Personal RePEc Archive (MPRA)*, Paper No. 15237.

Bannerman, P., & Zhu, L. (2009). Standardization as a business ecosystem enabler. In *Service-Oriented Computing–ICSOC 2008 Workshops* (pp. 298–303).

Barney, S., Aurum, A., & Wohlin, C. (2006). Quest for a silver bullet: Creating software product value through requirements selection. In *Software Engineering and Advanced Applications, 2006. SEAA'06. 32nd EUROMICRO Conference on* (pp. 274–281).

Barney, S., Aurum, A., & Wohlin, C. (2008). A product management challenge: Creating software product value through requirements selection. *Journal of Systems Architecture*, *54*(6), 576–593.

Barreto, A., Barros, M. O., & Werner, C. M. L. (2008). Staffing a software project: A constraint satisfaction and optimization-based approach. *Computers & Operations Research*, *35*(10), 3073–3089.

Beecham, S., Hall, T., Britton, C., Cottee, M., & Rainer, A. (2005). Using an expert panel to validate a requirements process improvement model. *The Journal of Systems & Software*, *76*(3), 251–275.

Beecham, S., Hall, T., & Rainer, A. (2003). Assessing Requirements Process Strengths and Weaknesses: A first step to prioritising requirements process implementation.

Beecham, S., Hall, T., & Rainer, A. (2005). Defining a requirements process improvement model. *Software Quality Journal*, *13*(3), 247–279.

Bhat, J. M., Mayank Gupta, & Murthy, S. N. (2006). Overcoming Requirements Engineering Challenges: Lessons from Offshore Outsourcing. *Software, IEEE*, *23*(5), 38–44.

Bieger, A., Borges, G., Kranz, S., McGowan, C., Meehan, K., Mancuso, L. G., … de Macedo Guimaraes, L. B. (2009). Increasing the efficiency of a Brazilian Emergency response Call Center. In *Systems and Information Engineering Design Symposium, 2009. SIEDS'09.* (pp. 125–130).

Bjarnason, E., Wnuk, K., & Regnell, B. (2011). Requirements are slipping through the gaps—A case study on causes & effects of communication gaps in large-scale software development. In *Requirements Engineering Conference (RE), 2011 19th IEEE International* (pp. 37–46).

Bleistein, S. J., Cox, K., Verner, J., & Phalp, K. T. (2006). B-SCP: A requirements analysis framework for validating strategic alignment of organizational IT based on strategy, context, and process. *Information and Software Technology*, *48*(9), 846–868.

Boehm, B. W. (2009). Software engineering economics. *Software Engineering, IEEE Transactions on*, (1), 4–21.

Breaux, T. D., Antón, A. I., & Spafford, E. H. (2006). A distributed requirements management framework for compliance and accountability. *North Carolina State University Computer Science Technical Report TR-2006-14, Raleigh, NC*.

Britton, C., Jones, S., Myers, M., & Sharif, M. (1997). A survey of current practice in the development of multimedia systems. *Information and Software Technology*, *39*(10), 695–705.

Burgaud, L. (2006). A Novel development framework combining requirement driven and model based engineering processes. In *4ème Conférence Annuelle d'Ingénierie Système« Efficacité des entreprises et satisfaction des clients»*. *TOULOUSE* (pp. 2–4).

Castro, J., Pinto, R., Castor, A., & Mylopoulos, J. (2003). Requirements traceability in agent oriented development. *Lecture Notes in Computer Science*, 57–72.

Catanio, J. T. (2006). Requirements Analysis: A Review. *Advances in Systems, Computing Sciences and Software Engineering*, 411–418.

Cerpa, N., & Verner, J. M. (2009). Why did your project fail? *Communications of the ACM*, *52*(12), 130–134.

Chang, G. S., Perng, H. L., & Juang, J. N. (2008). A review of systems engineering standards and processes. *Journal of Biomechatronics Engineering*, *1*(1), 71–85.

Charette, R. N. (2005). Why software fails. *IEEE Spectrum*, *42*(9), 36.

Cheng, B. H. ., & Atlee, J. M. (2007). Research directions in requirements engineering. *Future of Software Engineering, 2007. FOSE'07*, 285–303.

Chua Yan Piaw. (2006). *Kaedah dan Statistik Penyelidikan : Kaedah Penyelidikan*. Mc Graw Hill.

Cleland-Huang, J. (2005). Software Requirements. *Software Engineering: The Development Process*, 113.

Cleland-Huang, J., Settimi, R., Zou, X., & Solc, P. (2006). The detection and classification of non-functional requirements with application to early aspects. *Proc. of RE*, 36–45.

Damian, D., & Zowghi, D. (2003). Requirements Engineering challenges in multi-site software development organizations. *Requirements Engineering*, *8*(3), 149–160.

Davey, B., & Cope, C. (2008). Requirements Elicitation- What's Missing? *Issues in Informing Science & Information Technology*, *5*, 543–551.

Decker, B., Ras, E., Rech, J., Jaubert, P., & Rieth, M. (2007). Wiki-based stakeholder participation in requirements engineering. *IEEE Software*, 28–35.

Delbecq, A. L., Van de Ven, A. H., & Gustafson, D. H. (1975). *Group techniques for program planning: A guide to nominal group and Delphi processes*. Scott, Foresman Glenview, IL.

De Lemos, R., Giese, H., Müller, H. A., Shaw, M., Andersson, J., Litoiu, M., others. (2013). Software engineering for self-adaptive systems: A second research roadmap. In *Software Engineering for Self-Adaptive Systems II* (pp. 1–32). Springer.

Dorfman, M. (1977). Requirements engineering. *Software Requirements*, 7–21.

Dutoit, A. H., McCall, R., Mistrik, I., Paech, B., & service), S. (Online. (2006). *Rationale Management in Software Engineering*. Springer.

Ebert, C. (2006). Understanding the product life cycle: Four key requirements engineering techniques. *Software, IEEE*, *23*(3), 19–25.

Ebert, C. (2007). The impacts of software product management. *Journal of Systems and Software*, *80*(6), 850–861.

E. Damian, D., & Zowghi, D. (2003). RE challenges in multi-site software development organisations. *Requirements Engineering*, *8*(3), 149–160.

Egorova, E., Torchiano, M., Morisio, M., Wohlin, C., Aurum, A., & Svensson, R. B. (2009). Stakeholders' Perception of Success: An Empirical Investigation. In *Software Engineering and Advanced Applications, 2009. SEAA'09. 35th Euromicro Conference on* (pp. 210–216).

El Emam, K., & Madhavji, N. H. (2005). A field study of requirements engineering practices in information systems development. In *Requirements Engineering, 1995., Proceedings of the Second IEEE International Symposium on* (pp. 68–80).

Elizabeth Hull, & Ken Jackson. (2005). *Requirement Engineering* (Second Edition.). Springer.

Estefan, J. A. (2007). Survey of model-based systems engineering (MBSE) methodologies. *Incose MBSE Focus Group*, *25*.

Fernandes, J. M., Braga, P., Machado, R. J., Guimaraes, P., & Seidman, S. B. (2009). A Requirements Engineering and Management Training Course for Software Development Professionals. In *Proceedings of the 2009 22nd Conference on Software Engineering Education and Training-Volume 00* (pp. 20–25).

Foorthuis, R. M., & Brinkkemper, S. (2008). Best Practices for Business and Systems Analysis in Projects Conforming to Enterprise Architecture. *Enterprise Modelling and Information Systems Architectures*, *3*(1), 36–47.

Fricker, S., Gorschek, T., & Myllyperki\ö, P. (2007). Handshaking between software projects and stakeholders using implementation proposals. *Requirements Engineering: Foundation for Software Quality*, 144–159.

Fuggetta, A. (2000). Software process: a roadmap. In *Proceedings of the Conference on the Future of Software Engineering* (pp. 25–34).

Glinz, M., & Wieringa, R. J. (2007). Guest Editor's Introduction: Stakeholders in Requirements Engineering. *IEEE SOFTWARE*, 18–20.

Gomes, C. F., Yasin, M. M., & Small, M. H. (2012). Discerning Interrelationships among the Knowledge, Competencies, and Roles of Project Managers in the Planning and Implementation of Public Sector Projects. *International Journal of Public Administration*, *35*(5), 315–328.

Gonzalez, P., White, J., & Christie, B. (2011). *Applying Systems Engineering Principles to the Development of Transportation Communication Standards*.

Gorschek, T., & Davis, A. M. (2008). Requirements engineering: In search of the dependent variables. *Information and Software Technology*, *50*(1-2), 67–75.

Gorschek, T., & Wohlin, C. (2006). Requirements abstraction model. *Requirements Engineering*, *11*(1), 79–101.

Gruenbacher, P., & Briggs, R. (2001). Surfacing tacit knowledge in requirements negotiation: Experiences using easy win win. In *Proceeding of the Annual Hawaii International Conferrence on System Sciences* (pp. 35–35).

Gruenbacher, P., & Briggs, R. (2001). Surfacing tacit knowledge in requirements

negotiation: Experiences using easy win win. In *Proceeding of the Annual Hawaii International Conferrence on System Sciences* (pp. 35–35).

Habich, D., Richly, S., Demuth, B., Gietl, F., Spilke, J., Lehner, W., & Assmann, U. (2010). Joining Business Rules and Business Processes. In *Proceedings of the 16th International Conference on Information and Software Technologies (IT 2010, April 21st-23rd, Kaunas, Lithuania)* (pp. 361–368).

Hall, T., Beecham, S., & Rainer, A. (2002). Requirements problems in twelve software companies: an empirical analysis. In *Software, IEE Proceedings* (Vol. 149, pp. 153–160).

Hoorn, J. F., Konijn, E. A., Van Vliet, H., & Van der Veer, G. (2005). Goal-oriented RE for handling change requirements: an explanation of what stakeholders try to avoid and what they try to achieve. In *Proceedings of the International Workshop on Requirements Engineering for Business Need and IT Alignment (REBNITA'05) in Conjunction with the Thirteenth IEEE Requirements Engineering Conference (RE'05)(Paris, France)*.

Huang, S.-J., & Han, W.-M. (2008). Exploring the relationship between software project duration and risk exposure: A cluster analysis. *Information & Management*, *45*(3), 175–182.

Hussain, S. J., Rashid, K., Ahmad, H. F., & Hussain, S. F. (2007). Effective software management: where do we falter? In *Proceedings of the 6th WSEAS International Conference on Software Engineering, Parallel and Distributed Systems* (pp. 13–18).

Jafarinezhad, O., & Ramsin, R. (2012). Development of Situational Requirements Engineering Processes: A Process Factory Approach. In *Computer Software and Applications Conference (COMPSAC), 2012 IEEE 36th Annual* (pp. 279–288). IEEE.

Jiang, J. J., Klein, G., Hwang, H. G., Huang, J., & Hung, S. Y. (2004). An exploration of the relationship between software development process maturity and project performance. *Information & Management*, *41*(3), 279–288.

Jiang, L., & Eberlein, A. (2007). Selecting Requirements Engineering Techniques Based on Project Attributes--A Case Study. In *Engineering of Computer-Based Systems, 2007. ECBS '07. 14th Annual IEEE International*

Conference and Workshops on the (pp. 269–278).

Jiang, L., Eberlein, A., & Far, B. H. (2005). Combining requirements engineering techniques - theory and case study. In *Engineering of Computer-Based Systems, 2005. ECBS '05. 12th IEEE International Conference and Workshops on the* (pp. 105–112). doi:10.1109/ECBS.2005.25

Jiang, L., Eberlein, A., Far, B. H., & Mousavi, M. (2008). A methodology for the selection of requirements engineering techniques. *Software and Systems Modeling*, *7*(3), 303–328.

Jonathan Sidi, & Syahrul Nizam Junaini. (2006). Credibility Review of the Malaysian States E-Government Web Sites. *Public Sector ICT Management Reviw, Vol. 1 No. 1*(Implementation of Electric Government (EG) Project).

Jureta, I., Mylopoulos, J., & Faulkner, S. (2008). Revisiting the core ontology and problem in requirements engineering. In *Proceedings of the 2008 16th IEEE International Requirements Engineering Conference* (pp. 71–80).

K\äk\öl\ä, T., & Taalas, A. (2008). Validating the Information Systems Design Theory for Dual Information Systems. In *Proceedings of the 29th International Conference on Information Systems, Paris*.

Kaliannan, M., & Awang, H. (2008). ICT to enhance administrative performance: a case study from Malaysia. *International Journal of Business and Management*, *3*(5), P78.

Kapočius, K., & Danikauskas, T. (2006). The use of business rules for the specification of dynamic aspects of IS. *Information Technology and Control, Kaunas: Technologija*, *35*(3A), 327–332.

Kapuruge, M., Han, J., & Colman, A. (2010). Support for business process flexibility in service compositions: An evaluative survey. In *21st Australian Software Engineering Conference* (pp. 97–106).

Karlsson, L., Dahlstedt, \AA. G, Regnell, B., Natt och Dag, J., & Persson, A. (2007). Requirements engineering challenges in market-driven software development-An interview study with practitioners. *Information and Software Technology*, *49*(6), 588–604

Karow, M., Pfeiffer, D., & R\äckers, M. (2008). Empirical-Based Construction of Reference Models in Public Administrations. In *Proceedings of the Multikonferenz Wirtschaftsinformatik* (pp. 1613–1624).

Karsai, G., Krahn, H., Pinkernell, C., Rumpe, B., Schindler, M., & Völkel, S. (2009). Design guidelines for domain specific languages. In *The 9th OOPSLA workshop on domain-specific modeling* (pp. 7–13).

Kauppinen, M., Aaltio, T., & Kujala, S. (2002). Lessons learned from applying the requirements engineering good practice guide for process improvement. *Software Quality—ECSQ 2002*, 73–81.

Kauppinen, M., Vartiainen, M., Kontio, J., Kujala, S., & Sulonen, R. (2004). Implementing requirements engineering processes throughout organizations: success factors and challenges. *Information and Software Technology*, *46*(14), 937–953.

Kuhn, T. S. (2012). *The structure of scientific revolutions*. University of Chicago press.

LaToza, T. D., Venolia, G., & DeLine, R. (2006). Maintaining mental models: a study of developer work habits. In *Proceedings of the 28th international conference on Software engineering* (pp. 492–501).

Lázaro, M., & Marcos, E. (2006). An approach to the integration of qualitative and quantitative research methods in software engineering research. In *2nd International Workshop on Philosophical Foundations of Information Systems Engineering (PHISE'06) LNCS. Springer-Verlag, Berlin*.

Lim, S. L., Quercia, D., & Finkelstein, A. (2010). StakeNet: using social networks to analyse the stakeholders of large-scale software projects. In *Software Engineering, 2010 ACM/IEEE 32nd International Conference on* (Vol. 1, pp. 295–304).

Liu, K., Valerdi, R., & Laplante, P. A. (2010). Better requirements decomposition guidelines can improve cost estimation of systems engineering and human systems integration 8th Annual Conference on Systems Engineering Research. *Hoboken, NJ*.

Liu, L. L. (2006). Software Maintenance and CMMI for Development: A Practitioner's Point of View. *Journal of Software Engineering*, *1*(2), 68–77.

Lochmann, K., & Goeb, A. (2011). A unifying model for software quality. In *Proceedings of the 8th international workshop on Software quality* (pp. 3–10).

Louis A. Poulin. (2006). A Comparative Analysis of Process Maturity Level and Quality. In *Electrical and Computer Engineering, 2006. CCECE '06. Canadian Conference on* (pp. 2401–2404).

Luna-Reyes, L. F., & Gil-García, J. R. (2011). Using institutional theory and dynamic simulation to understand complex e-government phenomena. *Government Information Quarterly*, *28*(3), 329–345.

Makolm, J. (2006). A Holistic Reference Framework for e-Government: The Practical Proof of a Scientific Concept. In *System Sciences, 2006. HICSS'06. Proceedings of the 39th Annual Hawaii International Conference on* (Vol. 4, p. 77a).

Maseri, W., & Mohd, W. (2006). Categorizing users in requirement engineering process: A case study in e-university project. In *Computing & Informatics, 2006. ICOCI '06. International Conference on* (pp. 1–6).

McConnell, S. (2009). *Software project survival guide*. Microsoft press. Retrieved from http://books.google.com.my/.

McEuen, S. F. (2001). How fluent with information technology are our students. *Educause Quarterly*, *24*(4), 8–17.

McPhee, C., & Eberlein, A. (2002). Requirements engineering for time-to-market projects. In *Proceedings of the 9 th Conference and Workshop on the Engineering of Computer-based Systems, ECBS, Sweden*.

Mishra, D., Mishra, A., & Yazici, A. (2008). Successful requirement elicitation by combining requirement engineering techniques. In *Applications of Digital Information and Web Technologies, 2008. ICADIWT 2008. First International Conference on the* (pp. 258–263).

Mohamed, N., Hussin, H., & Hussein, R. (2006). Enabling change factors and IT success in the Malaysian e-government implementation. In *Proceedings of the 10th Pacific-Asia Conference on Information Systems, Kuala Lumpur* (pp. 6–9).

Mohamed Othman Rosita, & Musa Nadianatra. (2007). E-Recruitment Practice : Pros vs Cons.

Momoh, J., & Ruhe, G. (2006). Release planning process improvement-an industrial case study. *Software Process Improvement and Practice*, *11*(3), 295–307.

Muhammad Rais, A. K. (1995). Improving the efficiency of the Public Sector: A case-study of Malaysia. *Department for Development Support and Management Services of the United Nations Secretariat*.

Mutschler, B., Reichert, M., & Bumiller, J. (2008). Unleashing the Effectiveness of Process-Oriented Information Systems: Problem Analysis, Critical Success Factors, and Implications. *IEEE Transactions on Systems, Man, and Cybernetics, Part C: Applications and Reviews*, *38*(3), 280–291.

Nadianatra Musa, & Syahrul Nizam Junaini. (2006). Success of E-Learning initiative in Sarawak. *Public Sector ICT Management Review, Vol 1 No 1*.

Nasir, M. H. N., & Sahibuddin, S. (2011). Critical success factors for software projects: A comparative study. *Scientific Research and Essays*, *6*(10), 2174–2186.

Niazi, M., Wilson, D., & Zowghi, D. (2005). A maturity model for the implementation of software process improvement: an empirical study. *Journal of Systems and Software*, *74*(2), 155–172.

Norshidah, M. (2008). Internal users' self-assesment of Malaysia E-Government flagship application in lead implementation agencies I. *Public Sector ICT Management Reviw, Vol 2 No 1*(Electronic Service Delivery), 13–21.

Nurmuliani, N., Zowghi, D., & Powell, S. (2005). Analysis of requirements volatility during software development life cycle. In *Software Engineering Conference, 2004. Proceedings. 2004 Australian* (pp. 28–37).

Nurmuliani, N., Zowghi, D., & Williams, S. P. (2006). Requirements volatility and its impact on change effort: Evidence-based research in software development projects. In *Proceedings of the Eleventh Australian Workshop on Requirements Engineering*.

Nuseibeh, B., & Easterbrook, S. (2000). Requirements engineering: a roadmap. In *Proceedings of the Conference on the Future of Software Engineering* (pp. 35–46).

Okot-Uma, R. W. ., & London, C. S. (2000). Electronic Governance: re-inventing good governance. *Commonwealth Secretariat, London*.

Oktaba, H., Garcia, F., Piattini, M., Ruiz, F., Pino, F. J., & Alquicira, C. (2007). Software process improvement: The Competisoft project. *Computer*, *40*(10), 21–28.

Olsson, T., Doerr, J., Koenig, T., & Ehresmann, M. (2005). A Flexible and Pragmatic Requirements Engineering Framework for SME.

Omar, M. A., & Mohd. Yusof Mokhtar. (2006). Pelaksanaan Projek Kerajaan Elecktronik (Electronic Government-EG) - S atu Penilaian, *Vol 1 No 1*.

Pacheco, C., & Garcia, I. (2008). Stakeholder Identification Methods in Software Requirements: Empirical Findings Derived from a Systematic Review. In *Software Engineering Advances, 2008. ICSEA '08. The Third International Conference on* (pp. 472–477).

Paech, B., Dorr, J., & Koehler, M. (2005). Improving requirements engineering communication in multiproject environments. *IEEE Software*, *22*(1), 40–47.

Paetsch, F., Eberlein, A., & Maurer, F. (2003). Requirements engineering and agile software development. In *Proceedings of the Twelfth International Workshop on Enabling Technologies: Infrastructure for Collaborative Enterprises* (p. 308).

Pandey, D., Suman, U., & Ramani, A. (2010). An Effective Requirement Engineering Process Model for Software Development and Requirements Management. In *Advances in Recent Technologies in Communication and Computing (ARTCom), 2010 International Conference on* (pp. 287–291).

Pandey, D., Suman, U., & Ramani, A. K. (2010). Performance Measurement of Different Requirements Engineering Process Models: A Case Study. *International Journal of Computer Engineering & Technology (IJCET)*, *1*(2), 1–15.

Pandey, U. S., & Ramani, A. K. (2009). Social-Organizational Participation difficulties in Requirement Engineering Process-A Study. In *National Conference on Emerging Trends in Software Engineering and Information Technology, Gwalior Engineering College, Gwalior*.

Panian, Z. (2009). User Requirements Engineering and Management in Software Development. In *Proceedings of the European Computing Conference* (pp. 609–620).

Pohl, K. (1994). The three dimensions of requirements engineering: a framework and its applications. *Information Systems*, *19*(3), 243–258.

Power, N., & Moynihan, T. (2003). A theory of requirements documentation situated in practice. In *Proceedings of the 21st annual international conference on Documentation* (pp. 86–92).

Prause, C. R., Scholten, M., Zimmermann, A., Reiners, R., & Eisenhauer, M. (2008). Managing the iterative requirements process in a multi-national project using an issue tracker. In *Global Software Engineering, 2008. ICGSE 2008. IEEE International Conference on* (pp. 151–159).

Rainer, A., & Hall, T. (2002). Key success factors for implementing software process improvement: a maturity-based analysis. *The Journal of Systems & Software*, *62*(2), 71–84.

Rao, T. P. . (2004). ICT and e-Governance for Rural Development. *Institute of Rural Management, Anand, Gujarat*.

Roger, A. E., Marcel, F. N., & Lopez, A. C. (2010). Business Process Requirement Engineering. *International Journal on Computer Science and Engineering*, *2*(9).

Ross, D. T., & Schoman Jr, K. E. (1977). Structured analysis for requirements definition. *Software Engineering, IEEE Transactions on*, (1), 6–15.

Sabaliauskaite, G., Loconsole, A., Engström, E., Unterkalmsteiner, M., Regnell, B., Runeson, P., Feldt, R. (2010). Challenges in aligning requirements engineering and verification in a large-scale industrial context. *Requirements Engineering: Foundation for Software Quality*, 128–142.

Sahni, D., Van den Bergh, J., & Coninx, K. (2010). CoFra: Towards structurally selecting ICT tools and methods in multidisciplinary distributed projects. In *Collaborative Technologies and Systems (CTS), 2010 International Symposium on* (pp. 188–197).

Saiedian, H., & Dale, R. (2000). Requirements engineering: making the connection between the software developer and customer. *Information and Software Technology*, *42*(6), 419–428.

Salimi, M., Hadjali, H. R., & Sorooshian, S. (2012). Critical success practices (CSP) toward implementing lean production among international companies in Malaysia. *African Journal of Business Management*, *6*(27), 8118–8125.

Scheller, R. M., Sturtevant, B. R., Gustafson, E. J., Ward, B. C., & Mladenoff, D. J. (2009). Increasing the reliability of ecological models using modern

software engineering techniques. *Frontiers in Ecology and the Environment*, *8*(5), 253–260.

Scholl, H. J. (2003). E-government: a special case of ICT-enabled business process change. In *36th Hawaiian International Conference on System Sciences, Waikoloa, Big Island, HI*.

Shrivastava, A., Darbari, M., Yagyasen, D., & Singh, V. (2009). An Efficient Evaluation of Requirements Engineering Maturity Measurement Framework For Medium and Small Scale Software Companies. *Proceedings of the 3rd National Conference; INDIACom-2009 Computing For Nation Development, February 26 – 27, 2009 Bharati Vidyapeeth's Institute of Co Mputer Applications and Management, Ne W Delh I*, 26–27.

Sobczak, A., & Berry, D. M. (2007). Distributed priority ranking of strategic preliminary requirements for management information systems in economic organizations. *Information and Software Technology*, *49*(9-10), 960–984.

Solemon, B., Sahibuddin, S., & Ghani, A. A. (2007). Requirements Enggineering Process : A Review and Research Agenda. *MySEC '07. The 3rd Malaysian Software Engineering Conference*, (Striving for High Quality Software), 1–5.

Solemon, B., Sahibuddin, S., & Ghani, A. A. (2008). An Exploratory Study of Requirements Engineering Practice in Malaysia. *MySEC '08. The 4th Malaysian Software Enggineering Conference 2008*, (Empowering Software towards the Development of Human Capital), 142–146.

Solemon, B., Shahibuddin, S., & Ghani, A. A. (2009). Re-defining the Requirements Engineering Process Improvement Model. In *Proceedings of the 2009 16th Asia-Pacific Software Engineering Conference* (pp. 87–92).

Sommerville, I. (2005). Integrated requirements engineering: a tutorial. *IEEE Software*, *22*(1), 16–23.

Sommerville, I., Sawyer, P., & Viller, S. (1998). Viewpoints for requirements elicitation: a practical approach. In *Requirements Engineering, 1998. Proceedings. 1998 Third International Conference on* (pp. 74–81).

Suresh Babu, G. (2011). Increasing Success of Software Projects through Minimizing Risks. *International Journal of Research and Reviews in Software Engineering (IJRRSE)*, *1*(1).

Tang, M. J., & Zhu, Q. (2012). Towards Quantitative Assessment Model for Software Process Improvement in Small Organization. *Information Technology Journal*, *11*(1), 49–57.

Tessler, S., Barr, A., & Hanna, N. (2003). National software industry development: Considerations for government planners. *EJISDC*, *13*(10), 1–17.

Thayer, R. H. (2002). Software system engineering: A tutorial. *Computer*, *35*(3), 68–73.

Ur Rehman, T., Khan, M. N. A., & Riaz, N. (2013). Analysis of Requirement Engineering Processes, Tools/Techniques and Methodologies. *International Journal of Information Technology and Computer Science (IJITCS)*, *5*(3), 40.

Van Eijndhoven, T., Iacob, M.-E., & Ponisio, M. L. (2008). Achieving business process flexibility with business rules. In *Enterprise Distributed Object Computing Conference, 2008. EDOC'08. 12th International IEEE* (pp. 95–104).

Van Lamsweerde, A. (2005). Goal-oriented requirements enginering: a roundtrip from research to practice [enginering read engineering]. In *Requirements Engineering Conference, 2004. Proceedings. 12th IEEE International* (pp. 4–7).

Wan, J., Zhang, H., Wan, D., & Huang, D. (2010). Research on Knowledge Creation in Software Requirement Development. *Journal of Software Engineering and Applications*, *3*(5), 487–494.

Wheeldon, J. (2010). Mapping mixed methods research: Methods, measures, and meaning. *Journal of Mixed Methods Research*, *4*(2), 87–102.

Whitehead, J. (2007). Collaboration in software engineering: A roadmap. In *2007 Future of Software Engineering* (pp. 214–225).

Wiegers, K. E. (2000). When Telepathy Won't Do: Requirements Engineering Key Practices. *CUTTER IT JOURNAL*, *13*(5), 9–15.

Xue, L., & Feng, B. (2006). A model-driven approach for business constraints discovery. *Information Technology Journal*, *5*(3), 454–459.

Xu, H., Sawyer, P., & Sommerville, I. (2006). Requirement process establishment and improvement from the viewpoint of cybernetics. *The Journal of Systems & Software*, *79*(11), 1504–1513.

Zengjun, C. (2009). Information Resource Planning and Its Application in Indicator Management System. In *Computational Intelligence and Software Engineering, 2009. CiSE 2009. International Conference on* (pp. 1–5).

Zin, A. M., & Pa, N. (2009). Measuring communication gap in software requirements elicitation process. In *Proceedings of the 8th WSEAS International Conference on Software engineering, parallel and distributed systems* (pp. 66–71).

Zowghi, D., & Coulin, C. (2005). Requirements elicitation: A survey of techniques, approaches, and tools. *: Engineering and Managing Software Requirements*, 19–46.

Zowghi, D., & Paryani, S. (2003). Teaching requirements engineering through role playing: lessons learnt. In *Requirements Engineering Conference, 2003. Proceedings. 11th IEEE International* (pp. 233–241).

Zur Muehlen, M., Indulska, M., & Kamp, G. (2007). Business Process and Business Rule Modeling: A Representational Analysis. In *Proceedings of the 3rd International Workshop on Vocabularies, Ontologies and Rules for The Enterprise. Eds.: K. Taveter, D. Gasevic. IEEE: Baltimore, Maryland*.

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