A ROADMAP TO SOFTWARE QUALITY ASSURANCE OF CHANGE CONTROL MANAGEMENT FOR ISO INITIATIVE: IN THE CONTEXT OF MALAYSIAN SMEs IT INDUSTRY

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A project report submitted in partial fulfilment of the requirements for the award of Master of Information System

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DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

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APPROVAL FOR SUBMISSION

I certify that this project report entitled **"A ROADMAP TO SOFTWARE QUALITY ASSURANCE OF CHANGE CONTROL MANAGEMENT FOR ISO INITIATIVE"** was prepared by **TAI WAN WAH** has met the required standard for submission in partial fulfilment of the requirements for the award of Master of Information System at Universiti Tunku Abdul Rahman.

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ABSTRACT

Quality, is a famous word that is constantly quoted in the business world today. Products and services have to be of "quality" to stay competitive in today's challenging environment. In the IT industry, software quality is a trickier concept due to its complexity, invisible-nature and complicated production process. In order to make the claim that the software produced by the company is of quality, many software houses have resorted to adopting quality improvement methodology (QIM) or quality management system, especially one that meets the standard of international bodies. There are many QIMs where IT companies can choose to implement, such as ISO, CMMI, ITIL and Six Sigma. In Malaysia, ISO remains a popular option. However, the challenge in interpreting the requirements, putting them into practice and the lack of resources to consistently focus on the quality improvement project always leave companies going astray in the process, particularly to the IT SMEs in Malaysia. This paper aims to provide a roadmap to the implementation of ISO 9001:2015, delving into the details on establishing a QMS that is built on software change control management (for bug fix). The demonstration to establish a QMS based on this limited scope shall help the IT SMEs to kick start their journey to ISO 9001. This paper starts off by providing an overview of the IT Industry in Malaysia, the different QIMs adoption and their benefits and challenges, the justification of choosing software change control management as the scope in the demonstration of QMS set up, followed by a survey about QIMs adoption and SME characteristics, before moving to the proposed roadmap and development of the supporting tools such as quality policies, process flow charts, standard operating procedures, forms and templates. This paper ends with the validation of the proposed scope for the QMS namely the software change control management and recommendation for future works.

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LIST OF SYMBOLS / ABBREVIATIONS

CR Form	Change Request Form
IEEE	Institute of Electrical and Electronics Engineers
IT	Information technology
PMLC	Project management life cycle
QIM	Quality improvement methodology
QMS	Quality management system
SDLC	System development life cycle
SME	Small and Medium Size Enterprise
SQA	Software Quality Assurance
the Standards	ISO 9001:2015
WBS	Work Breakdown Structure

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CHAPTER 1

INTRODUCTION

1.1 General Introduction

In this increasingly competitive global environment, consumers are spoilt with variety of products and services that are growing in sophistication. Consumers around the globe, be it individual or corporate, are no longer just contented with a quality product or service but are expecting proof that an organisation is capable of producing quality product and services on a consistent basis.

The same expectation rings louder in the information technology (IT) industry as history has shown low success rate in software development projects. According to the Chaos Report 2015 released by Standish Group, a research firm that analyses software projects, only 29% of the 500,000 projects studied were implemented successfully (defined as on time, on budget, and meet expectation). 52% of the projects were considered challenged while the 19% were cancelled (Wojewoda and Shane Hastie, 2015). Worse, some unsuccessful projects have led to legal disputes. According to the survey conducted by the Cutter Consortium, it was found that a shocking 78% of IT organizations have been involved in disputes that ended in litigation. Issues involved among others, the functionality or performance of the software products that did not measure up to the claims of the software developers, delayed delivery and severe defects which rendered the software product unusable (Schach, 2007).

Quality is therefore a critical element for business survival in the competitive IT industry. In the context of IT industry, quality software product is associated with one that meets the features, functionality of customers' requirement and delivered as per agreed timeline and within budget. To develop a quality software product, a good quality software development process is deemed to be a critical factor (Yoo *et al.* 2006). In another word, quality not only refers to the end product, but also the way how a company produces it. It involves the people, processes and system, structured in the most effective way possible to ensure repetitive successful production of quality end products and allow continuous improvement (Wong et al., 2014). Putting in place a Quality Management System has never been more imminent to achieve the quality goals that is, to implement quality process and to produce quality products. This notion

is supported by survey that showed strong linear relationship between high quality IT development process and high-quality IT products (Wong, Lee, *et al.* 2012).

Software system development nowadays is always complex and costly. Approximately two thirds of the total software development cost were a resultant of the software maintenance (Schach, 2007). Software company which has clearly defined processes and proper documentation hence having good traceability with increased predictability of output and ability to detect faults at earlier stage of development, has become the obvious choice of customers as a safer investment bet to prevent project failure and ballooning cost. Most IT companies realises the importance of implementing quality strategies and in response to satisfy customers' requirement, have chosen certification as a demonstration of their achievement in software process improvement (Wong, Tshai and Lee, 2012).

1.2 Importance of the Study

In relation to the implementation of ISO 9001, there are limited works done on the implementation process and its effectiveness in the context of small-medium companies operating in Malaysia environment.

Samat et al. (2012) noted that studies and journals in regard of implementation process largely addressed large company structure with less constraints on resources as compared to SMEs. Whereas for studies where model or framework for implementation was proposed, they mainly based on the background of construction and manufacturing companies.

An implementation roadmap on change control management in the context of software companies is rather scarce, which is highly likely proposed with reference to ISO 9001:2008 version which has been superseded in 2015.

In an attempt to bring Malaysia small and medium size software companies to a world class standard, via more certified software companies as a proof of quality, a roadmap to software quality assurance of change control management for ISO initiative is hence worth to look into.

1.3 Problem Statement

ISO 9000 QMS has been widely accepted as a national standard for many nations (Liao et al., 2004) and in Malaysia, adapted by the Department of Standards Malaysia, an agency under the Ministry of Science, Technology and Innovation (MOSTI). The number of ISO 9001 registration grew steadily from 35,000 in year 2000 to over one million in over 170 countries now (ISO, 2018). However, despite its popularity and the customers' requests to adopt the Standards, companies seeking registration are still concerned with the high cost and extensive time to implement (Liao et al., 2004). Study by Stelzer et al., (1996) found that the average time needed to implement ISO 9000 was 1.5 years. Companies having a quality system in place prior to the ISO 9000 initiatives can implement it in a shorter timeframe. Approximately one year is required to adapt to the ISO requirement. But for those starting from scratch, 2 years or more is common.

Aside from the cost and time concerns, there are limited works done on the implementation process and its effectiveness in the context of IT SMEs in Malaysia, to provide guidance in ISO 9001 adoption. ISO 9000 set of standards provide generic references to quality system. However, this set of process-based standards, while describes what elements that a quality system shall comprise, is short of giving details on how the system can be implemented (Stelzer et al., 1996). The challenge in interpreting the standards requirement further hinders the adoption rate. There are no lacking of studies that highlighted the challenges in its implementation and even the less than satisfactory result thereof (Rodríguez-Escobar *et al.,* 2006).

Furthermore, IT companies' readiness in seeking certification is found to be unfavourable. Survey conducted to assess the project management maturity and successful project implementation for companies in Malaysia IT industry noted that the project management maturity performance was in fact rather poor, despite the fact that many surveyed companies had been in the IT-related businesses for years and self-perceived to have matured project management practices (Wong et al., 2016). The lack of guidance and the knowledge gap have therefore hindered many IT companies' from seeking ISO certification successfully.

ISO requirements underscores the need for any companies pursuing the certification to improve their processes in order to implement a QMS based on the Standards. To be ISO-compliant, IT small and medium size companies (IT SMEs) should have well-defined processes in relation to project management, not least but

including the critical one, software change control management. A QMS set up based on software change control management, with demonstration of process operation effectiveness, shall be an ideal candidate for ISO certification.

However, IT SMEs in Malaysia generally have started off and remained very lean in term of its manpower. They focus more on meeting customers' needs, which are often ad hoc, and are pretty relaxed on documentation and needless to say, formally defining the companies' processes. Therefore, it is common to find these IT SMEs to operate without a formally defined software change control management or process. Consequently, in the absence of change control, likelihood of change to production environment that results in serious mistake is high. Bugs which were resolved previously are likely to recur too. All these undesirable incidents will impact the software as well as the company's reputation in a negative way.

The lack of guidance to these companies to properly set up the change control process, including the mechanism such as defining responsibility and authority, prioritisation of change, the related release planning, testing requirement and the change procedures, has further impeded these companies' ability to comply with adopted standards.

1.4 Research Objectives and Research Questions

With reference to the challenges highlighted in the Problem Statement above, this paper aims to construct a roadmap to software quality assurance of ISO change control management. The roadmap shall act as a guide to embed ISO-compliant change control management system within the system development life cycle, the core process of a typical software companies, that can easily be referred to by IT SME for adaptation. Specifically,

(i) To conduct comprehensive literature review of ISO 9000 and ISO 9001, its principles and requirements, implementation, including the challenges and critical success factors.

(ii) To conceptualise a roadmap to software quality assurance of change control management for ISO initiative suitable for adoption by small and medium size software companies. The change control management shall start from business requirement (i.e. the change request requirement) to system/changes roll-out and lesson learnt event.

(iii) To develop and formulate policy, procedures, guidelines and flowcharts, if necessary, to support the change control management.

(iv) To validate the proposed framework via interview, also as part of the data collection process (i.e. interview, questionnaire, brainstorming etc.), with selected software companies' representative to ensure the feasibility of the framework, with any revision necessary based on feedback obtained.

(v) To prepare a final year project in accordance with UTAR format requirement.

(vi) To prepare a report of 10–15 pages of journal paper or summary report of 6-8 pages of conference paper.

This research aims to answer the following questions:

(i) What are the key principles and requirements of the revised ISO 9001 and how they affect the implementation of the QIM in IT companies and their projects?

(ii) What are the characteristics of small and medium size companies that distinguish them from large companies hence the impact on approach in implementation of ISO 9001 in change control management, the critical process in IT companies?

(iii) What are the basic elements of a change control management?

(iv) What are the key elements, principles and best practice in change control management that can be implemented by small and medium size companies to fulfil ISO requirement?

1.5 Scope and Limitation of the Study

The scope of this research places its focus on ISO 9001 Quality Management System, the requirements and the implementation thereof to the IT SMEs. Details are described as follows:

(i) Study and analyse literatures in relation to

a) ISO 9000-series standards and other alternative QIM models, compare and contrast the advantage and disadvantages of the models to develop a solid understanding on ISO 9000 and how it fares against other QIM.

b) SME's characteristics and its influence on implementation QIM.
c) Critical success factors, barriers and resistance in the implementation of QIM.
d) Change control management in IT industry to identify the relevant key elements / mechanisms.

(ii) Design a roadmap to software quality assurance of change control management for ISO initiative.

(iii) Propose policy and procedures, flowcharts and forms on change control management as tools to support the roadmap/framework and for better process control.

(iv) Validate the proposed roadmap for completeness and feasibility via review by assessors. Semi-structured interview will be conducted to collect feedback from the assessors.

1.6 Contribution of the Study

The aim of this research is to propose a roadmap to software quality assurance of change control management for ISO initiative. The roadmap shall act as a guide to IT SMEs to systematically implement change control management in ways that support the adoption of ISO 9001, yet in a practical manner by offering a set of customisable principles/policies, scope, procedures and templates.

The roadmap shall significantly reduce the time IT SMEs take to prepare for ISO 9001 certification, and concurrently prepare them for the challenges in the implementation of change control management with better insights and focus. Consequently, increasing the number of ISO-certified software companies in Malaysia and increase the visibility of these companies in the global market.

The assignments of UTAR undergraduates on software quality assurance and change control management, comprising quality plan, change policies, procedures, work flows, forms and templates, have served as a preliminary understanding for the author to kick off this project.

1.7 Outline of the Report

Chapter 1 of this report introduces the background of the study, including a brief overview on the adoption trend of quality improvement methodologies (QIM), followed by problem statement, the research objectives, the research questions attempted to be answered, the scope and the potential contribution of the research.

Chapter 2 covers comprehensive literature reviews on Malaysia IT industry, popular QIMs adoption in Malaysia, system development life cycle in relation to project management life cycle and overview of change control management.

Chapter 3 discusses research methodology used for this study, covering the qualitative and quantitative research method, data collection method and research instrument.

Chapter 4 presents research findings from the quantitative method, i.e. the survey questionnaire. Discussion is made on the findings in relation to a past similar survey, covering the QIMs adoption pattern, the objectives and resistance factors of adoption. The chapter is ended with the findings on SME characteristics and the impact to the proposed roadmap especially on the software change control management.

Chapter 5 presents the proposed roadmap in accordance with ISO 9001 requirements, supported with the change control process flow charts, a quality manual that documents the change control policies, roles and responsibilities, standard operating procedures and relevant forms and templates. An illustration on how the change control process will be captured and documented is also presented.

Chapter 6 discusses the validation of the proposed change control management. While it is a partial validation of the roadmap, it represents the critical element of the overall roadmap.

Chapter 7 is the last chapter that wraps up this report by revisiting the accomplishment of the research objectives and research questions.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter aims to present the overview on current IT industry in Malaysia, the various quality improvement methodologies (QIMs) commonly adopted in Malaysia, followed by discussing the core process in a typical software companies, project management life cycle and the subset of it, system development life cycle. The information is drawn from literature reviews including past studies, current country and industry data.

2.2 Malaysia IT Industry

Malaysia is classified by World Bank as an upper-middle income country (US Embassy, 2018). It has a population of 32.4 million in 2018 and as per data from Bank Negara Malaysia, 14.68 million was in employment in the second quarter of 2018. The country's GDP in 2017 is RM1,353 billion.

Malaysia has transformed from an agriculture and mining-based economy in the early 1970s to one that is relatively high-tech and competitive now. The economy is heavily service-driven with 51 percent of the country's GDP in 2017 contributed by service sectors. Manufacturing sector accounted for 22 percent of the GDP and the balance contributed by other industries (US Embassy, 2018).

Malaysia government has been spearheading the growth in IT industry since the development of Multimedia Super Corridor (MSC) flagship project in the 1990s. As per Department of Statistics, Malaysia, the sector's contribution to the economy has been growing and registered 8.7 percent growth in 2016. The country reported a GDP of RM1,231 billion in 2016, of which RM165 billion (13.4%) came from IT industry (BNM, 2018; Department of Statistic, 2017). The industry consists of information, communication and technology (ICT) services, ICT manufacturing, ICT trade, content and media, etc, and hired a total of 1 million persons, making approximately 7% of the total working population (Department of Statistic, 2017). The government expects the sector's contribution to GDP to further increase to 17 percent during the 11th Malaysia Plan (2016-2020) (US Embassy, 2018).

IT industry is the conduit for the country to achieve developed nation status, with various areas identified as the key drivers, such as Big Data, Internet of Things (IoT), Cognitive Cybersecurity, Robotics, Fintech and Block Chain (US Embassy, 2018). In addition to encouraging the advancement into Industry 4.0, the government has also established a Digital Free Trade Zone (DFTZ), a virtual zone, to stimulate e-Commerce. The DFTZ comprises Satellite Services Hub, e-Fulfilment Hub and e-Services Platform (US Embassy, 2018).

The government drives the adoption of IoT across key social and economic sectors and grows the data centres and IT infrastructure for cloud computing. Research and development in cyberspace security and investment in communications security to protect information confidentiality and integrity are deemed critical to forward this industry and hence are given focus by the government (US Embassy, 2018). IT industry in Malaysia, being the focus of the government in advancing the country to a developed nation, offers tremendous opportunities and prospects to companies involved in IT-related business. Software houses are poised to grow in tandem with this trend and the need to equip themselves for quality improvement is imperative in order to compete and thrive.

Literature reported that small and medium-size enterprises (SMEs) are the dominant business set up in the world (Richardson et al., 2007). In Malaysia, 98 percent of business establishments across all industries are of small and medium size, made up by 907,065 SMEs to which 89 percent are from services sector (SMEinfo, 2018). According to the data provided by SME Corp. Malaysia, 76.5 percent of the SMEs are actually micro, 21.2 percent are small and 2.3 percent are medium. The size is determined by the following criteria:

Table 2.1: Definition of SME

Category	Micro	Small	Medium
Manufacturing	Sales turnover: < RM300,000 OR Employees: < 5	Sales turnover: RM300,000 ≥ RM15 million OR Employees: 5 ≥ 75	Sales turnover: RM15 million ≥ RM50 million OR Employees: 75 ≥ 200
Services and Other Sectors	Sales turnover: < RM300,000 OR Employees: < 5	Sales turnover: RM300,000 ≥ RM3 million OR Employees: 5 ≥ 30	Sales turnover: RM3 million ≥ RM20 million OR Employees: 30 ≥ 75

Source: SMECorp (2018)

The SMEs services sector comprises subsectors wholesale & retail trade, food & beverage and accommodation; real estate, finance, insurance and business services; transportation & storage and information, communication & technology (ICT) (SME Corporation Malaysia 2018). SME Corporation Malaysia defines ICT as technologies that provide access to information through telecommunications, including all devices, networking components, applications and systems. ICT subsector covers IT companies like software development companies or software house (Sharif *et al.* 2013). Similar to the other countries in the world where the indigenous software companies are small and medium-sized (Lyu and Liang, 2014; Larrucea et al., 2016; O'Connor and Coleman, 2009), the IT industry in Malaysia is also made up of SMEs. Given the fact that 98 percent of the business in Malaysia is SME, clearly, most of the software companies in Malaysia are SMEs.

Despite the fact that Malaysia government has promoted the development of IT industry for more than 30 years, survey showed that the industry players have relatively young and inexperienced staff members who do not have strong IT project management experience. According to the survey conducted by Sharif et al., (2013), 74.3% of the staff respondents of SME software companies have less than 5 years of experience while 94% of the respondents have worked on less than 50 projects. More than half of the staff respondents have no education background or training in project management field. The survey result highlights the inherent challenges faced by IT SMEs in Malaysia in strengthening companies' performance in terms of quality management, where focus is on continuous improvement of business processes, but in reality, a lot of the IT SMEs may lack the knowledge and experience to kick off the process.

While Malaysia is categorised as a middle-ranked developing country in quality management implementation (Wong *et al.* 2014), this is already a worldwide trend demanding quality from companies. Many organisations in Malaysia are convinced of the importance and benefits in software process improvement (Abdul Latif *et al.* 2010). However, mere realisation is inadequate. To compete and survive in the information age, IT SMEs in Malaysia have the urgency to upgrade themselves by joining the rank of quality management and to increase the nation's IT industry competitiveness in the globalised world.

2.3 Quality Improvement Methodology (QIM) Adoption and Selection

Meeting customers' requirement and satisfying their expectation are among the critical success factors for software companies of any sizes. Winning a job and prove their ability to manage a software development project that can deliver quality software product timely seems a reasonable way to gaining customer's loyalty. However, from the customer's perspective, especially in the development of software system which is often of significance to the company's operation that requires high investment cost, there is no room for a bet to be placed on a company that does not offer confidence to the customers that they are capable of delivering. Such perception poses a real obstacle to small and medium size software companies when come to winning customer and business.

As pointed out by Lyu and Liang (2014), IT SMEs in developing nations must find an efficient way to measure the quality of software development for the sake of market survival. IT SMEs have to find a way to upgrade their product quality and provide proof to the customers that they are capable of doing so. One of the obvious options for these small and medium size companies to increase their visibility in the highly competitive market is to obtain quality certification.

Adopting QIM and to set up a QMS, is widely known ways to achieve quality and strengthen a company's performance. There are many QIMs available for the adoption by IT SMEs interested in establishing a QMS and in Malaysia, the most popular QIMs as per survey result by Wong et al. (2014) are:

(i) ISO 9000

(ii) Capability Maturity Model Integration (CMM/CMMI)

(iii) Information Technology Infrastructure (ITIL)

(iv) Six Sigma / Lean Sigma

The survey respondents were all from small and medium size IT organisations category, with employee number ranging from 5 to 50. Survey found that most respondents have implemented a QIM. The most popular QIM adopted in Malaysia in the past was ISO while ITIL and Six Sigma were fast catching up as the most popular QIMs moving forward.

Refer to the following page 13 for brief comparison of the models.

2.3.2 ISO 9000 Series Standards

ISO 9000-series standards are a set of international standards on quality management and assurance. The ISO 9000 family is made up of ISO 9000 (Fundamentals and Vocabulary), ISO 9001 (Quality Management Systems - Requirements) and ISO 9004 (Guidelines for Performance Improvements), where ISO 9001 is further interpreted with ISO 9000-3 when the standard is applied to software industry (Yoo *et al.,* 2006).

The standards offer a set of quality requirements to be followed by companies involving in international exchange of goods and services, facilitating trades by setting a baseline to which a company's quality system can be judged (Wong, Tshai and Lee, 2012). The process-based standards are applicable companies of all sizes and from any industries, be it a profit-oriented, non-profit or government agencies.

The standards aim to help companies to embed a QMS into their organisation to increase their business efficiency and customers' satisfaction. QMS is defined by the standard as the way an organisation arranges those activities which are related to achieve its intended results. Many IT companies choose ISO 9001 as a kick-start base for IT project quality management, although it has been reported that, more often than not, certification and adoption were result of external, customer-demand initiative than rather internally desired (Wong et al., 2012; Stelzer et al., 1996; Naveh and Marcus, 2004).

Table 2.2: Comparison of Different QIMs

	ISO 9001	CMMI	ITIL	Lean Six Sigma
Founder and establishment	Introduced by International Organization for Standardization (ISO) in 1987.	Developed by Software Engineering Institute which was founded by the US Department of Defence (Schach, 2007)	Introduced by U.K. Office of Government Commerce (previously known as Central Computer and Telecommunications Agency (CCTA)) (Nicho, 2012), in the 1980s.	Architectured by Motorola in 1979 (Heston and Phifer, 2011)
Approach / framework	Latest series of standards on QMS consist of ISO 9000, ISO 9001 and ISO 9004. ISO 9000 describes the fundamental concepts and principles of quality management, including the terms and definitions	A process maturity framework made up of sets of best practice suggestions in a variety of key process areas to increase software process capability, with 5 levels of maturity: Initial, Repeatable, Defined, Managed and Optimising.	A set of IT Service Management practices and processes for core IT areas like change management, service-level management, incident management, etc, which focuses on aligning IT services with the needs of the business.	A set of techniques, involving the use of statistics, that aims at reducing defects and achieving improvement, rather a distributed “model”. 2 processes are suggested: 1) For continuous improvement purpose - DMAIC (define, measure, analyze, improve, and

	ISO 9001	CMMI	ITIL	Lean Six Sigma
	applicable to quality management. ISO 9001 sets out the criteria for a quality management system. The standard is based on a number of quality management principles including a strong customer focus, the motivation and implication of top management, the process approach and continual improvement (ISO).	Each maturity level consists of a set of process goals that stabilize a critical component of the software process. (Paulk *et al.,* 1993)	It is basically a compilation of IT service management-related best practices, introduced via publication of a series of books and the latest version, ITIL v3, comprises five books relating to strategy, design, transition, operation, and continual service improvement. (Wong, Tshai and Lee, 2012)	control); 2) For new process design - DFSS (Design for Six Sigma). Improved process shall produce less than 3.4 defects / variation per million products. Evolved to embed Lean concept where waste reduction becomes one of the objectives. (Heston and Phifers, 2011)
Certification	Certification is awarded to company that fulfils the criteria for a quality	An organization is appraised using the Standard CMMI Appraisal Method for Process Improvement (SCAMPI)	Individual-based with 5 levels: *Foundation*, *Practitioner, Intermediate, Expert* and *Master,* for	Individual-based with few levels: Champion, Yellow/Green Belt, Brown/Black Belt, and Master

	ISO 9001	CMMI	ITIL	Lean Six Sigma
	management system as spelt out in ISO 9001 (ISO, 2018).	Class A appraisal and be awarded a maturity level rating (1-5), by SCAMPI Lead Appraiser then be published CMMI Institute website (CMMI, 2018).	practitioners to demonstrate their ability in adopting and adapting the framework ("ITIL Certifications_ AXELOS," 2018)	Black Belt, awarded by host of certifying bodies (Lawrence and Miller 2015).
Applicability	Any service or product companies, especially those desire to establish or improve **quality management system**. (Heston and Phifer, 2011).	Companies looking to improve **systems development and maintenance processes**, including requirement and project management, to enhance software quality. (Heston and Phifer, 2011).	Companies looking to improve **service management capabilities**, covering IT support, service delivery, security, and infrastructure, with particular focus to align IT better with the business objectives. (Heston and Phifer, 2011).	Companies already adopting quality program / framework, yet with rigor and commitment to **further improvement using measurement-based** approach. (Heston and Phifer, 2011).

ISO 9001 outlines a set of minimum criteria for an acceptable quality system, that ensure quality software product is delivered, covering all stages of development including design, production, installation and servicing (Paulk, 1998; K. Kulpa and Johnson, 2003). ISO 9000-3 guides the application of ISO 9001 to the development, supply and maintenance of software (Paulk, 1998; K. Kulpa and Johnson, 2003).

To achieve ISO certification, organisation has to comply with every requirement stated in ISO 9001 (Yoo *et al.,* 2006). ISO 9001 requires an organisation seeking certification to implement and document its quality system, supported with procedures and work instructions (K. Kulpa and Johnson, 2003). While ISO 9001 is commonly used for third-party certification, there is absence of international accreditation body. Despite, certification is issued by national or external certification bodies worldwide, which are set up based on a set of criteria for accreditation spelt out by ISO's Committee on Conformity Assessment (CASCO) (Paulk, 1998; ISO, 2018). Audits are carried out by the certification bodies where recommendations will be made before a certificate is issued. Annual surveillance audit is a norm and recertification is required every 3 years to ensure the QMS remains effective (ISO, 2018).

Strength and Benefits

External demonstration of company's achievement. Certification by third party certifier can be a credible tool used to demonstrate supplier's capability to deliver quality product and as achievement in software process improvement (Paulk, 1998; Wong et al., 2012). Huarng et al. (1999) discovered from their research that ISO certification sought due to customer request, was used as a marketing focus to demonstrate a company's commitment to quality and resulted in increased customer's satisfaction.

Improved business processes. The implementation and certification process help a company to take a reflective step, explore the current process deeply for weaknesses and inefficiencies, prior to defining clearly the core business process and organisational structure. The result is a simplified, more efficient execution of processes (Stelzer *et al.,* 1996).

Increased efficiency and effectiveness. ISO-certified companies are reported to have more consistent processes with minimal variation, arising from systemization,

result in efficient operation (McGuire and Dilts, 2008). The detailed documentation also enables fact-based decision making as opposed to assumption-based, helps in effective execution of operation (McGuire and Dilts, 2008).

Better team work. Implementation and certification process requires a company's personnel, of ALL levels, to have constant meetings to deliberate issues and to work towards solution. The process promotes open discussion and team work, resulting in strengthened team spirit and inter-departmental cooperation (Stelzer *et al.* 1996).

Improved financial performance. There is empirical evidence that conformance quality is correlated with market share and revenue (McGuire and Dilts, 2008). Customers who are willing to pay a premium for perceived added value due to higher product conformance quality results in revenue increase (McGuire and Dilts, 2008), and ISO 9000 is a quality management control system that has shown strong potential in raising conformance quality as well as reduction in quality cost.

International competitiveness. With the intention to expand to international market, ISO 9000 certification has shown improvement in international performance, acting as a powerful tool to achieve international competitiveness which can make positive contribution to sales performance (Huarng *et al.*, 1999).

Flexibility. The generic yet systematic standards allow companies interested in QIM to decide on the specifics of how the standards are applied (Wong, Tshai and Lee, 2012), meaning to devise a quality system which is suitable to the company's context and at the same time, comply with the standard's requirement.

Criticism and Challenges

Generic reference causes interpretation difficulties. Set of standards are generic reference to quality system but without giving details on how to implement (Stelzer *et al.,* 1996). Interpretation of the standards poses a challenge for organisations to comply with the requirement to be certified (Paulk, 1998)

No guarantee of quality product. Improved process and certification may not correlate to quality product but rather the real embrace of the practices in company's operation after certification is the key to improved performance (Naveh and Marcus, 2004).

Extensive documentation. The documentation requirement is negatively perceived as consultant-driven paper works which may systemize poor processes (Huarng *et al.,* 1999).

Time consuming. The average time needed to implement ISO 9000 was found to be 1.5 years; companies having a quality system in place prior to the ISO 9000 initiatives can implement it in a shorter timeframe, taking approximately one year to adapt to the ISO requirement; for those starting from scratch, 2 years or more is common (Stelzer *et al.,* 1996). The application exercise, involving interviews, collection of documents, training, is seen as draining resources from daily operation as well as time consuming (McGuire and Dilts, 2008).

High cost of implementation. Costs are incurred on auditors, training, and associated time lost due to interview sessions by auditors and attending training (McGuire and Dilts, 2008). Research by O'Connor and Coleman (2009) finds that respondents are critical of ISO 9000 due to the negative perception of cost, and bureaucracy, hence the widely held belief that the standards are oriented to big companies.

2.3.3 Capability Maturity Model Integration (CMMI)

Capability Maturity Model (CMM) was developed by the Software Engineering Institute (SEI) at the request of US Department of Defence, for the purpose to assess the capability of software organisations bidding for contracts from the department. It describes the process capability of software organisation and has since been widely adopted in the software community for software process improvement (Paulk, 1998).

Throughout the years, a plethora of models surrounding system engineering, software engineering, software acquisition and integrated product development was generated by SEI which has inevitably resulted in confusion in using these models for software process improvement (K. Kulpa and Johnson, 2003). Call for a halt of generating more models happened and the journey for integration began, giving rise to Capability Maturity Model Integration (CMMI) in 2000 (SEI, 2009). CMMI today is a merger of process improvement models for the above-mentioned domains, expanding the scope from software process focus to the entire enterprise, focusing on harnessing organisational capacity (Selleri Silva *et al.,* 2015).

The main aim of CMMI is to eliminate inconsistencies and to establish guidance for organisations in software project and ultimately reduce the cost of process

improvement (Selleri Silva *et al.,* 2015). CMMI concerns the maturity of software process and describes the principles and practices in a set of 22 process areas, grouped into 5 different levels that evolves from random, ad hoc to systematic, disciplined process (Selleri Silva et al., 2015; Paulk, 1998). Each level is generally made up of key process areas, except for Level 1. Level 2 has the focus on basic project management controls; Level 3 expands the focus from project to organisation, concerning the organisation overall capability on software engineering and management; Level 4 matures into quantitative performance measures on both the software process and product; Level 5 is the optimising stage that covers areas enabling continuous process improvement (Paulk, 1998). The model provides software companies which are interested in developing quality software and improving their process maturity with fundamental elements of a good software development process (Yoo *et al.,* 2006).

CMM-based appraisals are performed in 2 ways, internally for process improvement, known as *software process assessment*, and externally by customers to identify qualified software contractor, known as *software capability evaluation*. Both are conducted by trained software professionals (Paulk, 1998).

Strength and Benefits

Improvement in delivered quality. A stable process improvement infrastructure, conceivably built up by adopting CMMI, equips a company with process documentation, group activities and training materials (Grossi *et al.,* 2014), necessary in knowledge management and learning. The consequence being better leveraged knowledge and enhanced capability in delivering quality products. Goldenson et al. (2004) noted many companies adopting CMMI have seen a reduction in software defects and increased ability in defect removal. Garud and Kumaraswamy (2005) even found that a company at Level 5 maturity develop a mechanism in preventing defects.

Reduction in cost. With the use of quantitative management practice including the application of measurement and analysis, companies reported reduction in the cost of poor quality (Goldenson *et al.,* 2004). Cost reductions were also reported in many other areas such as the average cost to find and fix a defect, unit software costs, overhead rate.

Increased productivity and ability to meet schedule commitment. Many model adopters have recorded improved turnaround time and more releases a year, following the increase in process maturity level. Percentage of milestone met improved from half of the time to almost 95 percent for projects, meaning that delays were greatly reduced (Goldenson *et al.,* 2004). These reported improvements imply that one can better predict a project's ability to succeed. The more matured a software process is, the less difference one will expect between the targeted result and actual result (Paulk *et al.,* 1993).

Enhanced customer satisfaction. The benefits of adopting CMMI, seen from the customer's perspective, can be viewed from the angles of increased satisfaction, value add and achievement of their needs (Selleri Silva *et al.,* 2015). Better customer satisfaction rating was reported by companies adopting CMMI. Companies excel in contractor performance evaluation survey and award fees are increased significantly as a result of satisfactory performance (Goldenson *et al.,* 2004).

Criticism and Challenges

Complexed application and overly prescriptive. While CMMI helps in knowledge management, promotes learning and enhance overall business performance, critics nevertheless view its application complexed and overly prescriptive (Wong *et al.,* 2016). Any deviation from the standards or requirements will lead to lower maturity score. CMMI is so document-heavy, the guide itself running into few hundreds of pages, that its implementation requires the interested companies to be extensively aided and trained by CMMI-certified consultants (K. Kulpa and Johnson, 2003; Khurshid et al., 2009). The cost of obtaining the certification is therefore consequently high (Khurshid *et al.,* 2009). It is no surprise that the result from the research by O'Connor and Coleman (2009) to identify the reasons of software SMEs rejecting the model, discovered no respondent used CMMI although some of the quality managers had prior experience working with the model.

Scalability difficulties for small organisations. The applicability of CMMI in small organisations is still being debated. Issues such as CMMI is deemed too big or too prescriptive for small organisations to handle, CMMI is designed for big organisation and is written for already-mature organisations, the different way small organisation is run and hence faces challenges in applying CMMI (K. Kulpa and

Johnson, 2003). Advocates counter these arguments by stating that CMMI is a balanced model promoting many areas such as system engineering and software engineering, but one can choose which area to focus on (K. Kulpa and Johnson, 2003); CMMI also allows for tailoring of its formats and processes, given the different maturity levels that can be readily achieved by organisation of different (K. Kulpa and Johnson, 2003). Regardless, scaling and adaptation are not as simple without the necessary guidance from the CMMI professionals.

Lengthy implementation. The implementation of CMMI is time consuming (Selleri Silva *et al.,* 2015). Report by Software Engineering Institute showed that companies on average require 75 months to achieve CMMI Level-5: maturity level 1 to 2 is 19 months; maturity level 2 to 3 is 19 months; maturity level 3 to 4 is 24 months; maturity level 4 to 5 is 13 months (Mahmood *et al.,* 2008).

High cost of implementation. The lengthy timeframe needed in implementation means significant resources, both in manpower and monetary term, are required (Mahmood *et al.,* 2008). The training cost which is one of the cost elements for implementation, is higher than many have expected (Selleri Silva *et al.,* 2015). That Costly implementation is one of the key issues that put the model unquestionably out of reach for small and medium size software companies (Lyu and Liang, 2014; Herrera and Ramirez, 2003). The level of the details required by the model, coupled with the high cost of implementation, has proven to be a difficult and unwelcome choice for the small and medium size companies.

2.3.4 Information Technology Infrastructure Library (ITIL)

ITIL v1 was introduced by the Central Computer and Telecommunications Agency, CCTA, in the 1980s and has since developed into v3 today. ITIL v3 outlines 25 processes which encompass system lifecycle from design, build, test and deployment and are explained in five volumes – Service Strategy, Service Design, Service Transition, Service Operation and Continual Service Improvement (Eikebrokk and Iden, 2017). The reference processes that describe how IT services are to be delivered, are developed through experience by IT practitioners (Eikebrokk and Iden, 2017).

Simply, ITIL is basically a compilation of proven best practices applicable on core IT operational processes (Wong, Tshai and Lee, 2012). ITIL defines IT service management as,

> *"The implementation and management of quality IT services that meet the needs of the business. IT service management is performed by IT service providers through an appropriate mix of people, process and information technology."* (Axelos, 2018)

Hertvik (2016) provides further understanding of IT service management by distinguishing IT service management from traditional IT system development. He states that traditional IT systems management has a technology-oriented approach that focuses on "**IT software and hardware systems development, delivery and maintenance"**. IT service management on the other hand is process-oriented. It stresses **business needs, service delivery and customer value**, and has a continual improvement element built into its service delivery model that isn't always present in traditional IT systems management.

ITIL is largely about IT service management, i.e. focus on IT service delivery and support and the alignment thereof on specific domains to ensure proper business solution delivery (Abdul Latif et al., 2010; Cronholm and Persson, 2016). The best practices, while are for IT service management implementation, can also be used by organisations to fine tune their existing processes, providing organisations ready example for improvement. Organisations that adopt ITIL set baseline to plan, implement and measure improvement. ITIL is the most widely accepted approach to IT service management in the world (Wong, Tshai and Lee, 2012).

ITIL Service Lifecycle

ITIL follows a lifecycle approach to service management, grouped into 5 stages with defined processes to create, deliver and monitor IT services from ideas to retirement.

Table 2.3: ITIL Service Lifecycle

Stage	Description
Service Strategy	• Organisation defines vision, its market positioning, customer environment and action plans to achieve the strategic objectives. • Service provider bases these inputs to define and manage a portfolio of IT services that best address the business needs. • Key processes include: Strategy Management, Service Portfolio Management and Financial Management
Service Design	• Translate service strategy to actionable plans, i.e. design IT services and processes that are aligned with business objectives. • Concerning how new service is designed and existing service is changed. • Key processes include: Service Level Management, Availability Management and Information Security Management.
Service Transition	• Handle new service introduction into the organisation. Determine how IT services move from one state to another, between service pipeline, service catalogue and retired service state. • Manage how IT services are built, tested and deployed into production environment. • Key processes include: Change Management, Release and Deployment Management, Service Asset and Configuration Management.
Service Operation	• Cover coordination and execution of service delivery and support for day-to-day routine operations such as fixing defects, service helpdesk, backups, etc. • Key processes include: Incident Management, Problem Management, Request Fulfilment and Service Desk.

Stage	Description
Continual Service Improvement	• Aim to improve the service delivery by identifying opportunity for improvement and implementation, to the overall service management system. • Perform service review, conduct service improvement initiatives, etc.

Source: Axelos (2018); Hertvik (2016)

Strengths and Benefits

Less effort to construct own processes. ITIL models and processes are designed based on the premise on making them applicable to large number of IT departments or companies around the world. The generalisation of processes renders them readily adopted by any companies (Eikebrokk and Iden, 2017).

High level of reliability. Reference models / processes are collection of best practices developed through experience, offer high level of reliability and reduced risks of unwanted effects (Eikebrokk and Iden, 2017; Cronholm and Persson, 2016)

Cost efficiency. Budget control, reduced unplanned labour and cost via optimised handling of service interruption, and elimination of unnecessary works processes were observed (Cronholm and Persson, 2016).

Improved communication. ITIL framework supports communication by offering a common language and uniform vocabulary for service provider and customers (Cronholm and Persson, 2016).

Free from license fee. To practice ITIL framework, one does not need to pay license fee to any organisation. Its independence from any commercial platform free practitioners from being appraised or audited and hence the cost attached, has attracted many IT companies to switch from ISO to ITIL (Wong, Tshai and Lee, 2012).

Criticisms and Challenges

Too generic and abstract. Best practices are generalization of previously conducted successful actions acting as a guide, normally are too generic and abstract hence not easily transferred to new, unique context (Szulanski, 1996; Cronholm and Persson, 2016). Successful adaption much depends on the recipient's motivation,

absorptive capacity and retentive capacity (Szulanski, 1996). However, practitioners and service providers always desire a more specific framework that suits to their context, hence, there is always a conflict between having access to the benefits which best practices offer and their application to an organisation's uniqueness (Cronholm and Persson, 2016).

Unable to resolve issues. Taking a solution to a problem out of a specific context, and applying it across entire spectrum risk invalidating the entire purpose, a natural flaw when recipient blindly follows without analysing their suitability to the situation (Neward, 2010).

Loss of competitive edge. Best practice use tends to lead to high standardisation in companies' operation as the greater use of best practices, the more similar companies become (Cronholm and Persson, 2016). The ability to balance the unique quality of an organisation and best practices is important in order to avoid losing the competitive edge when business is performed in a standardised way (Cronholm and Persson, 2016).

Scalability problems. Earlier practitioners of ITIL in the IT Service Management community were mainly large organisations (Taylor and Macfarlane, 2007). Smaller organisations with the intention to adopt ITIL found that scaled adaptation was needed to benefit from the best practices. Unfortunately, not all ITIL processes can be scaled down easily and function as intended, most will break when the scaling exercise goes too far (Taylor and Macfarlane, 2007).

2.3.5 Six Sigma

Sigma refers to standard deviation which is used to measure variation in statistic, to which an increase in Sigma implies reduction in errors. Six Sigma philosophy is to create a world standard quality of 6 sigma and more, meaning a process free of defect 99.99966 percent of the time or equivalent of 3.4 defects per million outputs, in another word, improvements in a process to reach zero defect (Gulcin Daglioglu *et al.,* 2009). This methodology has been concisely defined by Schroeder et al. (2008) as

> "*an organized, parallel-meso structure to reduce variation in organizational processes by using improvement specialists, a structured method, and performance metrics with the aim of achieving strategic objectives*".

Six Sigma approach involves identifying defects, analysing defects via various measures, devising improvement plans and defining metrics to measure performance and controls to ensure improved process sustainability, in order to achieve business objectives (Gulcin Daglioglu *et al.,* 2009). It stresses the need to link performance metrics and business objectives (Card, 2000).

While Six Sigma has originated from manufacturing industry, being the improvement philosophy advocated by Motorola, it has since been adopted by various non-manufacturing industry including the IT industry, such as in software engineering (on process and product performance) and by internet service provider to measure the competition quality of satisfaction performance (Wong, Lee and Tshai, 2012). Survey conducted in Malaysia by Wong et al. (2012) revealed that Six Sigma is viewed as an opportunity rather a cost by its users and is acknowledged as the possible trend for future adoption, bringing quality improvement process to the next level. It has gained popularity in many industries and notably the business areas of IT processes, products and services.

Six Sigma is not connected to any formal certification program. It emphasizes long term business benefits and hence less focus on near term incentives such as certification for organisation adopting it. Nevertheless, Six Sigma Institute issues competence certification for individuals (Card, 2000). Six Sigma certification, similar to ITIL certification, is granted by universities, professional associations and for-profit training organizations, to individuals instead of company, to verify proficiency in the Six Sigma methodology, hence rendering it challenging to be used as a tool to demonstrate a company's capability in delivering quality software products (Lawrence and Miller, 2015; White, 2018).

Strength and Benefits

Gain competitive advantage. The integration of process with statistics, engineering, and project management, based on the use of six sigma methods, has enabled many companies in sustaining their competitive advantage (Kwak and Anbari, 2006)

Increased customer satisfaction. Six sigma focuses on improving customer requirements understanding, business system, productivity and effectiveness and

efficiency of all operations to meet or exceed customer's needs and expectations (Kwak and Anbari, 2006; Wong et al., 2012).

Improved financial performance. Six Sigma methodology applies advanced data analysis tools that focuses on customer concerns, such as defects measurement, leads to increased customer satisfaction; and coupled with measured and reported financial results, give rise to increased market share and better financial performance (Kwak and Anbari, 2006; Wong et al., 2012).

Criticism and Challenges

Failure to reap benefits in unstructured environment. Six Sigma is a process methodology that aims to root out defects in process (Mayor, 2003). Therefore, having clearly defined processes are a prerequisite for the effective adoption of this methodology. There are cases of large investments made on training personnel in Six Sigma but working in an unstructured environment has resulted in insignificant returns (Card, 2000). Six Sigma concerns learning from current, internal process experience, and its visibility (as the methodology originates from manufacturing process where material flows are visible) in order to measure and manage the process (Card, 2000). In software development, due to product's nature which lacks inherent visibility, process documentation is important to offer this characteristic before one can measure with confidence and accuracy hence the effectiveness in using Six Sigma (Card, 2000). To the first-time QIM adopter having no structured documented process in place, implementing Six Sigma is unlikely to realise claimed benefits.

Not realistic for small organisation. Mayor (2003) also observed that Six Sigma is popular with large organizations, but it's not as realistic for small IT businesses. Six Sigma requires large number of data in order to produce meaningful analysis to identify trends and causes of quality deviations, targets improvement at the cause level then measures result of fixes implemented (K. Kulpa and Johnson, 2003). Small businesses lack the data and the high degree of sophistication in aligning business objectives with Six Sigma techniques and areas of management, render the use of Six Sigma less effective in improving software process (K. Kulpa and Johnson, 2003). Not only that longer time is needed to reach the first million to know if they reduce the defects, the small team structure in small business makes it a challenge to assign a sole Six Sigma specialist in implementing the methodology (Mayor, 2003).

Commitment and participation of all levels required. Top down approach belt program training, covering top management to the operation level, that considers the company's needs and requirements, is essential to realise the economical and managerial benefits (Kwak and Anbari, 2006). Therefore, it is not for organisation that are not committed and supportive of the use of various resources (Kwak and Anbari, 2006).

Specialist and training program required. Training (belt program) is key to the success of Six Sigma adoption. Belt level experts, who are well versed with the tools and techniques of six sigma and are able to communicate with actual data analysis, are critical to guide the company into successful six sigma implementation (Kwak and Anbari, 2006). Assigning a Six Sigma specialist is a challenge to small team (Mayor, 2003).

2.4 Summary of QIMs Strength and Criticisms

The table below provides an overview of the strength and criticism of the QIMs discussed above.

Table 2.4: The Strength and Criticisms of QIMs Discussed

QIM	Strength and Benefits	Criticism and Challenges
ISO 9001	• External demonstration of company's achievement (Paulk, 1998; Wong et al., 2012; Huarng et al, 1999). • Improved business processes (Stelzer *et al.,* 1996). • Increased efficiency and effectiveness (McGuire and Dilts, 2008). • Better team work (Stelzer *et al.,* 1996). • Improved financial performance (McGuire and Dilts, 2008).	• Generic reference causes interpretation difficulties (Stelzer et al., 1996; Paulk, 1998). • No guarantee of quality product (Naveh and Marcus, 2004). • Extensive documentation (Huarng *et al.,* 1999). • Time consuming (Stelzer et al., 1996; McGuire and Dilts, 2008). • High cost of implementation (McGuire and Dilts, 2008; O'Connor and Coleman 2009).

QIM	Strength and Benefits	Criticism and Challenges
	• International competitiveness (Huarng *et al.,* 1999). • Flexibility (Wong, Tshai and Lee, 2012).	
Capability Maturity Model Integration (CMMI)	• Improvement in delivered quality (Grossi et al., 2014; Goldenson et al. 2004; Garud and Kumaraswamy 2005). • Reduction in cost (Goldenson *et al.* 2004). • Increased productivity and ability to meet schedule commitment (Goldenson et al., 2004; Paulk et al., 1993). • Enhanced customer satisfaction (Selleri Silva et al., 2015; Goldenson et al., 2004)	• Complexed application and overly prescriptive (Wong et al., 2016; Khurshid et al., 2009; K. Kulpa and Johnson, 2003; O'Connor and Coleman, 2009). • Scalability difficulties for small organisations (Johnson, 2003). • Lengthy implementation (Selleri Silva et al., 2015; Mahmood et al., 2008). • High cost of implementation (Herrera and Ramirez, 2003; Mahmood et al., 2008; Lyu and Liang, 2014; Selleri Silva et al., 2015).
Information Technology Infrastructure Library (ITIL)	• Less effort to construct own processes (Eikebrokk and Iden 2017). • High level of reliability (Eikebrokk and Iden, 2017; Cronholm and Persson, 2016). • Cost efficiency (Cronholm and Persson, 2016). • Improved communication (Cronholm and Persson, 2016). • Free from license fee (Wong, Tshai and Lee, 2012).	• Too generic and abstract (Szulanski, 1996; Cronholm and Persson, 2016). • Unable to resolve issues (Neward, 2010). • Loss of competitive edge (Cronholm and Persson, 2016). • Scalability problems (Taylor and Macfarlane, 2007).
Six Sigma	• Gain competitive advantage (Kwak and Anbari, 2006).	• Failure to reap benefits in unstructured environment (Card, 2000).

QIM	Strength and Benefits	Criticism and Challenges
	• Increased customer satisfaction (Wong et al., 2012; Kwak and Anbari, 2006). • Improved financial performance (Wong et al., 2012; Kwak and Anbari, 2006).	• Not realistic for small organisation (K. Kulpa and Johnson, 2003; Mayor, 2003). • Commitment and participation of all levels required (Kwak and Anbari, 2006). • Specialist and training program required (Kwak and Anbari, 2006; Mayor, 2003).

2.5 Project Management Life Cycle and System Development Life Cycle

Software companies' core business is developing software product, be it customised to specific customer's needs or packaged software for mass market. Naturally, the core process of a software company is to manage the software process, commonly known as software development lifecycle (SDLC). SDLC is a well-known phase model that provides a lifecycle perspective in the development of software products, consist of a series of defined steps that are generally divided into phases, with each phase being characterised with distinct activities and different priorities (Lai and Tsen, 2013).

Different researchers have defined SDLC phases with slight deviation but the processes or activities are largely similar, differ only by the granularity in defining the phases or naming convention. Some instances are shown in the following table:

Table 2.5: SDLC Phases

Researcher	SDLC Phases
Malik (2017)	Requirement Analysis > Design > Implementation and Unit Testing > Integration and System Testing > Operation and Maintenance
Blake (2004)	Requirements > Design > Construction > Implementation
Tayntor (2003)	Project Initiation > System Analysis > System Design > Construction > Testing > Implementation
Snyder and Cox (1985)	Problem Definition (Requirements) > Design > Programming > Testing > Implementation (Deployment)

As per IEEE Standard Glossary of Software Engineering Terminology, software development cycle typically "includes phases on requirements, design, implementation, test, and sometimes, installation and checkout". With reference to these literatures, it shows that there are many variations and no one definite SDLC. Generally, a typical SDLC shall follow these sequential phases: **Requirements, Design, Development and Testing, and Implementation.**

There is a common misconception between SDLC and Project Management Life Cycle (PMLC). SDLC is not PMLC, but a part of PMLC. The two lifecycles are complementary to each other, with PMLC having 2 additional phases – Initiation and Closing, while SDLC may have a Maintenance phase, like one defined by Malik (2017). When a system is deployed to production, it is handed to support team for maintenance and the project moves into Closing stage.

According to the Project Management Body of Knowledge, "a project life cycle is the series of phases that a project passes through from its start to its closure". Project phases can be broken down by various means such as objectives, deliverables or milestones, and are basically a collection of related activities to achieve the means (Rose 2013).

On the other hand, SDLC is defined as "The period of time that begins with the decision to develop a system and ends when the system is delivered to its end user" per IEEE Standard Glossary of Software Engineering Terminology (The Institute of Electrical and Electronics Engineers, 1990). SDLC also differs from software life cycle which has longer time extension till the product is no longer used.

SDLC focuses on how to develop a software product while PMLC describes how work shall be managed from project conception till closure. PMLC complements SDLC, providing the wholeness and holistic view of a project, starts off way before business' requirements are defined (the first step of SDLC) by ascertaining project goals and assessing project feasibility. For external customers, PMLC first phase shall normally conclude with a contract signed between software companies and the customers, a project charter and initial project plan. After deployment of system and signing of acceptance test, the final phase of SDLC, the project moves to the closeout stage where project assessment is conducted to identify lessons learned. All project information is archived accordingly.

SDLC deliverables are the key outputs of any IT project, with the single most vital output being the system or software product, supported by artifiacts such as test results, user manual, functional and technical specifications. PMLC deliverables are generally of interim nature, produced and refined at each phase, until the project is completed (Blake, 2004). For example, project plan and schedules are updated continuously, change control log is triggered as and when change arises. Refer to the following figure, built based on understanding from the studies by Malik (2017); Blake (2004); Tayntor (2003); Snyder and Cox (1985), for illustration of relationship between PMLC and SDLC.

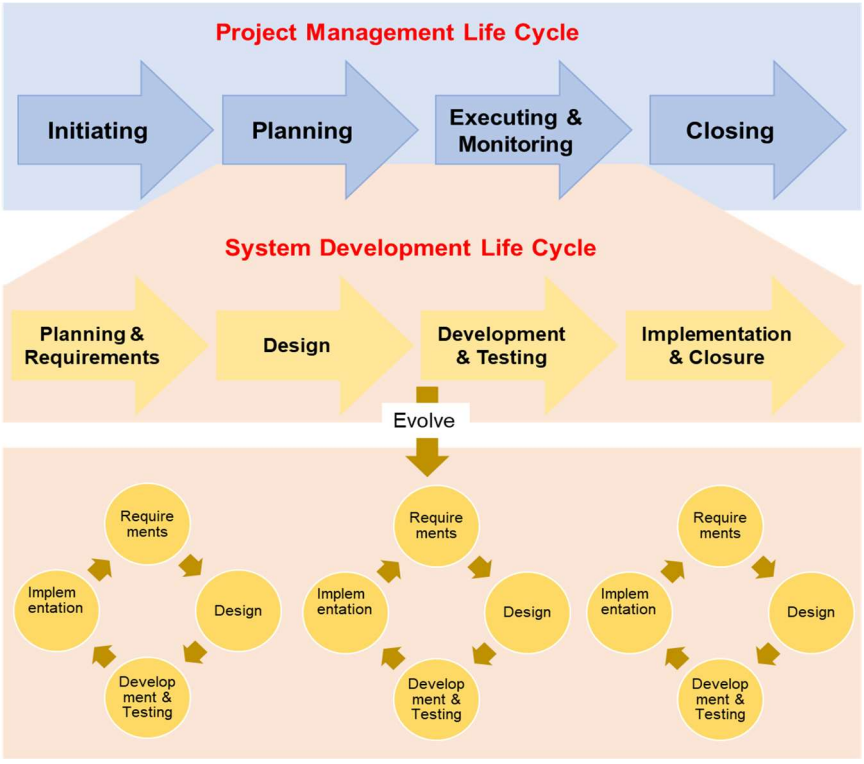

Figure 2.1 Relationship between PMLC and SDLC

The following table provides a brief overview of SDLC activities and deliverables.

Table 2.6: Overview of SDLC

Phase	Activities	Deliverables
Planning	• Define goals, boundaries, constraints • Develop preliminary project plan.	• Project charter • Initial scope and schedule • Initial budget
Requirements	• Identify and validate business requirements • Define process and data models • Produce functional specifications • Develop conceptual design	• Requirements specification documents • Process model • Functional specifications
Design	• Define technical architecture • Prototype systems components • Produce technical specifications	• Technical architecture • System standards • System prototype • Technical specifications • Logical data model
Development and Testing	• Build system components • Conduct system testing • Produce technical documentation	• System modules • Test plan • Unit test results • Integration and system test results • System documentation
Implementation	• Convert / Initiate data • Perform system acceptance • Deploy and transition system • Conduct user training	• User manuals • Training materials • Training assessment • Acceptance test results
Maintenance	• Perform project assessment • Identify lessons learned • Archive project information	• Lessons learned • Project assessment report

Source: Blake, 2004; Tayntor, 2003

In recent years, SDLC has evolved and many have observed the blurring distinctions between phases. The occurrence of phases may not be distinct in real life and likely to overlap especially when the system is developed incrementally and iteratively (Blake, 2004). This is true with the increased popularity of agile methodologies in system development which witnesses the SDLC being transformed into repeated cycles when system is delivered in multiple iterations. One of the key factors that contribute to the "retirement" of traditional approach, where specifications are frozen at the early stage of SDLC and software project carried out in a linear manner, is the cognizance of the volatile environment and the need to cater to users' genuine requirements (Snyder and Cox, 1985). The commonly-acknowledged wise response is to manage and track the change instead. In embracing this new development, SDLC is now seen a circle model, a continuous one, that allows user feedbacks and requirement change to be taken into account in system development (Snyder and Cox, 1985).

Project lifecycle management is seen a necessity in current dynamic environment where changes are constant, to monitor the environment, to adapt any changes to the SDLC and to keep stakeholders informed of project progress, all aim to making the software process more responsive and effective (Snyder and Cox, 1985).

According to Lai and Tsen (2013), SDLC lays out the foundation of project success for software companies, via the detailed guidance to develop and implement system in which project goals are continuously examined throughout the project. Software companies that routinely carry all types of software projects are also likely to systematise their most efficient and effective strategies and practices into their internal operational procedures, i.e. creating their very own version of SDLC. These processes in the SDLC are the key organisational processes of software companies that are to be improved or aligned with ISO 9001 requirements for the purpose of formalising quality management system, and ultimately seeking ISO certification.

2.6 Change Control Management

What is change? What causes it?

Change, is a characteristic of project management. This cannot be more real for software projects where requirements are not easily defined at the early stage of project.

As project progresses, it is not unusual that additional requirements arise due to various factors such as better understanding of the needs, business environmental change, regulatory directives where change to the system is mandatory in order to comply with the laws, business structure change or even cost and time constraint (Wang et al., 2008; Martins de Andrade et al., 2016; Asl and Kama, 2013; Chen and Chen, 2009). Frequent interaction with the stakeholders has helped in refining the requirements as stakeholders become clearer of what is expected out of system (Asl and Kama, 2013). Nevertheless, bug fixing is still the highest reported reason of change request (Martins de Andrade et al., 2016; Asl and Kama, 2013).

What is the concern?

Requirement change normally comes in the form of deletion, modification and addition, to any plan, document, work product, deliverable or artefact is a change (Asl and Kama, 2013). No one can predict when change can happen. Changes are therefore inevitable and persist throughout the SDLC, intertwined as the software product evolves (Asl and Kama, 2013; Chen and Chen, 2009). Run-away requirements and scope creep are likely consequences and the project team may soon find themselves working on a moving target and eventually faced with a poor-quality system. In large project, uncontrolled change often results in chaos, delays and a system that does not meet the requirements of the customers, despite additional cost and time incurred (Wang *et al.,* 2008).

The common risks faced by IS projects now are changing requirements and scope which tend to cause project drift. The focus of software project management is hence on managing risks and controlling changes (Paulk, 1998).

How can we address the risk?

To satisfy all the evolving needs and expectations of customers may be ideal, but project manager cannot be answering to all the whims of customers that may eventually affect the system performance negatively and lead to project overrun (Asl

and Kama, 2013). Implementing change control to IT project is therefore of utmost importance. Change control not only can reduce the risks of project drift, it helps project manager in maintaining a cordial relationship with the customers. Having a defined, mutually-agreeable approval workflow in managing changing requirements, project manager can deny irrelevant requests and focus on core requirements of the system being developed, sparing the project team from unnecessary workload (Wang *et al.,* 2008). Project team, together with the customers, can define the core requirements or configuration baseline. Once approved, any ensuing change requests have to follow the change control process (Wang et al., 2008).

Change control is defined by Project Management Institute as:

"*the process of reviewing, approving and managing changes to deliverables, including communicating the decision thereof*" (Project Management Institute, 2017).

Change control management in an IT company involves critical assessment of suggested changes to the software, including the impact of change to product release, cost and time, with vested authority to make decisions after assessment, followed by managing the approved change from build, test to deployment. This is to ensure disruptive effect of change is avoided ultimately to deliver the product to customers as promised, with quality. Furthermore, a rigorous change control process, one with defined procedure, approving authority and documentation requirement, offers certain degree of flexibility to the software development.

What role does change play in quality management system?

Success of a project depends on how change, an inevitable variable in project, is managed. Change control management is such an integral part of project management that the both disciplines are complementary and mutually supportive (Hornstein, 2015). Unsurprisingly, change control is a focus advocated by widely recognised project management guides, such as APM Body of Knowledge and PMI Body of Knowledge (Hornstein, 2015; Martins de Andrade et al., 2016). In PMBOK, integrated change control is not a knowledge area on its own, but rather a concerted effort that is applied across all the knowledge areas.

In view of the importance of change control management in IT companies' operation, any IT companies seeking quality certification have no option but to put in place a change control management which is in compliant with IT or quality standards.

The latest version of the standard requires formally defined policy, responsibilities and authorities with respect to the process. While necessary support in the form of competent personnel, awareness and adequate communication is required, the process from customers' requirements, design, development, verification, control changes to traceability, also have to be clearly defined (ISO, 2018).

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter aims to present the methodology to which this research is carried out to achieve the objectives outlined in Chapter 1. The research design is first introduced, followed by the stages of research explained in detailed, including the research method, data collection method and research instrument relevant to each stage.

3.2 Research Design

Research design is the plan and structure of investigation, an overall scheme of research, so conceived as to obtain answers to research questions. It gives an outline of what the investigator or researcher will do, from writing hypotheses to the final analysis of data. The ultimate aim being seeking empirical evidence on relations of the problem (Kerlinger, 1986). Blumberg et al., (2014) views research design being a plan built on research questions to guide researcher on the selection of sources of information, types of information and outline of procedures for research activities.

Having in mind the fundamental objective of this research, that is to create a roadmap to a change control management for the adoption of ISO 9001 quality standard by SME software companies in Malaysia, various approaches are explored to ensure the most appropriate approach is reached. Research, as defined by O'Dwyer and Bernauer (2014), is "a systematic process to make things known that are currently unknown by examining the phenomena multiple times and in multiple ways". Hence, the design of the research is guided by the "*what is desired to be known*" and not to be confined in specific research method. A 3-stage approach, comprising both quantitative and qualitative research method, is therefore designed and illustrated in the next page:

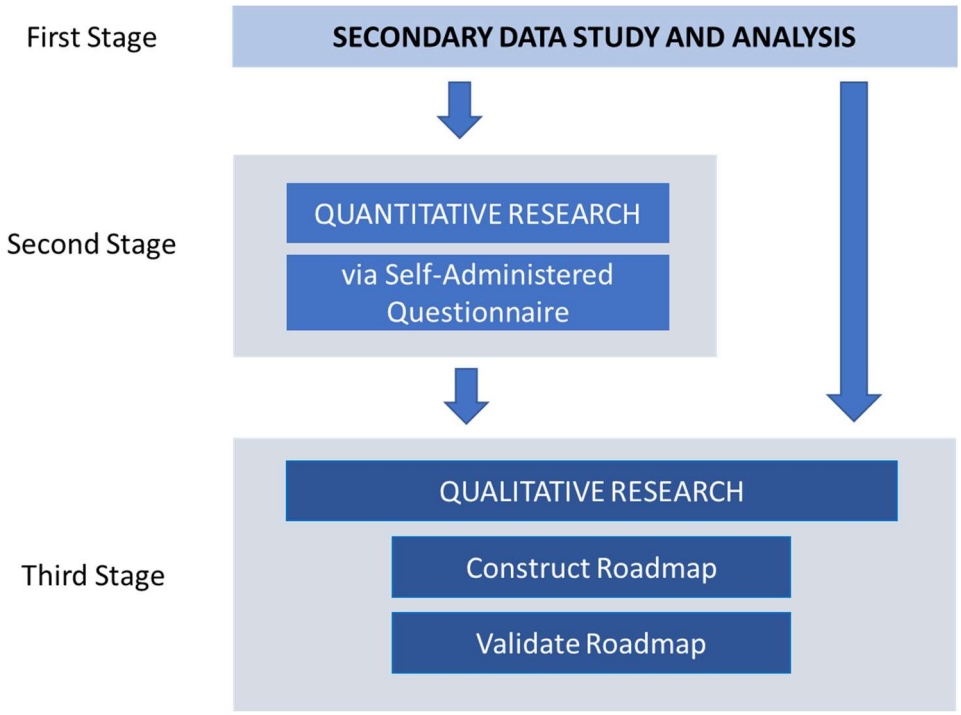

Figure 3.1 3-Stage Approach Research Design

With a large number of past research data and findings on the topics relating software quality improvement, organisation structures and characteristics and design of roadmaps and framework, secondary research is the ideal choice to kick start the research process. Secondary research, via collection, study and analysis of secondary data presents a cost and time efficient method to first obtain the background knowledge and understanding on the research topic. Furthermore, in-depth knowledge of ISO quality standard must begin with reading on the standard itself.

Developing a roadmap and the related validation work to ascertain its practicality, the research is indisputably more descriptive and exploratory in nature. Qualitative study design is therefore deemed to be more appropriate where a new roadmap is explored, as opposed to a quantitative one. However, to develop a roadmap which is friendly and applicable to IT SMEs, it is important to understand and determine the characteristic of IT SMEs, in addition to identifying the critical success factors in implementing a roadmap. It is therefore important for the researcher to establish the “what”, “when”, “how to” in regard to the IT SME’s characteristics and critical success factors. These considerations led to the decision to carry out a quantitative research aim to obtain the latest findings in these respects, with

preliminary data obtained from secondary research. The findings were used the third, final stage, in coming up with a roadmap.

This proposed 3-stage research approach or a similar approach was considered feasible in view of its adoption by other researchers in their attempt in developing a framework or methodology (Kumar et al., 2011; Mata-Lima et al., 2016; Baba et al., 2006).

3.3 First Stage – Secondary Data Study and Analysis

There are generally two approaches in collecting data namely from primary source and secondary source. Information gathered from primary source is known as primary data, i.e. the first-hand information gathered directly from the respondents. On the other hand, information gathered from secondary source is known as secondary data or second-hand information. As the name suggests, secondary data is previously gathered by others to address their areas of concern or to achieve their specific objectives. The overview of the methods of data collection:

Table 3.1: Sources of Information and Method of Data Collection

Source of Information	Method of Data Collection
Primary Source	1. Interview a. Structured b. Unstructured 2. Questionnaire a. Mailed questionnaire b. Collective questionnaire 3. Observation a. Participant b. Non-participant
Secondary Source	1. Documentation a. Research journals, articles b. Publication from government, professional and trade association, c. Books and periodicals d. Media sources

Source: Kumar (2011); Blumberg et al. (2014)

For the purpose of this research, both types of data were collected. Data collected in the first stage of this research were secondary, mainly the earlier research studies and literatures which were of high credibility, also is a form of qualitative study. Publications from the ISO as well as books published in relation to the standard were referred to whenever appropriate. Primary data was collected in the second stage and third stage of the research (described in the following sections).

In the first stage, secondary literature review was conducted and analysed. Studies made by others for their own purpose represents secondary data. With the wealth of fact-rich literatures, it was an efficient way to discover anew through study of secondary data on what had already been done and reported at a level sufficient to give answers to researcher (Blumberg *et al.,* 2014). Secondary research is becoming a popular approach and the general rule of thumb – exhaust all the potential sources of secondary data before moving primary data research.

Based on the literature reviews performed thus far, researcher was confident with this approach due to the enormous volume of available literatures on the interested areas namely the ISO 9001 standards in comparison with other quality improvement methodology, characteristics of SMEs and critical success factors on implementation of QIM. Examples of some authors who have conducted research on these topics are as follows:

Table 3.2: Vast Number of Secondary Sources of Information

Areas of Study	Authors or Researchers
ISO 9001 related topics	1. Helgi Thor Ingason, 2014 2. Samat, Kamaruddin, Chin, 2012 3. Aldowaisan, Youssef 2004 4. Chen, Anchecta, Lee, Dahlgaard, 2016 5. Lee & Gilbert, Lim, 2001 6. Love, Li, 2000 7. Aggelogiannopoulos 2006 8. Olivier Boiral, 2011 9. Manders, Basak, Vries, Henk J.de Blind, Knut, 2016
Proposed Framework/ Methodology / Roadmap on QIM	1. Niazi, Wilson, Zowghi, 2004 2. Kumar, Anthony, Tiwari, 2011 3. Samat, Kamaruddin, Chin, 2012

Areas of Study	Authors or Researchers
	4. Herlander, Morgado-Dias, Galuzzi, Silva Alcantara, Jose Antonio, 2016 5. Reyes, Lona and Kumar, 2015 6. Basir, Ghani Azmi, 2011 7. Yusuf & Aspinwall, 2000 8. Aldowaisan, Youssef, 2004 9. Deros, 2006 10. Baidoun & Zairi, 2003 11. Chen, Anchecta, Lee, Dahlgaard, 2016 12. Love, Li, 2000 13. Aggelogiannopoulos 2006
Characteristics of Small and Medium Size Companies	1. Kumar, Anthony, Tiwari, 2011 2. Yusuf & Aspinwall, 2000 3. Aldowaisan, Youssef, 2004 4. Deros, 2006
Critical Success Factors & Barriers	1. Niazi, Wilson, Zowghi, 2003 2. Helgi Thor Ingason, 2014 3. Tan Chin Keng, Syazwan Zainul Kamal, 2016 4. Baidoun & Zairi, 2003 5. Love, Li, 2000 6. Aggelogiannopoulos 2006 7. Olivier Boiral, 2011 8. Wong et al, 2014

It is further noted that a large number of researchers have relied on secondary data heavily in their research (Niazi et al., 2005; Kumar et al., 2011; Manders et al., 2016). The study by Niazi et al., 2005, found that the critical success factors in implementing software process improvement, identified from literatures review, had relatively similar ranking in terms of occurrences, with those obtained from interviews. This proved the validity of secondary data analysis technique for certain types of information such as those researchers were looking for. By reviewing the prior studies, the following were attained:

- Analyse the principles and requirement of ISO9001:2015.
- Identify and ascertain the unique characteristic of SME as opposed to large companies.

- Identify and analyse the critical success factors and barriers in the implementation.

3.4 Second Stage – Quantitative Research: Survey

3.4.1 Research Method

Quantitative research is an objective research approach used to solve problem and test hypothesis, particularly useful when the aim is to validate or confirm phenomena and relationships, or to generalise an observation of a population (Leedy and Ormrod, 2004). Quantitative research uses quantitative information like numbers and figures. Quantitative study often follows a qualitative study where a phenomenon is explored, to which quantitative study is then used to validate the propositions formed earlier from the qualitative study (Blumberg *et al.,* 2014). Contrasting qualitative study, quantitative study is more structured and predetermined, enabling the researcher to ensure accurate measurement and classification of data obtained (Kumar, 2011).

With reference to the quantitative study conducted by Wong et al., 2012 where QIM adoption pattern was identified in Malaysia, as well as the objectives and resistance factors in doing so, there is already an understanding of the receptance and perception by Malaysia IT industry towards quality management system. The findings are valuable source or justification to this current research in proposing a roadmap to software quality assurance of change control management in alignment with the ISO 9001 requirement.

Nevertheless, the research was conducted a few years ago and changes may have happened. A fresh survey was good to be conducted to reaffirm if the findings are still valid after the progression of some years. Additionally, the author of this research can attempt to identity the characteristics of IT SMEs in Malaysia. Therefore, another quantitative research is best suited in this case to allow the author to achieve the following objectives:

a) To find out the QIM adoption status / pattern among the IT SMEs, - to check if Malaysia IT companies have already evolved from Quality Control (QC) to Quality Assurance (QA), or are still at QC stage (shown by adopting ISO or ITIL, instead of Six Sigma).

b) To explore the potential root causes and resistance factors for slow progress in implementation.

c) To identify the objectives of adopting QIM by IT SMEs, as a support the selection of QIM used for the roadmap development.

d) To gauge the level of QIM formalisation as a means to check how much companies have developed in term of quality management; to cross validate a company's claim on successful implementation and the time taken to do so.

e) To find out the characteristics of SME, information needed to customise an implementation roadmap suitable for SME.

3.4.2 Data Collection Method

The quantitative research chosen is the descriptive research, a classification explained by Leedy and Ormrod (2014) as a research design where characteristics of phenomena and the possible correlations among the phenomena, are identified. A commonly used technique in collecting data for descriptive research is via survey, where the perceptions and attitudes of a target group can be identified.

First, the research conducted by Wong et al. (2012) was studied thoroughly where relevant information were identified (see Chapter 4 for survey analysis made in reference to this study). Secondly, literature reviews to other studies were done to identify other relevant variables and potential measurements to be built into the survey questionnaire. Variables and measurements are important elements in conducting quantitative studies as the emphasis is to find out the generalisability of the study population (Kumar 2011), in this case, the IT SMEs.

Questionnaire was then designed and contacts were identified from the website of Malaysia Digital Economy Corporation Sdn. Bhd. ("MDEC"), where a database of IT SMEs was available. In addition to sending the questionnaire to these companies, close contacts in the industry were also invited to respond to the survey.

The survey was conducted via self-administered questionnaire. Due to the time limitation and financial constraint, online self-administered questionnaire was deemed to be the most appropriate as opposed to pen-and-paper survey and telephone survey. The survey questionnaire was sent to a large number of potential respondents in a shortest time for an extremely low cost. Google form was used, which was free of charge, but limitation was faced in formatting the questionnaire. Questions where preference measurement response is required, such as ranking scale where respondent was asked to rank their order of preference, could not be set, unless premium was paid

to the host. This type of questions was adapted to seeking response from yes, no or maybe options. Response to this type of questions were therefore risk being seen as bias.

3.4.3 Research Instrument

A structured self-administered questionnaire made up of 3 sections was designed to collect data. A copy is appended in Appendix A.

The questions and statements contained in the questionnaire are largely based on secondary data, past research studies conducted by researchers around the world. The quantitative research carried out here aims to reaffirm if the findings by these researchers remain valid or relevant in Malaysia context.

Table 3.3: Sources of Questions and Statements

Section / Statements	**Sources of Reference**
Section 1: Company and Respondent Background	
1. The nature of your company business	Wong et al., 2012
2. Number of years of operation	Churchill and Lewis, 1983
3. The size of your company / department	Definition by SME Corp Malaysia for SME by company size or by company revenue.
4. The company's revenue	
5. Respondent job role	Nasir et al., 2008; Brietzke and Rabelo, 2006; and Wong et al., 2012
6. Respondent's years of relevant experience in IT project or IT operation	Guide to Job Mapping, Watson Wyatt Data Services EMEA Pakistan Forum, 2007
Section 2: Company Characteristics	
1. Simple structure.	Scott and Bruce, 1987; Taylor and Macfarlane, 2007
2. Entrepreneurial and direct supervision.	
3. Close, highly informal interaction among employees.	
4. Strong team spirit demonstrated by a single team with common goals.	
5. Communication is quick and wide reaching (within days and to multiple levels).	
6. High responsiveness with decision made within a day.	
7. Flexibility in making changes and corrective actions.	
8. Everyone understands the process chain and operation of the company.	

Section / Statements	Sources of Reference
9. Heavy reliance on limited few individuals / specialists for decision making.	
10. Most employees carry out different roles or job functions.	
11. Specialist skills are sometimes sought from third-party supplier.	
Section 3: QIM Implementation	
1. Status of quality management system in the company or department	Tricker, 2010
2. Years of implementation	Mahmood et al., 2008; Stelzer et al., 1996
3. Objective in implementing quality management system	Wong et al., 2014; Kwak and Anbari, 2006; Stelzer et al., 1996.
4. Primary choice QIM in the past, current and future.	Wong et al., 2014
5. Secondary choice of QIM in the past, current and future.	
6. Resistance factors in QIM implementation	
a) Lack of skill, knowledge and experience in software process improvement.	Wong et al., 2014; Nasir et al., 2008; Mahmood et al., 2008; Brietzke and Rabelo, 2006
b) Lack of consistent support and understanding from senior management.	Wong et al., 2014; Nasir et al., 2008; Mahmood et al., 2008; Brietzke and Rabelo, 2006; Beecham et al., 2003
c) Unclear goals and objectives in software improvement project and clarity in the progress milestones.	Wong et al., 2014; Nasir et al., 2008; Brietzke and Rabelo, 2006
d) Employees are not trained on software process improvement.	Wong et al., 2014; Nasir et al., 2008; Brietzke and Rabelo, 2006; Beecham et al., 2003
e) High cost of implementation.	Wong et al., 2014; Nasir et al., 2008; Mahmood et al., 2008; Brietzke and Rabelo, 2006; Love and Li, 2000
f) Company is not clear on the quality policies and standards.	Wong et al., 2014; Nasir et al., 2008; Mahmood et al., 2008; Brietzke and Rabelo, 2006
g) Insufficient assessment of current software process.	Wong et al., 2014; Nasir et al., 2008; Brietzke and Rabelo, 2006
h) Insufficient assessment of company's need with respect to quality initiative implementation.	Wong et al., 2014; Brietzke and Rabelo, 2006
i) Implementation causes lack of focus on core business or distraction from urgent need.	Wong et al., 2014; Nasir et al., 2008;
j) Lack of teamwork.	Wong et al., 2014
k) Lack of commitment and participation from ALL levels of the company.	Nasir et al., 2008; Brietzke and Rabelo, 2006; Beecham et al., 2003

Section / Statements	Sources of Reference
l) Unrealistic expectations of software process improvement project, including the goals, deadlines and results.	Nasir et al., 2008; Mahmood et al., 2008; Brietzke and Rabelo, 2006
m) Lack of focus or low priority on the software process improvement project.	
n) Excessive documentation requirement of software process improvement.	Nasir et al., 2008; Mahmood et al., 2008; Brietzke and Rabelo, 2006; Love and Li, 2000

The result from the second stage of the research was used to support the development of a roadmap to change control management that is in compliance with ISO 9001 requirement.

3.5 Third Stage – Qualitative Research: Construct and Validation of Implementation Roadmap

3.5.1 Research Method

A qualitative study design is less specific and precise as compared to quantitative study design which is normally well structured and explicitly defined to ensure accuracy in measurement and classification. However, qualitative study design, of which the focus is to understand, explore and clarify situations or experiences, is more appropriate for exploring variation and diversity (Kumar, 2011). Qualitative refers to the meaning, the definition or model characterizing something, and base on qualitative information such as sentences and narratives to study a phenomenon (Blumberg *et al.,* 2014).

As qualitative study is more flexible and adopts a subjective approach in conducting research, it allows researcher to gain more insights in the interested topic rather than studying a large number of samples.

First, an implementation roadmap to facilitate IT SMEs in formalising change control management that was in compliance with ISO 9001, was constructed based on the secondary data obtained from literature reviews. Wide variety of sources were studied, including publications, textbooks, online resources, journals and articles, on ISO 9001 requirements, change control process, versioning control system. Based on this information, the roadmap, the detailed operating procedures, process flowcharts, forms and templates were developed to meet the requirement of ISO 9001. See Section 5.8 for the mapping of proposed roadmap to ISO 9001 requirement.

The constructed roadmap, along with the supporting components were then validated via in-depth, semi-structured interviews with selected IT SMEs' representatives for practicality and applicability. Amendments are made with reference to the feedbacks and comments from these assessors, if appropriate.

3.5.2 Data Collection Method

Using the semi-structured interview approach, researcher will begin the interview with specific questions and interviewees are then allowed to offer their views and thoughts freely. The interviewees will nevertheless be guided by researcher to avoid digression from the key issue. This approach, as opposed to a predefined set of questions, gives researcher the flexibility to use probing technique to evoke additional information (Blumberg *et al,.* 2014).

Semi-structured interview is preferred as opposed to structured interview due to the its flexibility. Structured interview is guided by a set of predetermined questions where all the respondents are expected to answer hence limiting the researcher's ability to seek elaboration or clarification which may arise from how the respondents provide their answer. Whereas, unstructured interview which mostly starts with respondent's narrative and may not have any specific questions or topic risk digressing too much and losing sight on the information researcher attempts to find out.

Semi-structure interview was hence ideal that it allowed the author to gain insight to what the respondents consider relevant to the proposed roadmap, as well as how they interpret it, while at the same time be guided along by the author to ensure all the key areas are covered. The interview process was flexible and evolving. Supplementary questions were raised in response to the answer provided by the participants, in addition to observing the body language or facial expression.

The selection of people for the semi-structured interviews was made with the aim to offer different perspectives to the constructed roadmap. People of 3 different backgrounds or roles were invited,

a) Person of managerial position who has experience playing the role of review and overseeing the whole project,
b) Person of operational position who is more involved in the implementation of change request, from design to coding, testing and deployment, and
c) Person with experience working with ISO 9001, hence was able to provide opinion on the designed roadmap from the perspective of ISO compliance.

Concordance is an important concept in qualitative research. The agreement of participants or interviewees to the proposed roadmap is important validation that influence the value of this research. Efforts were therefore made with repeated attempts to seek the participants' agreement to the author's presentation of the roadmap, its components and interpretation of the ISO 9001 requirements. See Chapter 6 for result of validation.

3.5.3 Research Instrument

This research uses an interview guide to conduct the semi-structured interview. As pointed out by Blumberg et al. (2014), writing an interview guide is an important part of qualitative interviewing to learn more about the respondents' view point. An interview guide serves as a memory list to ensure that the same issues are addressed in every interview and hence to increase the comparability of multiple qualitative interviews.

There was no specific format on the interview guide which was intended to be flexible, and depended on the course of the conversation, follow-up and new questions were raised. The author was mindful in preparation of the interview guide questions as there were always trade-offs to consider. The more specific the questions were then the more structured the interviews would become, and that would mean interviewer will be less flexible to respond to the feedback of the respondents. Bearing this in mind, the questions surrounded the following focus:

a) Background of the participant, including his/her job scope, the nature of business and the size of the company the participant works in;
b) Comment regarding the human resources requirement of the proposed roadmap;
c) Comment regarding the documentation requirement of the proposed roadmap; and
d) Comment regarding the process requirement on preparation, review and approval.

3.6 Summary

The research methodology described here provides an overview of the approach on how this research was carried out, to the best extent the author deems appropriate. The 3-stage research which was heavily reliant on the secondary data was complimented with semi-structured interview in third stage where first-hand validation was sought. Amendment to the approach was made when necessary.

CHAPTER 4

SURVEY FINDINGS AND DISCUSSIONS

4.1 Introduction

Based on the research finding by Wong et al. (2014), as shown in Chapter 2, ISO 9000 or 9001 was a popular QIM choice among IT SME in Malaysia. The selection is in consistent with the view of Heston and Phifer (2011) where ISO 9000 / 9001 being the model best suit companies aiming to establish or formalise their quality management system. While these findings provide support to this paper to focus on ISO 9000 / 9001 as an "entry level" to quality management system and to construct a roadmap to assist companies interested in upgrading their quality system to kick start the journey, we decide to conduct a survey to reaffirm the selection.

In addition to reaffirming the selection of QIM model to be adopted, the survey is also carried out to bring lights to the following areas of concern:

- The overall QIM adoption status / pattern among Malaysia IT SMEs, the level of QIM formalisation and the average duration for QIM implementation,
- The objectives and the resistance factors of QIM adoption, and
- The characteristics of SME.

The online survey questionnaire was distributed to a total of 130 potential respondents, mainly IT companies of small and medium scale (with contact obtained from the website of Malaysia Digital Economy Corporation Sdn. Bhd. ("MDEC")), to which 18 responses were received. The response rate was 14% but, fortunately there was no unanswered questions nor missing value in the responses received which rendered the entire response invalid. While the lacklustre response to the survey did raise the question of Malaysia IT industry's general interest in this field of quality assurance or merely the lack of familiarity, which can be a topic for future research, the author focused on the limited responses received to conduct the analysis.

4.2 Demographic Information and Analysis

The demographic information for the study largely centred on the background of company and respondent, for the purpose to distinguish the size of the company (if it fits into the definition of SME as shown in Table 2.1) and to understand the experience of the respondent in IT project and / or IT operation, which the author is of the view that may add credibility to the response provided.

4.2.1 Background – Company / IT Department

Most of the respondent companies (12 or 67%) have been in operation for more than 10 years, of which 7 or 39% of the samples operated for more than 20 years. There were 2 or 11% of the samples which were relatively young companies with operation below 5 years (see Figure 4.1).

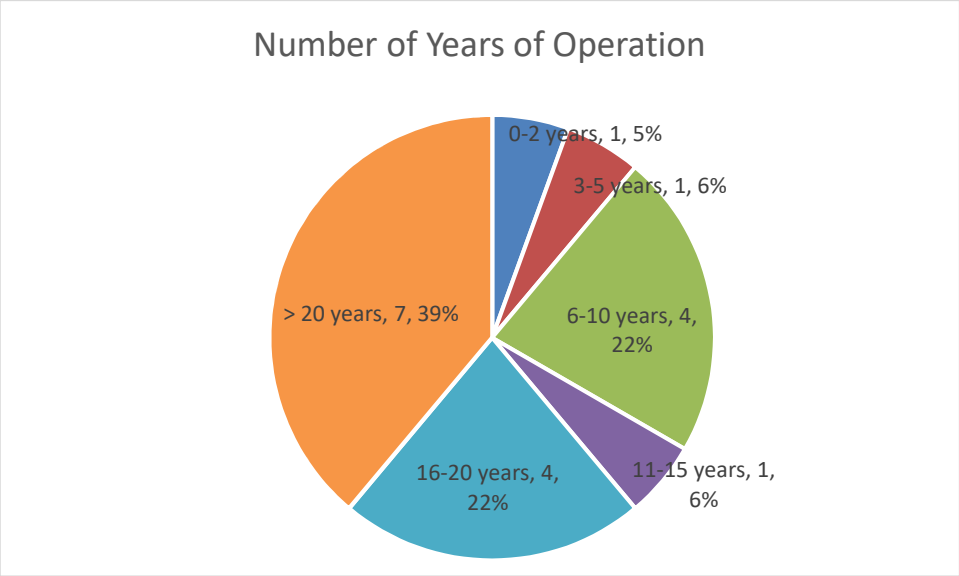

Figure 4.1: Company Years of Operation

More than half of the respondent companies (11 or 61%) were from the IT industry, involving in hardware manufacturing or retailing, IT consulting and software house. 7 or 39% of the respondents were inhouse IT department from various industries such as manufacturing, logistic service, etc. (see Figure 4.2).

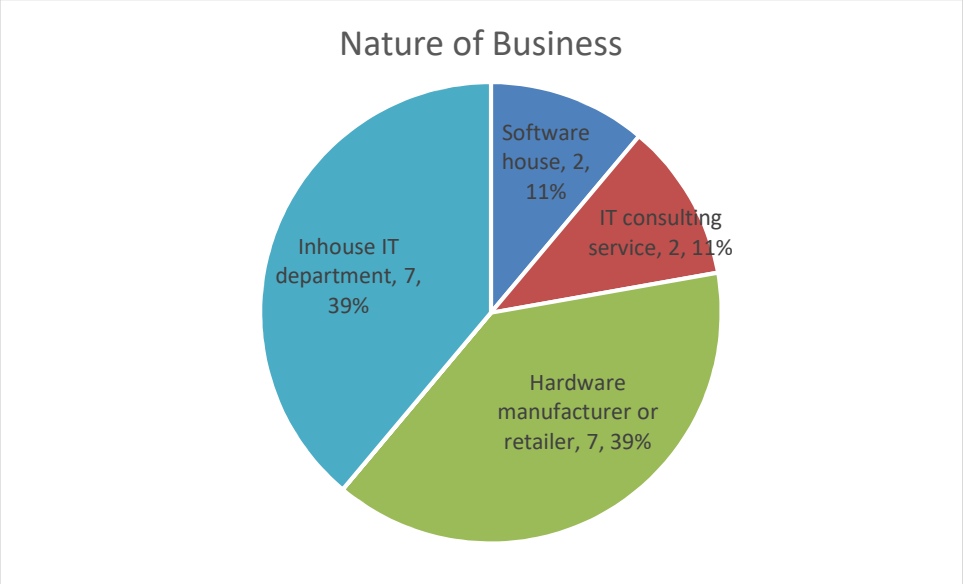

Figure 4.2: Company Nature of Business

A total of 9 surveyed companies or half of the sample size were from SME category[1] by definition of employee size, made up of medium-size with 31 to 75 employees (2 respondents or 11%); small-size with 6 to 30 employees (6 respondents or 33%); and micro-size with 5 employees or less (1 respondent or 6%) (see Figure 4.3). Besides judging a company size by the manpower strength, SME Corp also defines a company with revenue of less than RM20 million as SME even if the employee size is more than 75. Measuring from the perspective of company revenue, a respondent with more than 75 employees was considered medium-size with its revenue of less than RM20 million, bringing the total SME samples to 10 or 56% (see Figure 4.4).

[1] For the purpose of this survey analysis, respondents that are from IT departments with 75 employees or less are grouped as SME.

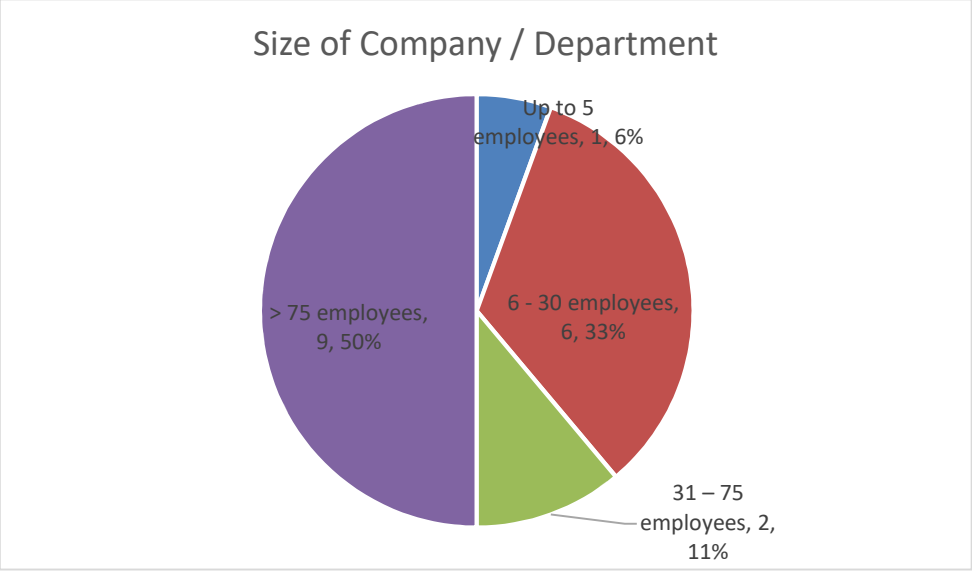

Figure 4.3: Size of Company or Department

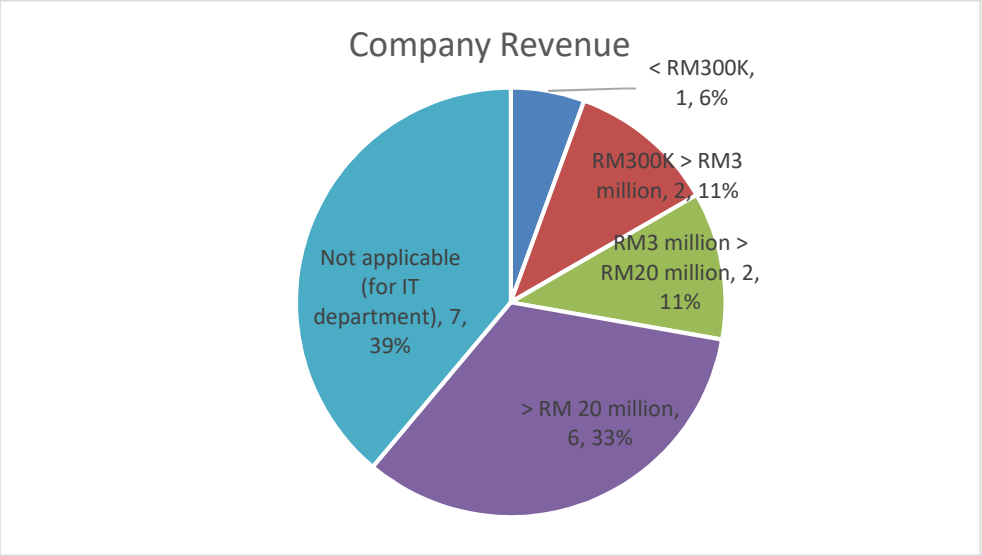

Figure 4.4: Company Revenue

4.2.2 Background – Respondents who Answered the Survey

Majority of the respondents (7 or 39%) were from managerial positions, comprising project manager, quality manager, enterprise infrastructure service manager and sales director, etc. The remaining being roles involved in project, 4 (22%) each identified themselves as software developer and software engineer; 3 (17%) were System Analysts (see Figure 4.5). 10 or 56% of the respondents reported working experience in IT Project of 5 years or more, with 6 (33%) having more than 10 years of experience

(see Figure 4.6). The number of years of working experience reported was consistent and correlated to the seniority level of the respondents. Only 1 respondent was noted to have working experience of less than 2 years. In other words, the responses received were largely from experienced IT personnel and hence lending more credibility to the views obtained from this survey.

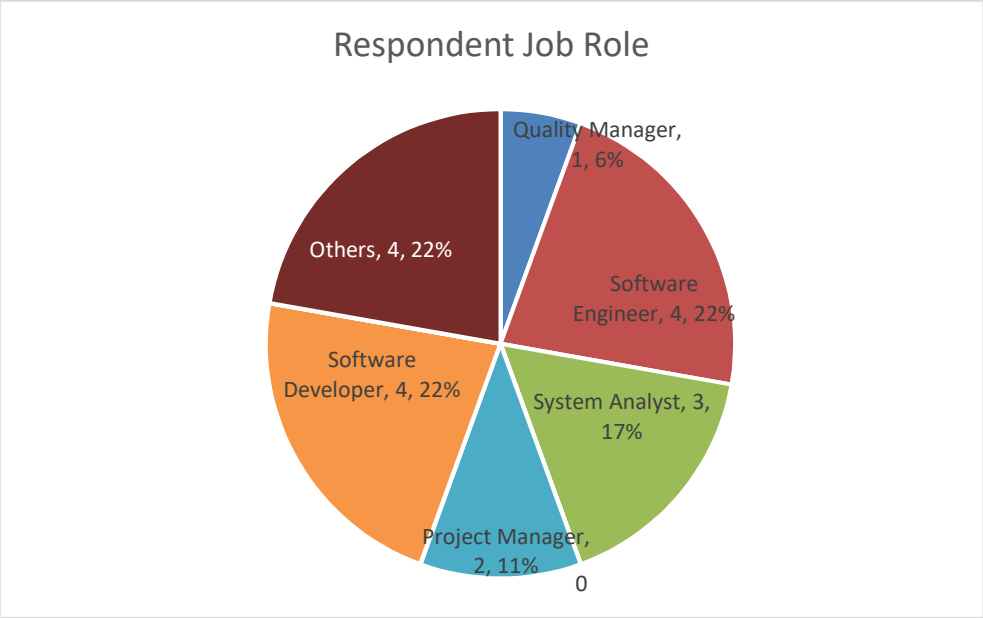

Figure 4.5: Respondent Job Role

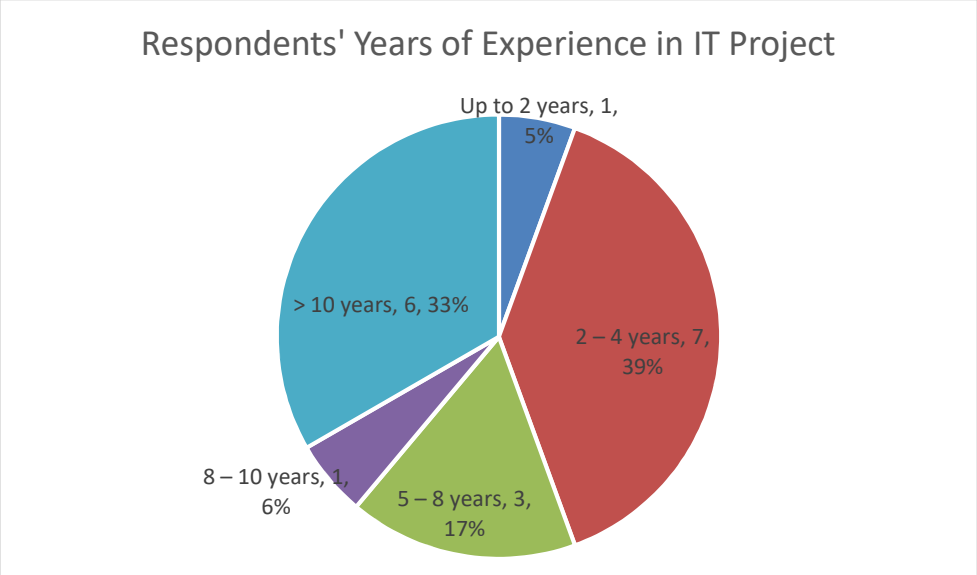

Figure 4.6: Respondent Years of Experience in IT Project

4.3 QIM Adoption, the Objectives and Resistance Factors

More than half of the respondents (10 or 56%) claimed to have adopted a formal quality management system, with 8 or 44% acknowledging the lack of one. However, none of the respondents have achieved a certification with respect to the formal quality management system implemented (see Figure 4.7), giving doubts to the perceived formality of the quality management system that has been put in place. 3 (30%) out of the 10 respondents, that claimed to have adopted a formal quality management system, reported a duration of more than 3 years for the adoption; 2 (20%) stated a duration between 1 to 2 years; no specific period was provided by the rest.

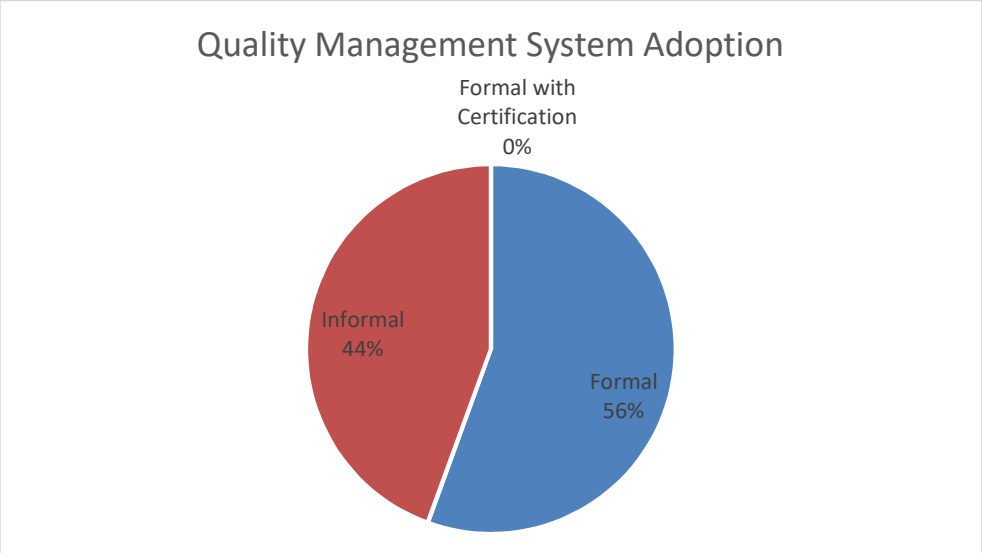

Figure 4.7: The Adoption of Quality Management System

The finding where no certification was obtained by any respondent with respect to any QIM was out of the expectation of the author. This was a strong indicator where challenges were likely faced by the IT industry in formal QIM adoption, one that can be independently verified by third party such as certification body, despite the strong desire in putting a quality management system in place.

4.3.1 The Pattern of QIM Adoption

Questions in respect of QIM adoption in the past, current and future were answered by all the 18 respondents. However, 10 (56%) out of 18 respondents showed indifference between their primary and secondary choice of QIM, i.e. the choices for primary and secondary QIM are the same.

The survey result showed that ISO was the most adopted QIM in the past, gaining a favourable selection of 44% (see Figure 4.8). ITIL was the most preferred choice in the current (39%) whereas Six Sigma (28%) was the favourite candidate in the future (see Figure 4.9 and Figure 4.10).

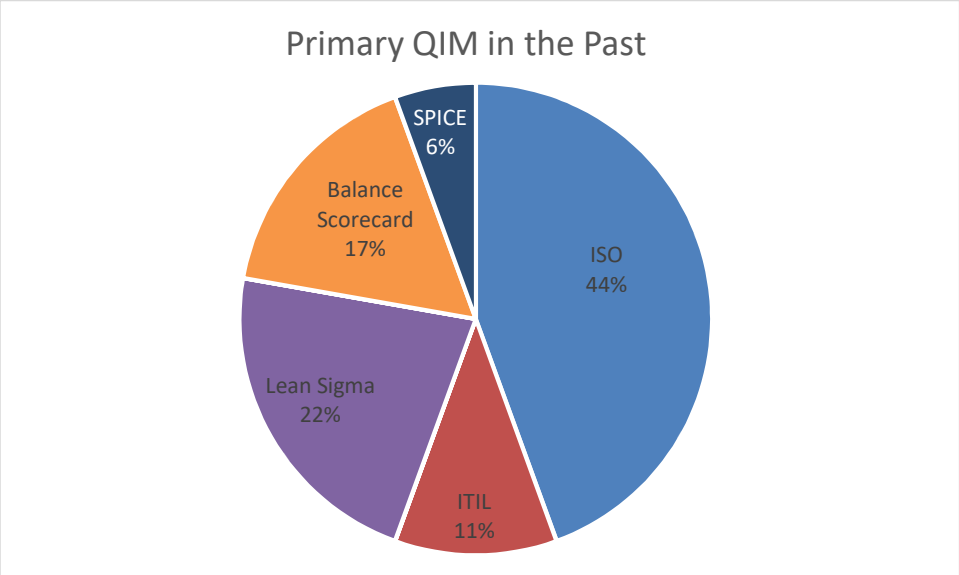

Figure 4.8: Preferred Primary QIM in the Past

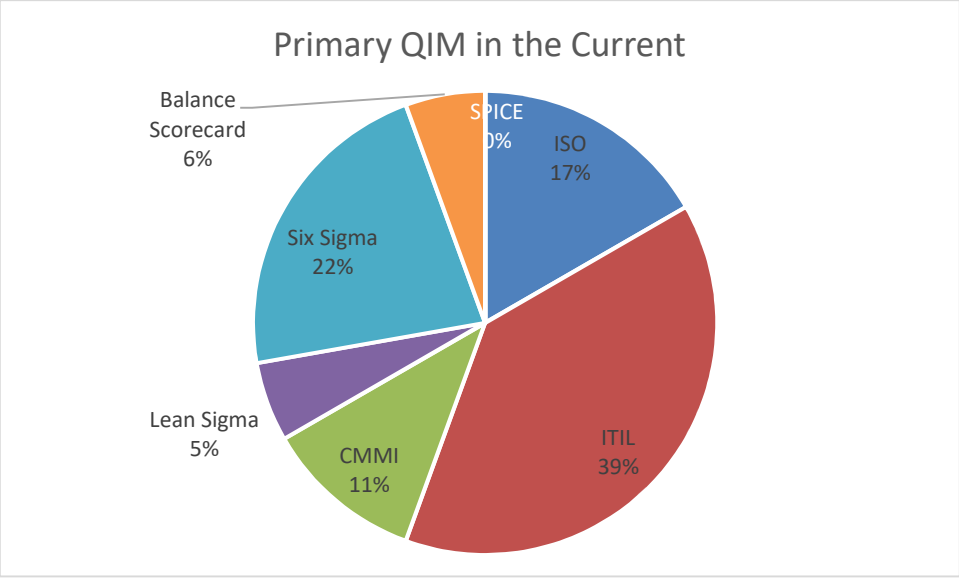

Figure 4.9: Preferred Primary QIM in the Current

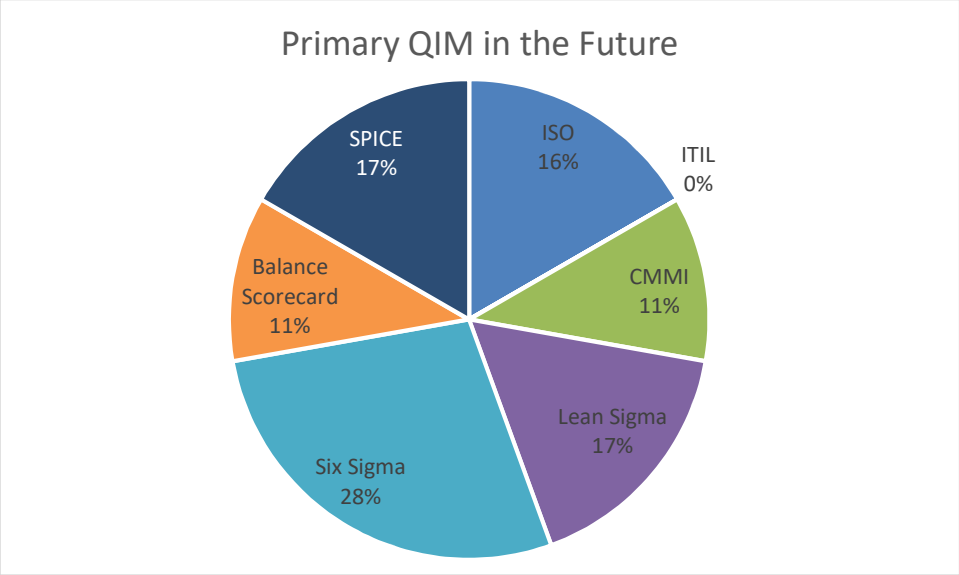

Figure 4.10: Preferred Primary QIM in the Future

The result of this survey was **consistent with the similar survey conducted by** (Wong *et al.* 2014)**)**, in term of favourable **primary choice** of QIM in **the past, to-date and in the future**, strongly indicating that ISO being a favourable "starter" to setting up a quality management system. The result also showed that **the pattern of primary QIM adoption revealed in the same study remained unchanged** (see Figure 4.11), while we noticed that the favourability for ISO and ITIL selection has strengthened, as follows:

Primary QIM Choice	Wong et al., (2014)*	Current Survey#
Past - ISO	19%	44%
Current - ITIL	26%	39%
Future - Six Sigma	29%	28%

Table 4.1: Comparison of Primary QIM Choice from Current Survey with Survey conducted by (Wong *et al.* 2014)).
* Research finding is based on actual adopted QIM
# Research finding is based on preferred choice of QIM

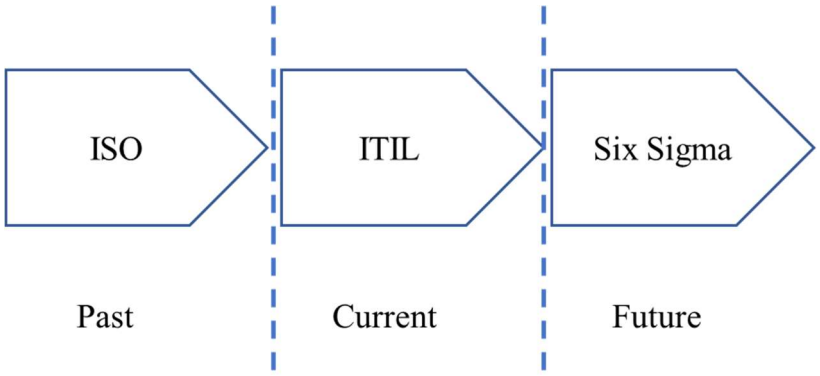

Figure 4.11: The Evolution Pattern in QIM Adoption

No attempt was made to compare the pattern in secondary QIM adoption as 10 responses were noted to be not valid.

In conclusion, there is no drastic change in the trend of adopting QIM in Malaysia IT industry. The choice of QIM, if given an opportunity to implement one, is highly similar to what the industry has chosen to adopt five years ago based on the finding from survey conducted by Wong et al., (2014).A study shall be worth investment by the government agency such as MDEC, to identify the root cause of the slow evolution in order to come up with supporting measures to help the industry to mature and to build up the capability to compete globally.

4.3.2 The Objectives in Adopting QIM

There are numerous benefits in implementing quality management system, the chief being improvements to the IT project management that translate into higher success rate in software project implementation. As per author's collective literature review (Wong et al., 2014; Kwak and Anbari, 2006; Stelzer et al., 1996), the common objectives companies strive to achieve by implementing QIM are:

a) To improve organisational efficiency and effectiveness,
b) To improve products and / or services,
c) To improve operation process,
d) To increase customers' satisfaction / to fulfil customers' requirement,
e) To gain competitive advantage / market share,
f) To cut cost,
g) To reduce response time and improve cycle time,
h) To increase productivity,

i) To improve financial performance / increase profitability, and
j) To strengthen team work and team spirit.

Based on these collective views, the author has sought the opinion from the respondents with regard to the reasons of QIM adoption. The respondents were asked to provide a "Yes", "No" or "Maybe" answer to the list of suggested objectives (see Table 4.2 for response). The top 3 objectives of QIM adoption, which is also the consensus among ALL the respondents are: **(1) To improve organisational efficiency and effectiveness; (2) To improve operation process; and (3) To increase customers' satisfaction / to fulfil customers' requirement** (see Figure 4.12). These objectives or benefits are highly correlated and compliment to each other. Improved operation process, always a result of clear standards and procedures which are characterised by proactive approach in addressing project risks, is a key contributor to improved organisational efficiency and effectiveness. Non-conformance can be dealt with swiftly and unambiguously in view of the defined standards. All these can save time and cost, improving the chance of project success hence ultimately improve customer satisfaction.

Table 4.2: Survey responses to the objectives of adopting QIM

No.	Suggested Objectives	Response			
		Yes	No	Maybe	Total
1.	To improve organisational efficiency and effectiveness	18	0	0	18
2.	To improve operation process	18	0	0	18
3.	To increase customers' satisfaction / to fulfil customers' requirement	18	0	0	18
4.	To improve products and / or services	17	0	1	18
5.	To increase productivity	16	0	2	18
6.	To gain competitive advantage / market share	15	2	1	18
7.	To improve financial performance / increase profitability	14	2	2	18
8.	To reduce response time and improve cycle time	13	2	3	18
9.	To strengthen team work and team spirit	12	4	2	18
10.	To cut cost	10	6	2	18

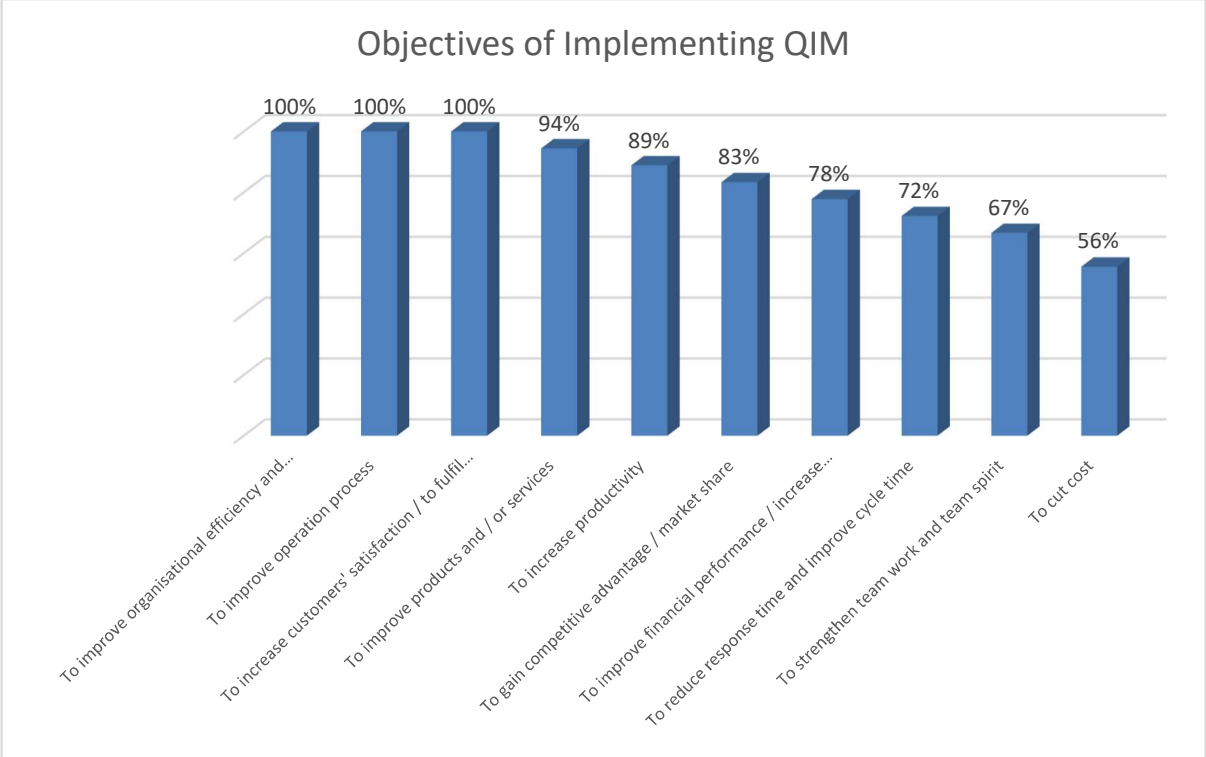

Figure 4.12: Objectives of Implementing QIM

The top 3 objectives selected by the respondents **were coherent with the findings revealed by Wong et al., (2014)**, which surrounded collaboration and standardisation of practices aim to **getting things right**; **meeting customer's expectation** and improving relationship; and **corporate sustainability**, the natural result when the first 2 objectives were met.

In conclusion, there are many reasons why a company chooses to adopt QIM but cost cutting seems to be a complimentary result from doing so instead of being the key objective. Increasing company's efficiency and effectiveness and enhancing customers' satisfaction are the key objectives. IT companies are therefore recommended to review and assess their existing processes, identify the gaps and improve. Enhanced customers' satisfaction is likely the consequent result of doing so. The proposed roadmap in this paper, with the focus on one of the key business processes in IT companies, i.e. change control management, will be a good start to this journey.

4.3.3 The Resistance Factors in Adopting QIM

In view of the favourable response to the objectives, which are also the benefits of QIM adoption, as shown in section 1.3.1, it showed that implementing QIM can be / is a well-received approach by IT companies to improve their organisation. However, the survey at the same time, revealed the disappointing fact when come to seeking certification to the QIM adopted among the respondents. None of the respondents who claimed to have a formalised QIM in place was actually certified. This implies the potential gap between the quality management system implemented by industry players and the requirement of internationally recognised standards.

This section aims to explore further on the factors or hindrances that have kept a company from adopting a formal QIM or seeking quality certification. Understanding the resistance factors is a must for one to implement quality improvement initiative successfully (Wong et al., 2014).

Similar to the approach in designing the survey questions to gather opinion on QIM implementation objectives, an extensive literature review (Schwalbe, 2015; Wong et al., 2014; Nasir et al., 2008; Mahmood et al., 2008; Brietzke and Rabelo, 2006; Beecham et al., 2003; Love and Li, 2000) was also conducted to form the list of questions devised to identify the resistance factors.

Respondent to the survey questions chose from 5 predetermined options for each resistance factors, *Strongly Disagree, Disagree, Neutral, Agree* and *Strongly Agree*, where each option was deemed as an influence level (*L*) to which weightage (*W*) to each level was defined (see Table 4.3).

Influence Level, *L*	**Weightage Score, *W***
Strongly Disagree, 1	1
Disagree, 2	2
Neutral, 3	3
Agree, 4	4
Strongly Agree, 5	5

Table 4.3: Value of Influence Level (*L*) and Weightage (*W*)

The response was then analysed using the influence level weightage, a similar approach adopted in past studies of similar nature (Wong et al., 2014; Brietzke and

Rabelo, 2006), to provide a comparison among the resistance factors from criticality point of view. The higher an influence score indicated the more critical impact the resistance factor had in QIM implementation. The total influence level score for each resistance factor was computed using the following formula:

$$T(f_n) = \sum_{n=14}^{n=1} L(f_n).W(f_n)$$

T(fn) was the total influence level score for one factor (f), summed up based on the number of responses to the levels of influence of each factor, multiplied by the respective weightage score.

fn was the factor number.

n was the number of resistance factors. There was a total of 14 factors.

L(fn) was the number of responses to an influence level.

W (fn) was the weightage score to the influence level, as shown in Table 4.3 above.

The small deviation in the weighted score of the resistance factors showed that the respondents were generally agreeable to most of the resistance factors highlighted. Nevertheless, the **findings** were **similar to** the **survey result by Wong et al. (2014)** (see comparison of study in Table 4.5) and were consistent with literature review of Brietzke and Rabelo (2006), indicating that the challenges in implementing QIM remained relatively unchanged. The top 3 resistance factors rated by the respondents were **(1) Lack of senior management support; (2) Lack of skill and knowledge; and (3) Unclear goals and objectives in the software improvement project**. The same literatures attributed these resistance factors as organisational-driven, in other words, organisational management attention and approaches are instrumental in ensuring successful QIM implementation.

In conclusion, companies interested in implementing QIM are recommended to strengthen the leadership skill of the senior management to be more instrumental in showing the vision, goals and objectives in implementing QIM. They need to provide the management support, via appropriate supervision, unlimited access for advice, practicing transparency in information sharing, which are critical for successful implementation. Necessary training shall be provided to the employees involved to equip them with the skill and knowledge in the implementation of QIM. Professional help from outside the company shall be sought if needed to demonstrate to the

employees that the company is ready to assist them in closing the knowledge gap in order for them to complete any tasks related to QIM implementation.

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Table 4.4 shows the summary of the total influence score for the 14 resistance factors contained in the survey based on all the 18 responses.

	Resistance Factors	Level of Influence					Weighted Score $T(f_n)$
		Strong Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	
F1	Lack of consistent support and understanding from senior management.	0	0	3	11	4	73
F2	Lack of skill, knowledge & experience in SPI.	0	0	3	13	2	71
F3	Unclear goals & objectives in software improvement project and clarity in the progress milestones.	0	0	4	12	2	70
F4	Employees are not trained on software process improvement.	0	0	5	11	2	69
F5	Lack of commitment and participation from ALL levels of the company.	0	2	3	10	3	68
F6	Implementation causes lack of focus on core business or distraction from urgent need.	0	2	3	11	2	67
F7	Lack of focus or low priority on the software process improvement project.	0	0	6	12	0	66
F8	Excessive documentation requirement of software process improvement.	0	2	5	8	3	66
F9	Insufficient assessment of company's need with respect to QIM.	0	1	6	10	1	65
F10	Unrealistic expectations of SPI project, including the goals, deadlines and results.	0	1	5	12	0	65
F11	Insufficient assessment of current software process.	0	1	7	9	1	64
F12	Company is not clear on the quality policies and standards.	0	3	7	7	1	60
F13	High cost of implementation.	0	1	12	4	1	59
F14	Lack of teamwork.	0	3	7	8	0	59

Table 4.5 shows the comparison of ranking of the resistance factors between survey by Wong et al. (2014) and current survey

	Current Survey		Survey by Wong et al. (2014)	
	Resistance Factors	**Weighted Score $T(f_n)$**	**Resistance Factors**	**Weighted Score $T(f_n)$**
F1	Lack of consistent support and understanding from senior management.	73	Lack of leadership, skill and professional knowledge in implementation.	812
F2	Lack of skill, knowledge & experience in SPI.	71	Lack of support from senior management.	774
F3	Unclear goals & objectives in software improvement project and clarity in the progress milestones.	70	Lack of clear goals and objectives.	774
F4	Employees are not trained on software process improvement.	69	Insufficient training and awareness for individuals in ALL levels in the organisation	710
F5	Lack of commitment and participation from ALL levels of the company.	68	Costs higher than budgeted.	662
F6	Implementation causes lack of focus on core business or distraction from urgent need.	67	Lack of clear organisational and/or quality policies making intentions clear regarding quality improvement initiative	641
F7	Lack of focus or low priority on the software process improvement project.	66	Insufficient analysis of current situation of software process	610
F8	Excessive documentation requirement of software process improvement.	66	Failure to conduct an initial analysis checking if organisation required the implementation of this particular initiative	565
F9	Insufficient assessment of company's need with respect to QIM.	65	Implementation in counterproductive; causes distraction from more urgent needs	533
F10	Unrealistic expectations of SPI project, including the goals, deadlines and results.	65	Lack of teamwork and participation among members of ALL levels in the organization	493
F11	Insufficient assessment of current software process.	64		
F12	Company is not clear on the quality policies and standards.	60		
F13	High cost of implementation.	59		
F14	Lack of teamwork.	59		

The result of the survey on resistance factors depicted in pictorial form:

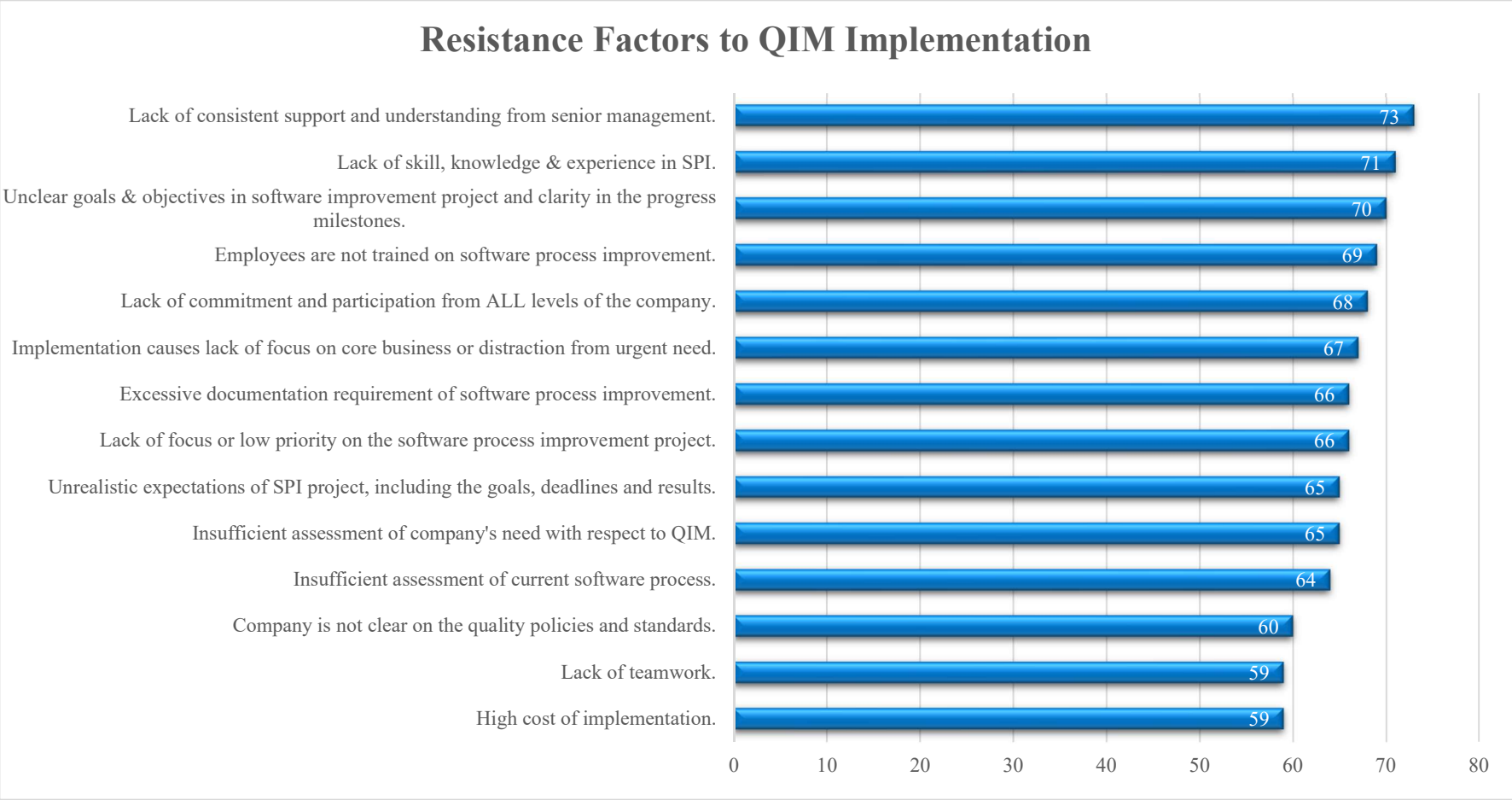


Figure 4.13: Resistance Factors to QIM Implementation

4.4 SME Characteristics

As explained in section 4.2.1, a total of 10 respondents were from SME category, judged based both the manpower and revenue factors. As the author is interested in identifying and confirming the characteristics of a SME as a consideration in designing the change control process, only the responses from this group of 10 surveyed companies were taken into account for this analysis.

The respondents were asked to select the options ranging from *Strongly Disagree* to *Strongly Agree*, for the list of characteristics commonly noted in SME as identified from literature review (Scott and Bruce, 1987; Taylor and Macfarlane, 2007) performed by the author.

The responses from this group of respondents were analysed using the similar approach explained in Section 4.3.3 above, i.e. the influence level weightage method, to find out the significance of the characteristics. The total influence level score was computed using the same formula.

The result again showed a small deviation from one characteristic to another, implying the validity of identified characteristics from the literature review (see Table 4.6 and Figure 4.14). Based on this survey, the top 3 characteristics where no one disagreed were **(1) entrepreneurial and direct supervision; (2) employees perform multiple roles, and (3) strong team spirit.** These characteristics have direct impact to how decision, communication and changes are managed, which were revealed by the survey in ranking order: **quick and wide-reaching communication**, **high responsiveness in decision making** followed by **flexibility in making changes**.

These characteristics enable the author to propose a change control management featured with flexibility. The ability of the team to perform multiple roles allows the defined change control project roles to be fulfilled by SME known to have lesser manpower (see clause 5 of Section 5.8 Quality Manual). The strong team spirit also implies certain level of tolerance and willingness to play multiple roles assigned to project team members. The companies adopting this approach shall nevertheless be mindful to reward the employees appropriately to avoid job dissatisfaction in long run, among employees who assume more workload.

The quick communication and high responsiveness in decision making allow leeway in how communication is carried out within the project team or company. No definite communication channel is suggested but rather be left for the decision of the

team. Examples like communication of task assignment and change request implementation (see Step P3.5 of Change Request Scheduling and Assignment Process in Section 5.8 Quality Manual).

A software change control process which is in compliance with ISO 9001, will inevitably involve comprehensive documentation for tracking, as evidence of work performed with authorisation, if required, as well as various defined roles. The survey result was encouraging that SMEs, while limited by the resource constraint, are flexible and highly responsive. The culture of direct supervisory will help in giving close guidance to project staff. The practice where employees tend to perform multiple roles means that the defined roles in the change control process can be taken up by fewer employees, who possess strong team spirit.

However, these seemingly good characteristics can also be a challenge in adhering to the proposed change control process. Project team members may make changes "flexibly" and pose risks of unauthorised change which likely result in project slip and wasted resources. Simple structure may be construed as authorisation and execution of tasks can be carried out by same person, posing issue on improper segregation of duties. Lastly, the confidence that everyone understands the process and operation may result in incorrect execution of procedures that results in rework.

A proposed roadmap to software change control management shall assist IT SME companies in kicking off and accelerating their QIM journey. Nevertheless, to ensure the process a fruitful endeavour, the following recommendations are made:

a) Multi-tasking shall be practiced with proper segregation of duties. Roles and responsibilities are to be clearly defined, taking into consideration of the potential conflict of interest. General rule of thumb is to separate authorisation role with execution role [Recommendation: refer to Clause 6: Authority in Section 5.8 Quality Manual, for proper segregation of duties].
b) Formally documented policies and procedures shall be established. Training is necessary to educate the team of the content as well as to convey the message of significance of compliance. However, exceptions shall be dealt with separately and for flexibility sake. A small committee can be set up for discussion and decision making with respect to exceptions [Recommendation: refer to policies and procedures as outlined in Section 5.8 Quality Manual].

c) While communication can be casual, important information or message (such as request from customers) shall be defined, where formal documentation is a must. The form of documentation shall be determined [Recommendation: refer the use of Customer Call Log (Appendix C) and Change Request Form (Appendix D)].

4.5 Conclusion

The survey findings were highly consistent with similar research studies conducted by other researchers, from the QIM adoption pattern, choice of QIM[2], objectives of QIM adoption to the resistance factors faced in the implementation. The survey showed that the ISO remained as the popular choice of "entry level" QIM. The pattern of QIM adoption also remained unchanged with ISO, ITIL and Six Sigma as the favoured choice for the past, current and future.

Besides, the characteristics of SME identified from literature reviews were largely affirmed based on the responses.

This survey result supports the choice of ISO, in addition to the justification put forth in Chapter 2 which demonstrate the "suitability" of ISO being the option for company to establish a quality management system. A proposed roadmap to software quality assurance of change control management for ISO initiative is therefore a justified effort to assist interested IT companies in kick-starting their process of QIM adoption, which may reduce the time and effort required in achieving the ultimate goal obtaining the relevant certification.

[2] This research finding refers to the "preferred choice", in contrast with past studies that collected data on "adopted" QIM. The design of the question aimed to identify companies' preferred QIM, to avoid circumstance where respondent that does not have a formal QIM from ignoring this important question, hence leaving the author without / with low response to conclude which QIM to focus on in proposing a roadmap.

Table 4.6: Total Influence Level Score for SME Characteristics

	SME Characteristics	Level of Influence					Weighted Score *T(fn)*
		Strong Disagree (1)	**Disagree (2)**	**Neutral (3)**	**Agree (4)**	**Strongly Agree (5)**	
C1	Entrepreneurial and direct supervision.	0	0	1	8	1	40
C2	Most employees carry out different roles or job functions.	0	0	1	9	0	39
C3	Strong team spirit demonstrated by a single team with common goals.	0	0	3	6	1	38
C4	Communication is quick and wide reaching (within days and to multiple levels).	0	1	2	5	2	38
C5	High responsiveness with decision made within a day.	0	1	3	4	2	37
C6	Flexibility in making changes and corrective actions.	0	1	2	6	1	37
C7	Simple structure.	0	2	2	4	2	36
C8	Everyone understands the process chain and operation of the company.	0	0	5	4	1	36
C9	Heavy reliance on limited few individuals / specialists for decision making.	0	1	4	3	2	36
C10	Close, highly informal interaction among employees.	0	2	2	5	1	35
C11	Specialist skills are sometimes sought from third-party supplier.	1	2	2	4	1	32

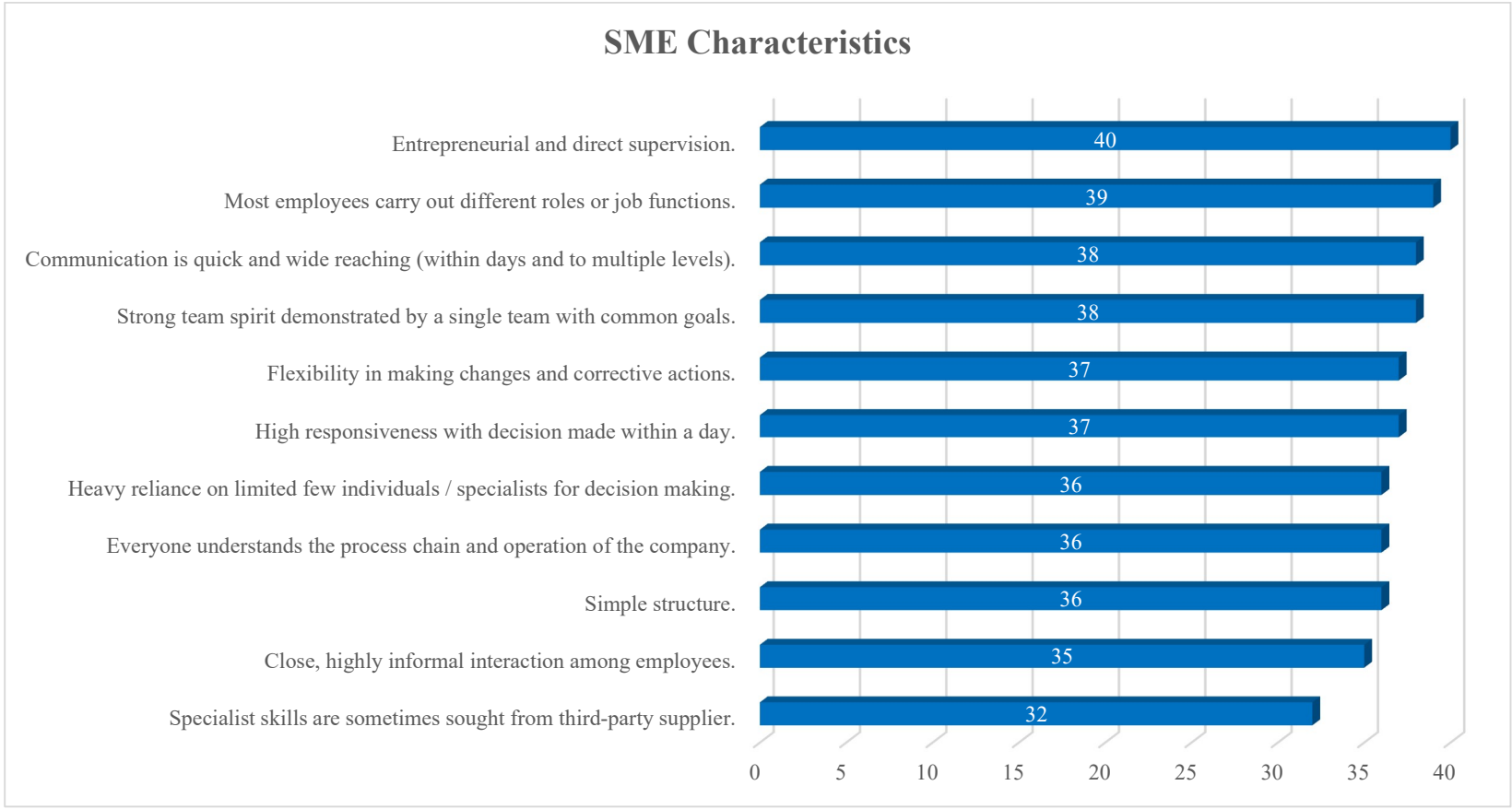


Figure 4.14: Characteristics of IT SME

CHAPTER 5

PROPOSED ROADMAP IN COMPLIANCE WITH ISO 9001

5.1 Introduction

This chapter discusses the adoption of ISO 9001 in details, with an overview on the evolution of the standard, the motivational factors and criticism from its adoption, followed with a proposed roadmap in the implementation of a QMS in compliance with the requirement of ISO 9001.

The roadmap provides an overview on the journey or steps that a company will need to take to reach certification status. The author will look into the design and documentation of the QMS in detail, based on the key process of IT companies namely the change control management, as the identified scope for the QMS. Considering the adoption of small and medium size company, all the critical components, i.e., the process flowcharts, standard operating procedures, relevant forms and templates are recommended.

The readers will then be shown how these procedures and documents are to be used in practice. The compliance level of the designed roadmap is finally checked against the ISO 9001 requirements by mapping relevant sections/components of the roadmap to the requirements.

5.2 ISO 9000 Series Adoption and Certification – First Step in Implementing a QMS

When come to the selection of QIM for adoption, there is a need to potential adopters to understand quality management, and the distinction between quality assurance (QA) and quality control (QC), in order to realise the promised benefits of having a quality management system. The misinterpretation and confusion between QA and QC may lead to inappropriate QIM adoption.

QA, deemed as the traditional quality management, refers to **planned activities (processes)** in a quality system to ensure quality requirements of a product or service can be met. It improves processes and takes proactive approach to prevent or minimise errors or defects via the process stabilisation. The systematic measurement against standard and process monitoring strengthen organisation's ability in error prevention.

QC, on the other hand, focuses on **process outputs**. It fulfils quality requirement by employing observation technique and activity, such as testing, to detect defects (Wong, Tshai and Lee, 2012).

Traditional quality management emphasises on defining preventive and proactive rules, i.e. the processes and structures, is the first step to quality management. QC offers promise for the next step – continuous improvement and ongoing revolutionary results. Organisations need to first resolve current, imminent business problems and lay a strong foundation that renders them the capability to move forward to the next level to build the ability in business operation evaluation, that is, building a well-rounded QIM (Wong, Tshai and Lee, 2012).

The era of integrating and aligning different QIMs into a more effective and impactful combined QIM has already begun (Abdul Latif et al., 2010; Chan et al., 2008; M. Kumar , J. Antony , R. K. Singh, 2006). QIM which provides quality assurance in the quality system with focus on day-to-day procedural activities is complimented with the more metric-driven QIM, to address the weaknesses while retaining the strengths of different QIMs. The result is a more consistent, measurable and sustainable business performance, enhanced bottom line and customer loyalty (Wong, Tshai and Lee, 2012).

Having said that, while companies may move from developing a traditional QM to a lifecycle approach of QM to enforce continuous improvement, this shall be applicable to those which have already put in place a quality management system, albeit QA-focused. For companies which have yet to implement a QMS or are still at the nascent stage of implementing one, they should commence with QA related QIM, aiming to first put the house in order by defining and stabilising the core processes. ISO 9000 standards, ITIL and CMMI (when meeting the lower level of maturity) are considered QA-related QIM as they are heavily focused on process improvements. Six Sigma on the other hand is generally deemed as a methodology of QC-focused.

While literature on ISO 9000's effectiveness in improving organisation's performance is mixed, and the certification itself does not necessary correlate with improved quality, there is no dispute that its adoption makes a company more attractive to customers (Naveh and Marcus, 2004). Companies wanting to impress customers still pursue the certification as powerful industrial and service organisation still demand their suppliers to be ISO 9000-certified (Naveh and Marcus, 2004).

Based on the above considerations and in the context of Malaysia environment where software companies are predominantly small and medium sized, author opts for the ISO 9000-series standards as the foundation to build a QMS and to propose a framework based on ISO 9001 for the purpose of certification.

5.3 Evolution of ISO 9001 and the Motivational Factors in the Adoption of ISO9001

International Organization for Standardization (ISO) was founded in 1947 in Geneva, Europe. It is a United Nations agency with representatives from more than 90 countries. It was formed to develop and promote common industrial standards worldwide. It coordinates the work of standardisation for products, services as well as business. To date, it has developed approximately 220,000 standards. Most countries are affiliated to ISO via their own National Standards Organisation and, among others, Malaysia, which is known as Department of Standards Malaysia (ISO, 2018; JSM; 2018).

Arising from the expectations of consumers worldwide, both individual and corporate users, for quality assurance to the products and services, not only by the quality standards as intended or claimed by the producers and sellers but also the maintenance of the level of quality, some form of QMS has to be set up to control and monitor every stages of the production process to provide proof to the consumers that the company is capable of producing quality products and services at a consistent manner. The growing demand for quality assurance has prompted many countries to develop their set of quality standards and requirements, as guidance to and proof of a QMS. With the proliferation of QMS and quality standards developed by national bodies and committees around the world, came the need for the industries players to come up with a set of internationally recognised standards of quality (Tricker, 2005; ISO, 2018).

ISO 9000:1987

ISO's first attempt to produce an international standard on quality management took place in 1987. The harmonisation of the standards to be recognised internationally aids acceptance by all member countries and assure the interoperability of their countries standards (Tricker, 2005).

The ISO 9000 contained 20 elements of a quality system. The ISO 9000 series consisted of ISO 9001, ISO 9002, ISO 9003 and ISO 9004. ISO 9001 to ISO 9003

were intended to be certified against while the ISO 9004 is a suggestion document to provide guidance to top management on how to structure an organisation to achieve continuous improvement for excellence. ISO 9001 specifies quality requirements for companies involved in design and production. ISO 9002 focuses on production or manufacturing only while ISO 9003 applies to companies whose operation concerns mainly the inspection and testing process, such as for warehousing and retailers (Tricker, 2005; ISO, 2018).

ISO 9000:1994

All the existing ISO standards are required to be re-inspected every 5 years to assess if there is a need for revision, to reflect the current development and relevance to users. ISO 9000-series standards were revised in year 1994 as part of the routine revision process. 250 changes were made to the standard but were mainly changes in wording for better clarity and easier reading by users. The more significant changes being the streamlining of indexing and an explicit requirement on job profiles to be formalised for all members of a company to define their authority and responsibility (ISO, 2018; Tricker, 2005).

ISO 9001:2000

A revamp of the ISO 9000-series standards was carried out with the revised series rolled out in year 2000, in response to the growing popularity of the quality standards and the inadequacies flagged up in the adoption process. The standards were noted to be biased to manufacturing industry and were difficult to be implemented by the service industry. Some requirements were repeated in other standards causing duplicate efforts in compliance while the ambiguities in the standards have also led to different interpretation. There was also a need for the standards to better address customer satisfaction and to cater for continual improvement (Tricker, 2005).

The revision has seen the integration of ISO 9001, ISO 9002 and ISO 9003 into a single standard, ISO 9001. The 20 isolated elements were replaced by 4 major sections, namely management responsibility, resource management, product realisation and measurement, analysis and improvement. The revised standard transformed from system-based to process oriented focus. It required the identification and definition of organisation processes, including the mapping of the processes in the

company quality manual showing their interactions. This change was made on the belief that outputs of a company were a result of execution of a group of inter-related activities. The revised standard is also more customer-focused with its requirement to identify the stakeholders of the companies and how to satisfy their needs. Emphasis was placed on employee training and the need for continuous improvement. The influence of Total Quality Management was reflected in the this revision. (Rodríguez-Escobar et al., 2006; Tricker, 2005)

ISO 9001:2008

The 2008 revision saw no major changes but rather to offer better clarity of the standard requirement. The need for controls to be defined for outsourced processes, corrective actions for non-compliance to be reviewed for effectiveness, training to enhance awareness were now made more explicit in the requirements of the standard.

ISO 9001:2015

A Justification Study including a worldwide user feedback study was performed by a Technical Committee set up to study the needs of revision on ISO 9001. Needs for a revision was identified from the study, among others, to:

- adapt to a changing world;
- enhance an organization's ability to satisfy its customers;
- provide a consistent foundation for the future;
- reflect the increasingly complex environments in which organizations operate;
- ensure the new standard reflects the needs of all relevant interested parties; and
- align with other management systems.

(International Organisation for Standardisation 2009)

The new standard is now driven by risk-based thinking, helps to address the risk and opportunities faced by the organisation in a more structured manner. The formal risk management requirement in the 2008 version is removed but the need for risk analysis is embedded throughout the standard. More emphasis is now put on the leadership engagement where top management is accountable for the company's QMS.

The standard is also made more user friendly for service and knowledge-based industry, in tandem with the global shift from manufacturing-heavy to service base economies.

Companies certified with ISO 9001:2008 are given 3 years transition period up to September 2018 to adopt the new ISO 9000:2015 (ISO, 2015). The evolution of the ISO 9000 and 9001 standards is summarised below:

Table 5.1: Evolution of ISO 9000 and 9001

Year	Version Description

1987	• ISO 9000 series comprised ISO 9001, ISO 9002, ISO 9003 and ISO 9004.
	• ISO 9000 contained 20 elements of quality system.
	• Standards to be certified against and applicable industry / business nature
	  o ISO 9001 – design and production.
	  o ISO 9002 – production or manufacturing.
	  o ISO 9003 – inspection and testing.
	• ISO 9004 was a suggestion documentation on how to structure organisation for excellence.

1994	• 250 changes. Mainly were wordings for clarity.
2000	• Integration of ISO 9001, 9002, 9003 into single ISO 9001. • 20 quality system elements replaced by 4 major sections, namely management responsibility, resource management, product realisation and measurement, analysis and improvement. • Transformed from system-based to process-oriented. • More customers-focus, emphasis on training and continuous improvement.
2008	• Changes were on clarity of standard requirement.
2015	• Standard requirements are risk-driven, friendlier to service and knowledge-based industry. • More emphasis is placed on top management accountability.

Motivational Factors for the Adoption of ISO 9000-Series Standards

Extensive literatures have been carried out to identify and study the motivational factors and the related impacts on the adoption of ISO 9001. Generally, they can be grouped into 2 main categories, internally-driven (proactive reasons or management-motivated) and externally-driven (reactive reasons or stakeholder driven).

The internally-driven factors are stemmed from the management's desire to improve their internal operation process, for better control and transparency, in order to reduce unnecessary cost, increase productivity and business efficiency. These companies gain better corporate image and reputation as a result. The impacts of the adoption for this group of companies are normally positive and tend to be longer lasting (Rodríguez-Escobar et al., 2006; Stelzer et al., 1996).

The externally-driven factors, also known as reactive, show the not so voluntary option in doing so. Usually a consequence of commercial reality such as customers' requirement to be qualified to participate in the supplier selection process, regulatory or public policies which require certification before a government contract is awarded, etc. With the growing complexity in the global supply chain, it has become a norm where certification and quality assurance being part of the requirement in international trading. To be part of the global supply chain, companies naturally make the choice to be certified (McGuire and Dilts, 2008; Rodríguez-Escobar et al., 2006; Stelzer et al., 1996).

While one may think that the reason for adoption will be externally-driven, given the natural tendency to remain status quo, a number of studies however showed that adoption is quite a combination of dual factors, albeit skewed slightly towards external such as customers' pressure (Georgiev and Georgiev, 2015; Rodríguez-Escobar et al., 2006).

5.4 The Proposed Roadmap to Software Quality Assurance of Change Control Management for the Initiative of ISO

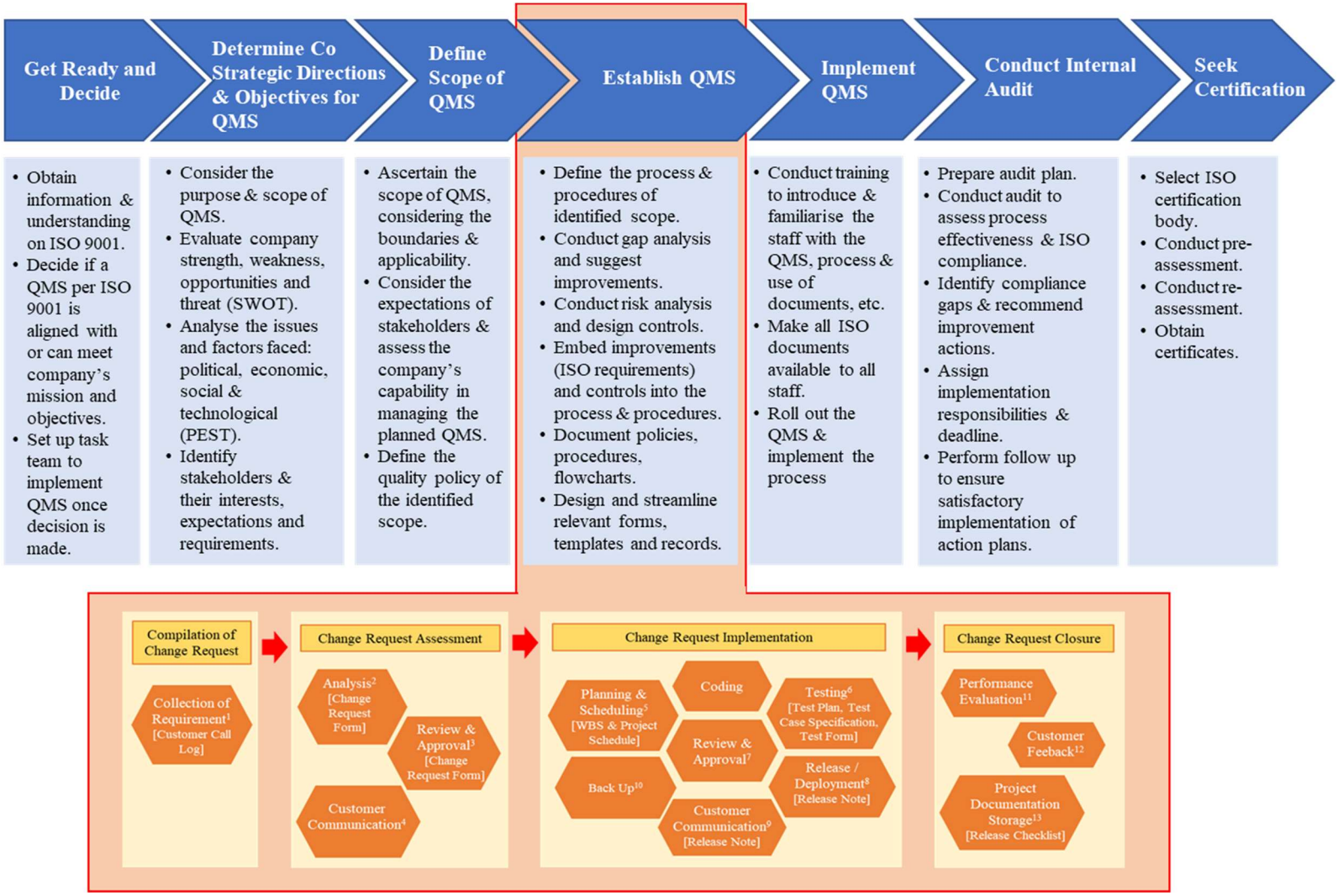


Figure 5.1(a) : Roadmap to Software Quality Assurance of Change Control Management for the Initiative of ISO

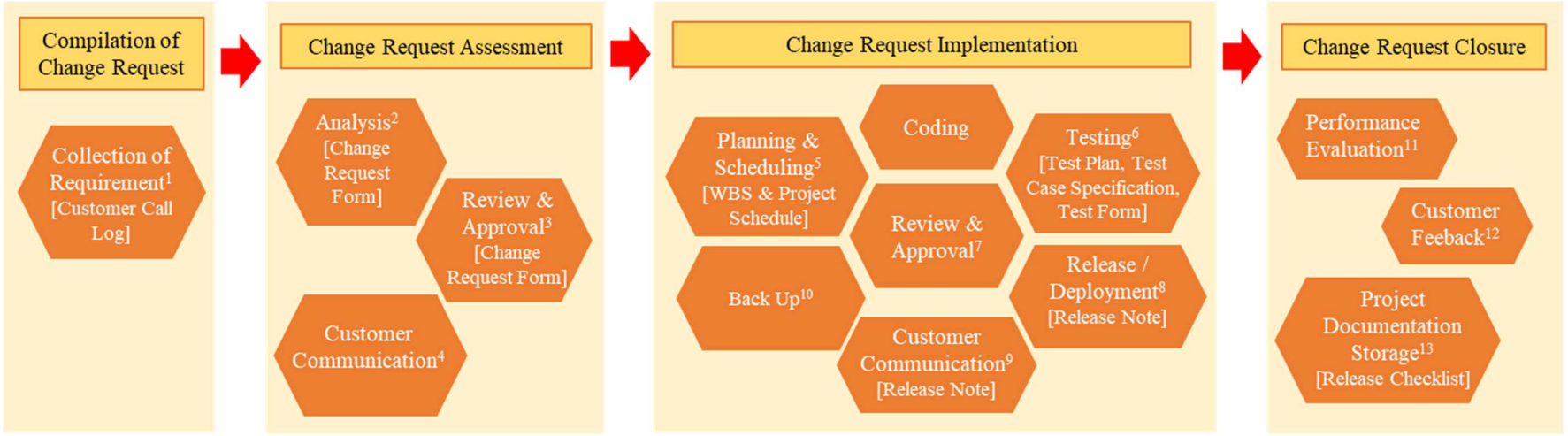


Figure 5.1(b): Change Control Management Process

Note:
Activities in compliance with ISO 9001:2015 Quality Management Systems – Requirements:

(1) Clause 8.2.1 & 8.2.2
(2) Clause 8.2.3, 8.3.2, 8.3.3, 8.5.1
(3) Clause 8.2.3, 8.2.4, 8.6
(4) Clause 8.2.1 & 8.2.4
(5) Clause 8.3.2
(6) Clause 8.3.2, 8.3.4, 10.2
(7) Clause 8.3.4, 8.6
(8) Clause 8.5.1, 8.6
(9) Clause 7.4, 8.2.1
(10) Clause 8.5.4
(11) Clause 9.1.3 & 10.3
(12) Clause 8.2.1, 9.1.2 & 10.3
(13) Clause 8.5.4

After the due discussion on the ISO adoption and its evaluation, a roadmap to ISO certification is proposed as depicted in Figure 5.1(a) and Figure 5.1(b). The roadmap is a construct of 2 levels. The first level of the roadmap in Figure 5.1(a) depicts the phases that a company has to go through to achieve certification from initial decision to obtaining the certificate from certifying bodies.

The first 3 phases of the roadmap deal with the high-level thinking that is unique to companies, from deciding if ISO is to be adopted to understanding and evaluating the company and determining the scope for QMS. Always, companies face tremendous challenges when come to the setup of QMS for the identified scope, which demands lots of resources in designing quality processes that are compliant with ISO requirement. The need to interpret the ISO requirements, followed by designing processes, putting them into writings, and along with the supporting documents that evidence the operation effectiveness of the processes, have overwhelmed many and stalled the progress of QMS implementation, some never see it taking off.

This brings us to the second level of the roadmap where the author chooses the change control management process as the identified scope for the QMS. The scope covers the compilation of change request, change request assessment, change request implementation and change request closure. Under each sub-scope, illustrated are the activities and indication of the relevant ISO's requirements the activities are to fulfil. The second level of this roadmap namely the software change control management is the thrust of this research paper, that intends to focus on QMS establishment. Readers are guided from the next section till the end of this chapter on how the software change control management works in the IT environment, seen from the perspective of PMLC and SDLC in a detailed step-by-step procedure. The software change control management is illustrated further in a pictorial presentation of process flows, outlined in writings as standard operating procedures, and supplemented with all the forms and templates necessary to capture the process and evidence the process compliance with ISO.

With the setup of the QMS based on software change control management, companies can then proceed to the next phases of implementation and auditing, before engaging certifying body for assessment and certification.

5.5 Software Change Control Process for Bug Fix: The Chosen Scope to Begin the ISO Journey

Many companies interested in seeking ISO 9001 certification are always overwhelmed by the requirements of the Standards. Not only do they find the requirements "vague", having no ideas of where to start, setting up a QMS that covers the company's operation prove to be a mammoth task to fulfil. The challenge often leaves the idea of implementing a QMS remain an idea.

In fact, it has always been the proposition of ISO 9001 that companies decide the scope of the QMS they want to set up. In the revised standard, ISO 9001:2015, more clarifications are provided. It is stated in Section 4.3 of the standard that:

> *"The organisation shall determine the boundaries and applicability of the quality management system to establish its scope. When determining this scope, the organisation shall consider:*
>
> *a) The external and internal issues that are relevant to its purpose and strategic direction, and ability to achieve intended results of the QMS;*
> *b) Requirement of relevant interested parties; and*
> *c) The products and services of the organisation."*

It is common that companies choose to set up a QMS that covers only part of the operation, for example, one or more of the products, locations, industries, manufacturing facilities, etc. The key is to clearly define the scope, which is normally documented in the scope statement.

Software change control management, as discussed in Section 2.6, is a key business operation process for IT companies. Having a clearly defined software change control process is imperative to ensure software changes are executed in a controlled and coordinated environment, with the ultimate aim to meet customers' requirement and enhance customers' experience. With this in mind, the author chooses to come out with a roadmap to software quality assurance of change control management, which is ISO-compliant, to help IT SMEs in Malaysia to kick start their journey to ISO 9001 certification.

5.6 Software Change Control Process: From the Perspectives of Project Management Life Cycle and System Development Life Cycle

Software change control management is an integral part of project management. Faced with the ever-changing operating environment both from forces within and outside an organisation, business has to adapt in order to sustain. Any software system implemented by organisation, be it already deployed for service or in the midst of development, has to change in tandem to the change in business needs. Project team has to ensure change requests are adequately assessed, approved and tracked for implementation, to avoid wasted resources on unnecessary changes or repeated issues faced after change.

Changes are such a norm in current project management. They are introduced progressively into the deployed system and often than not, treated as a project and managed using the project management knowledge, tools and techniques (Wong *et al.,* 2018). Software change control is implemented within PMLC and SDLC. SDLC, as described in details in Section 2.5 above, is part of PMLC. The activities of PMLC and SDLC are inter-related and dependent on each other, with PMLC concerns all activities of a project from conception of idea to retirement of a system while SDLC focuses on delivering a software requirement. To promote the view that software change control activities are an integral part of PMLC (as opposed to traditional view of being solely SDLC activities), the change control activities are presented and illustrated in all phases of PMLC and SDLC in Figure 5.2 below. Software quality assurance activities are embedded in the change control process.

		Project Management Life Cycle						
		Initiating	Planning			Executing	Monitoring	Closing
System Development Life Cycle	Planning initiation	(1) User identifies problem (bug) in the system and reports the problem to the Helpdesk (Support Team); OR problem identified by project team, then goes to Step (3) directly.						
		(2) [Applicable for problem arises from customer rather than project team] Helpdesk records the case in the **Customer Call Log** and assigns a Log Case ID.						
			(3) Helpdesk / project team member raises a **Change Request Form (CR Form)** and submits to Project Lead. CR Form ID is to be created with reference to sequential number in the **Change Log**.					
					(9) Project Manager reviews analysis and makes recommendation to change, hold or reject, signs off and hands the CR Form to Change Control Board (CCB) Coordinator.			
					(10) CCB Coordinator prepares and distributes **agenda**, along with duplicate copy of CR Forms to CCB members for review before CCB meeting.			
					(11) For emergency bug fixes, approval to be sought from Emergent Change Authority. Rectification to be carried out immediately instead of assigning to release batches / schedule. Implemented change to be tabled to CCB in the routine CCB meeting.			
					(12) CCB to approve or reject change request, consideration given to Project Manager's recommendation.			
					(13) CCB Coordinator updates CR Form as per CCB's decision and forward all CR Forms to Project Manager.			

		Project Management Life Cycle						
		Initiating	Planning			Executing	Monitoring	Closing
System Development Life Cycle	Planning initiation				(14) CCB Coordinator prepares CCB **meeting minutes** and distributes to all CCB members.			
					(15) Project Lead updates the status of CR Form into **Change Log** and determines the release based on defined release criteria.			
					(16) Project Lead prepares the **Work Breakdown Structure** (WBS)(re-estimate effort if necessary) and the project schedule for upcoming release; proposes task assignment and submit for the approval of Project Manager.			
					(17) Project Manager reviews and approves WBS and project schedule, task assignment.			
					(18) Project Lead assigns change task to Programmer and shares the WBS and project schedule with all the assigned Programmers, by granting read access to the document which is to be stored in server.			
					(19) [Applicable for problem reported from customer] Helpdesk notifies user the change priority of the reported case.			
	Requirement			(4) Project Lead records the CR Form in the **Change Log** and assigns Programmer / Analyst (P/A) for analysis.				
				(5) P/A performs change request analysis, assesses the impact of making the change and ascertain the priority of change.				
				(6) P/A estimates effort and resources required, duration estimation and affected files / functions / components.				
				(7) P/A determines the required testing and expected new files to be created following the change.				
				(8) P/A records work performed in (5), (6) and (7) into the CR Form and submits to Project Lead for review.				
	Design					(20) Programmer designs change and prepares all the relevant **test plans** with test specifications.		
						(21) Programmer submits test plan for review and approval of Project Lead.		

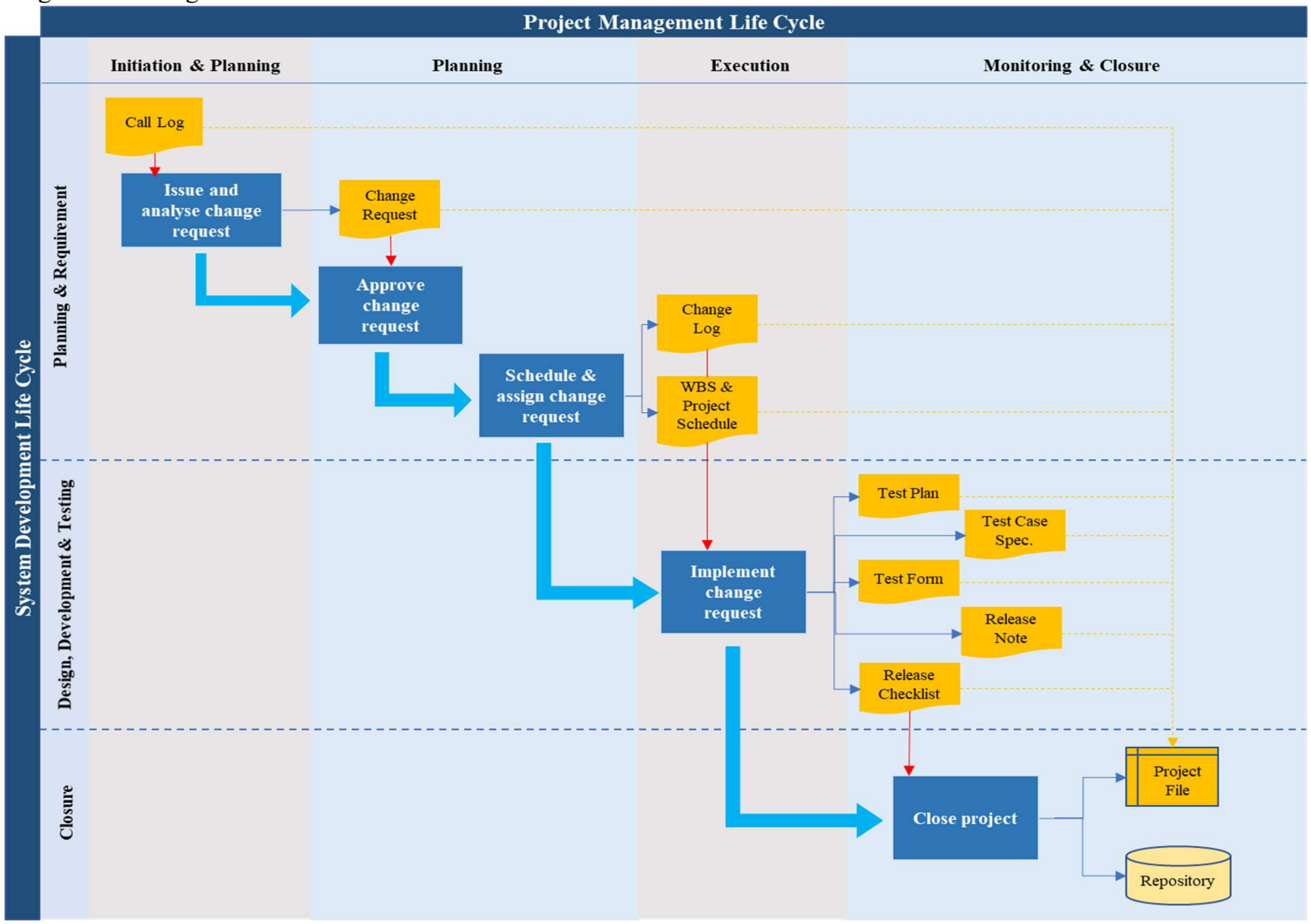
		Project Management Life Cycle						
		Initiating	Planning			Executing	Monitoring	Closing
System Development Life Cycle	Development, Testing & Implementation					(22) Programmer clones a single version of the project, i.e. a copy of the origin / master repository containing all the project files, to local working directory [for distributed version control system] OR checks out affected files from central repository to local workspace or branch [for centralised version control system].		
						(23) Programmer makes the necessary changes to the affected files and produces new files if needed. [Programmer shall perform informal tests to check if change is complete prior to commit]		
						(24) Programmer commits or stores all the affected files in the develop branch, ready for formal unit test. [Programmer who works in more than 1 branch must ensure proper merging and resolving any conflicts prior to committing. Logical lines of conflict shall be resolved with programmers involved in the changes along with Project Lead]		
						(25) Programmer performs unit test as per approved test plan and record the test results in the **Test Case**.		
						(26) Project Lead / Senior Team Member reviews the unit test results and signs off on the **Test Case**.		
						(27) [In the event of failed test] Programmer reperforms coding, unit test and updates into Test Case after review by Project Lead / Team Member.		
						(28) [If changes affects other modules or systems] Programmer / Assigned Tester performs integration test after all the unit tests are approved. Integration test result is recorded in the Test Case. [In the event of failed test, Programmer reperforms Step 20 to 25].		
						(29) Project Lead / Senior Team Member reviews, approves integration test results.		
						(30) Project Lead / Team Member creates release branch and moves the affected files (committed changes) into the branch. [Any minor bug fixes in release branch must be merged back to develop branch. No major change is permitted in the release branch]		
						(31) QA tests full and complete codes prior to release. Any bugs arising from QA test to be fixed in the release branch.		
						(32) Programmers merge the release branch to the develop branch and remove any temporary branches such as release branch.		

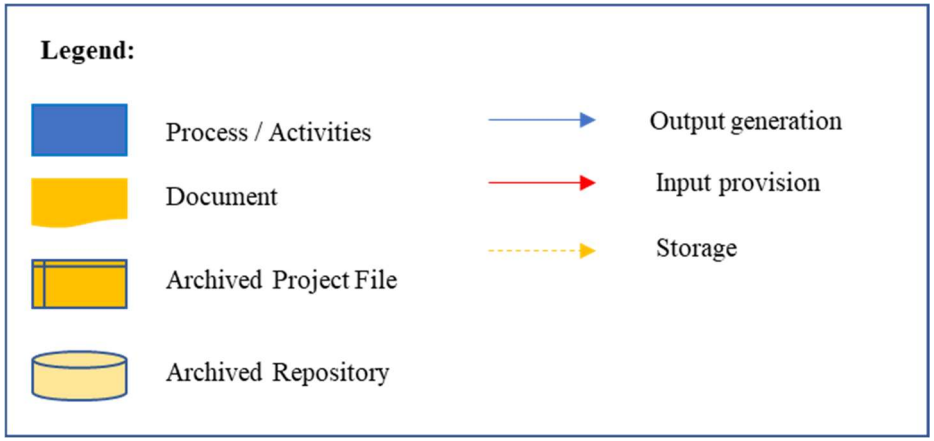
		Project Management Life Cycle						
		Initiating	Planning			Executing	Monitoring	Closing
System Development Life Cycle	Development, Testing & Implementation					(33) Project Manager / Project Lead arranges for User Acceptance Testing to be performed for changes arising from customers. Users signs of UAT after the test.		
						(34) Project Lead prepares patch release pack.		
							(35) Project Lead prepares Release Checklist and Release Note, for the approval of Project Manager.	
							(36) Project Manager notifies all affected parties of the planned release.	
						(37) Project Lead issues patch release pack and Release Note to customers.		
						(38) Project lead updates (pushes) the develop branch to the origin / master repository and increment the version number for the repository (tag the master).		
						(39) Project Lead creates a duplicate copy of the repository as back up.		
	Maintenance						(40) Project Lead updates Change Log with latest status.	
								(41) Helpdesk notifies customer of deployed changes and closes the case.
								(42) Project Lead finalises Release Checklist for the review and approval of Project Manager.
								(43) Project Manager performs post implementation review.

Figure 5.2: Mapping Change Control Process to SDLC and PMLC

Based on this mapping, a high-level change control work flow can be depicted as follows:

Figure 5.3: High-level Change Control Process





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5.7 Software Change Control Process Flow

The software change control described in the context of SDLC and PLMC in the section above is best demonstrated in the following detailed pictorial process flows for better understanding. These process flows can also be easily adopted by organisations, modified to suit, and make a good reference for software change control flow chart.

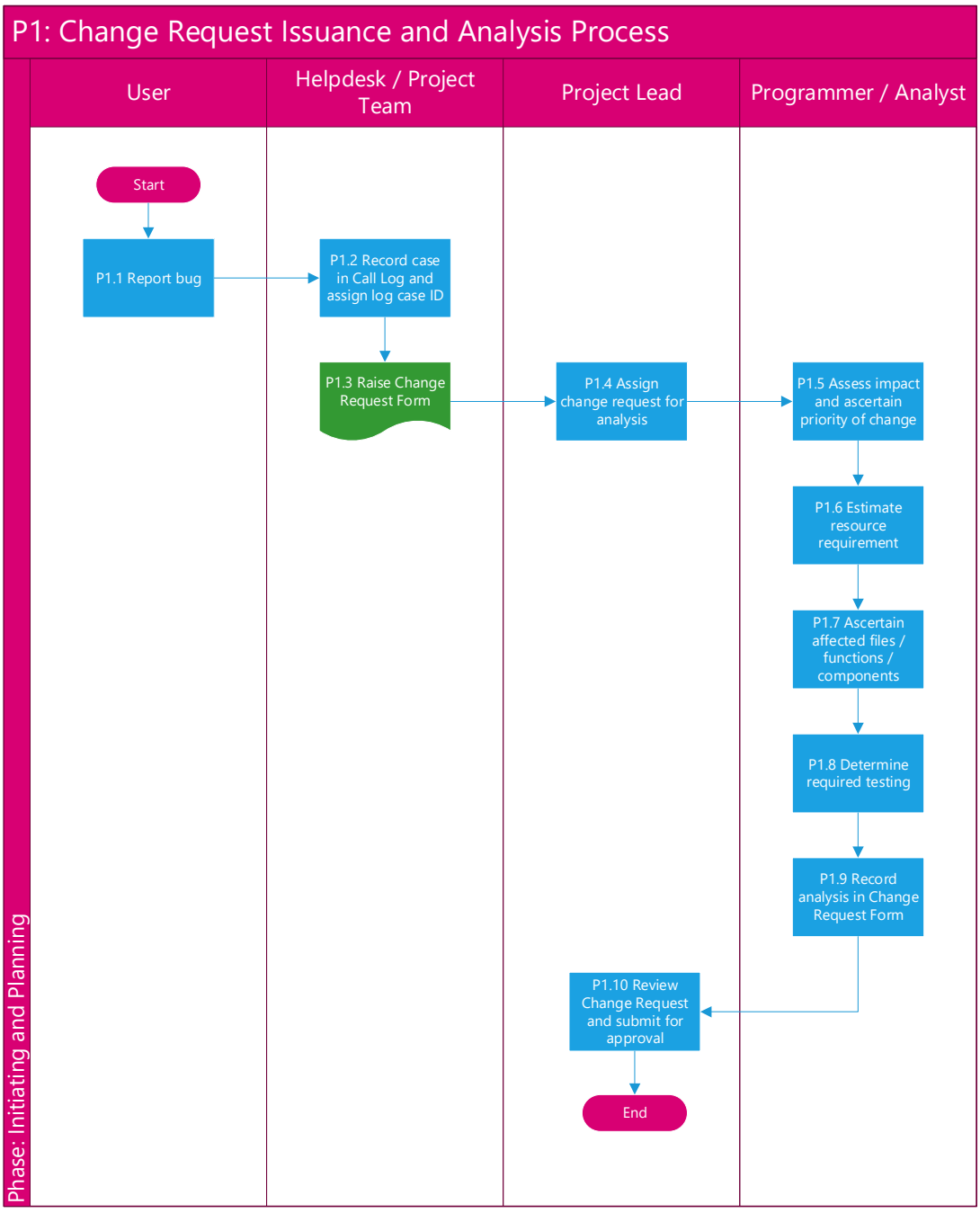

Figure 5.4: Change Request Issuance and Analysis Process

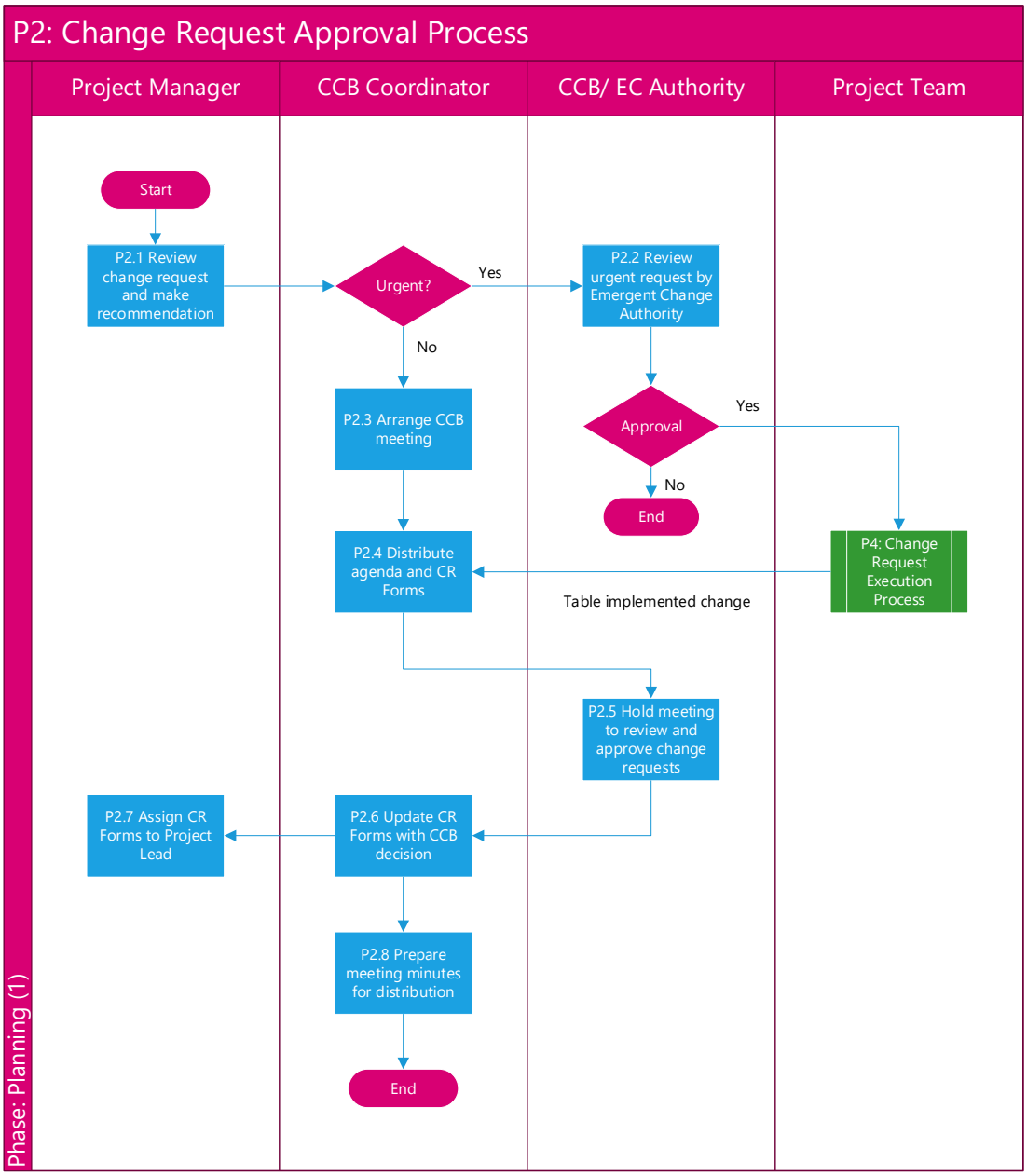

Figure 5.5: Change Request Approval Process

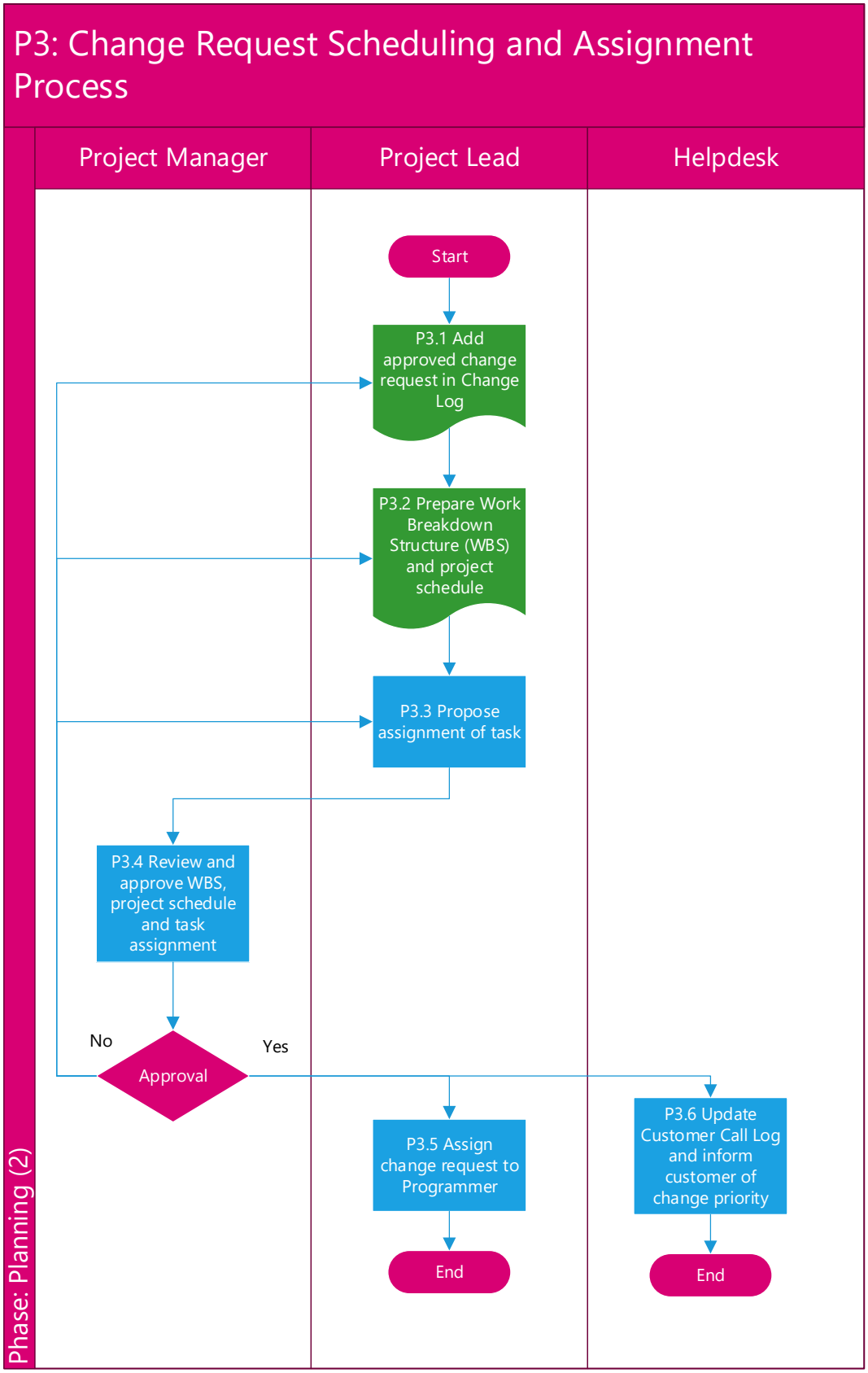

Figure 5.6: Change Request Scheduling and Assignment Process

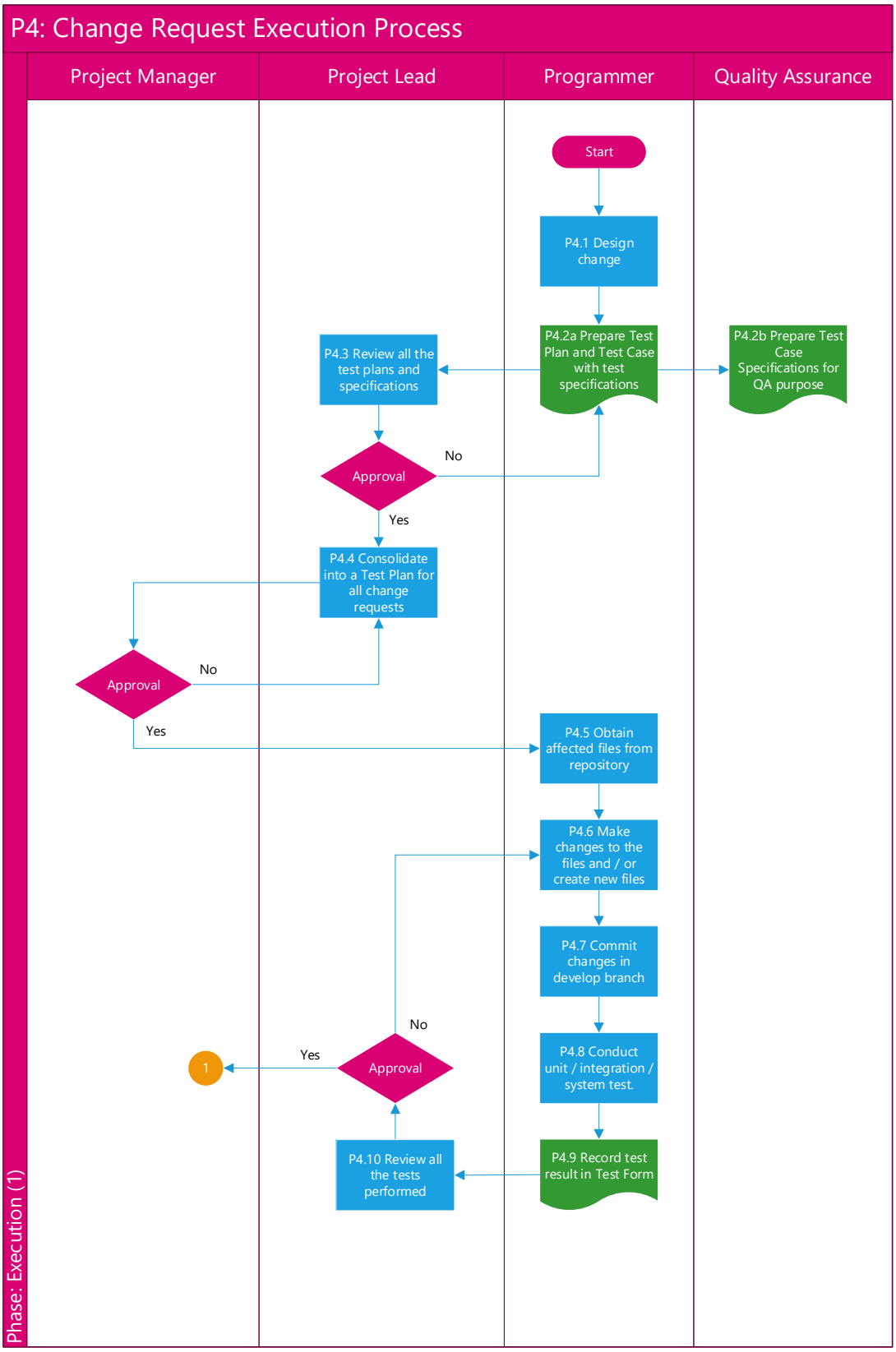

Figure 5.7: Change Request Execution Process

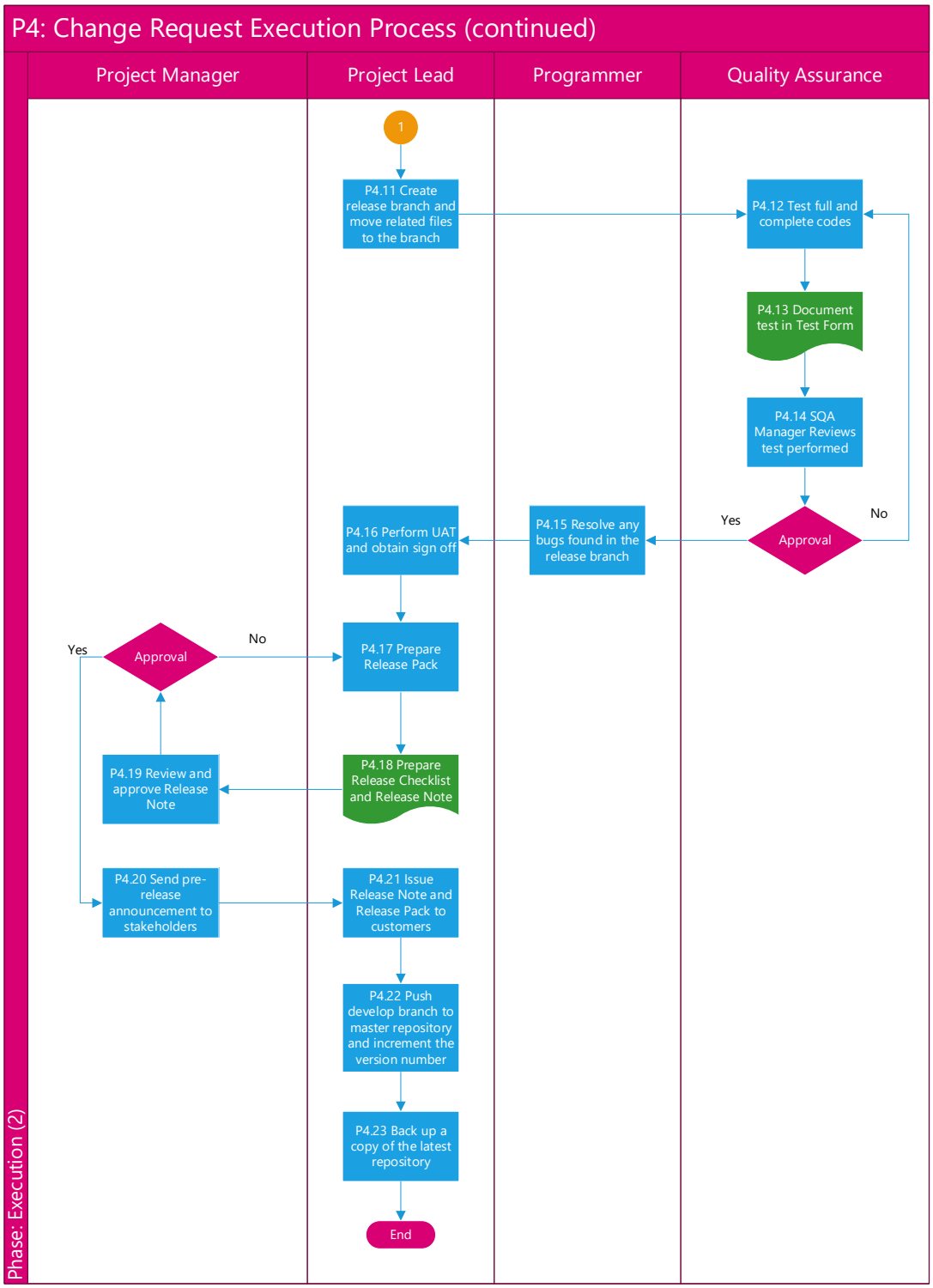

Figure 5.7: Change Request Execution Process (continued)

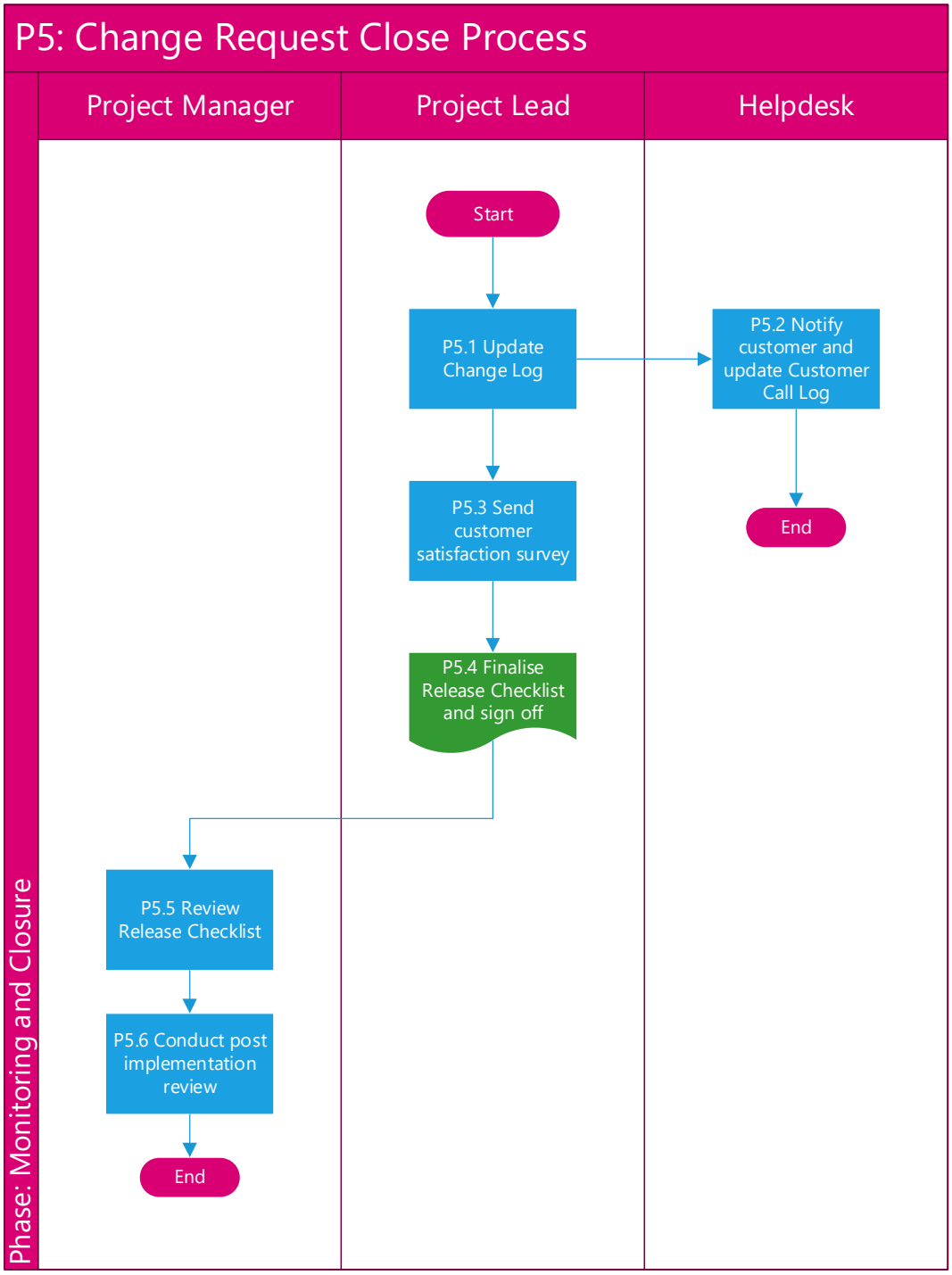

Figure 5.8: Change Request Close Process

An overview of these subprocesses that make up the overall change control process is illustrated below:

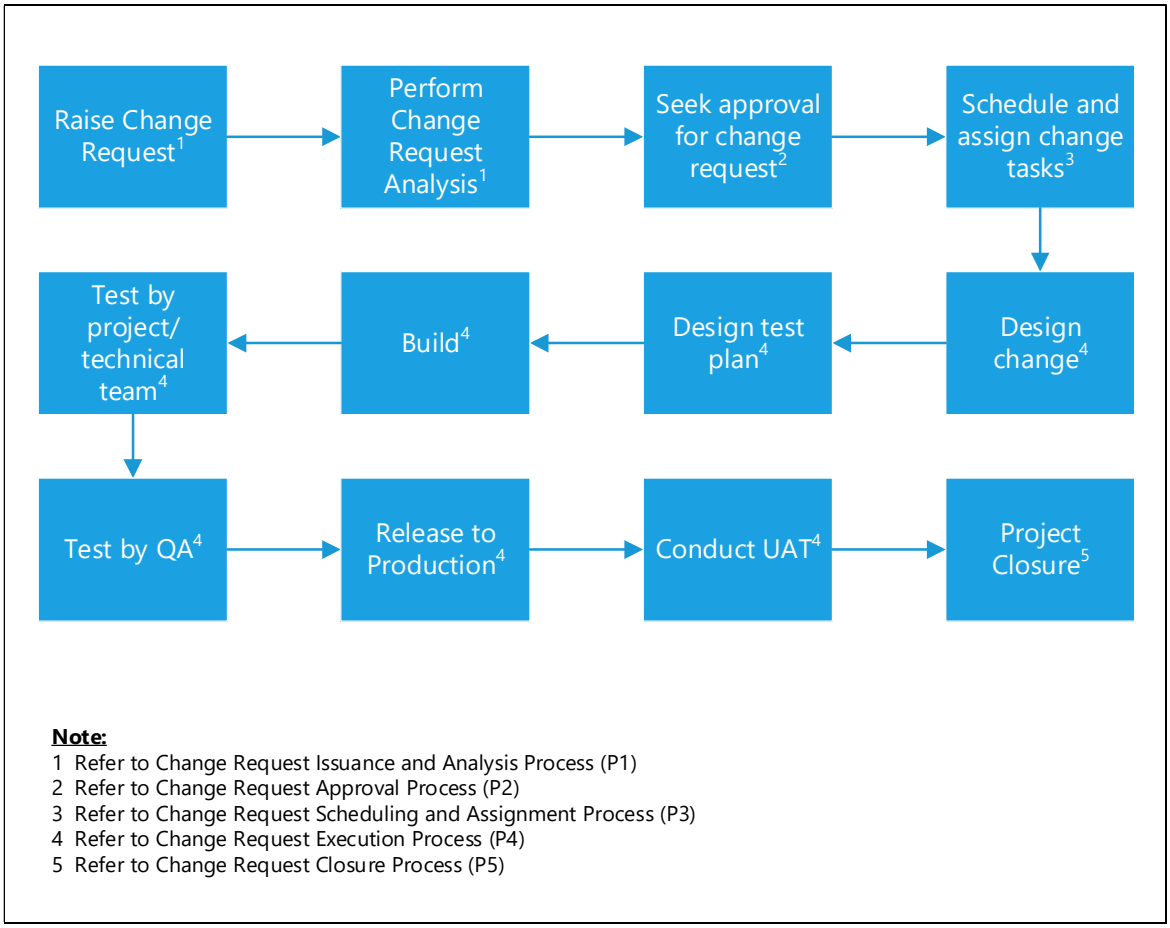

Figure 5.9: Overview Change Control Process

5.8 Quality Manual – a Good Idea to Document Your Quality Procedure and Quality-related Information

The latest Standard does not require a Quality Manual from organisation seeking certification, unlike the ISO 9001:2000. However, it is a useful tool to document the change control process, the related policies, quality objectives and its supporting documentation like templates and forms. The author has therefore suggested a Quality Manual to be prepared, with the following sections:

1. Introduction
2. Quality policy, change control policies and quality objectives of change control management
3. Authority, roles and responsibilities to the change control management
4. Change control procedures
5. Performance evaluation
6. Risk and control matrix (as an evidence of developing the policies and procedures after risk assessment exercise)

A sample of the Quality Manual is presented in Figure 5.10. Revision to the Quality Manual and templates can be documented on the historical record on first page of these documents, along with the evidence of review and approval by authorised quality personnel.

Figure 5.10 Quality Manual

Document No.:	**SQA-QM-01**	**Document Name:**	**Quality Manual**
Revision No.:	1	Revision Date:	1 January 2019
Prepared by:	Choong Soo Ching, SQA Executive	Reviewed by:	John Tan, Project Manager
Approved by:	Ali Abdullah, CEO		

Record of Past Revisions

Revision	Date	Summary of Change	Preparer	Reviewer	Approver
1	1/1/2019	Initial version	*Signature* Mary Chin, IT Executive	*Signature* John Tan, SQA Manager	*Signature* Ali Abdullah, CEO

QUALITY MANUAL

Table of Content **Page**

1. Introduction

Introductory note to the purpose of this quality manual. Examples as follows:

1.1. Purpose

To document the change control management system to serve as a guide to the company to meet the objectives of ensuring changes to software products due to bugs and defects are adequately assessed, authorised for implementation, properly tracked, reported and closed.

1.2. Abbreviation

Abbreviation	**Description**
Examples:	
Board	Board of Directors
CCB	Change Control Board
CCC	Change Control Coordinator
CR Form	Change Request Form
EC Authority	Emergent Change Authority
PLC	Project lifecycle
QMS	Quality Management System
SDLC	System development lifecycle
UAT	User acceptance test
WBS	Work Breakdown Structure

1.3. Definitions

Words	**Description**
Examples:	
Shall	Adverb indicating the requirement / policy / procedure is mandatory. Synonyms are “must” and “will”.
Should	Adverb indicating requirement / policy / procedure is not mandatory, but adherence is desirable.

2. Quality Policy

Provide a brief description of the organisation purpose, mission and vision; meeting requirement; interested parties; and, promotion for improvement. State the channel and frequency of quality policy communication and distribution.

Example:

General policy:

"The policy of FYP company, as a software house that strives for excellence, is to deliver software products which include defect rectification requests, that meet the expectation of customers and needs of all stakeholders. This is accomplished by establishing a clear change control process, with defined authorities and responsibilities, and to continually improve the process for execution. This policy applies to all the projects undertaken by the company."

The quality policy is accessible to all employees in the company's portal. Changes to the policy will be made known to all employees via email announcement. A copy of the quality policy can be issued to interested parties such as customers and suppliers, upon request and subject to the approval of company director.

3. Change Control Policies

State the policies in relation to the scope / process to ensure clear rules are defined for adherence and consistent practice. Examples are shown below by project document:

3.1. Customer Call Log (SQA-F-002)

3.1.1. Each reported case shall be assigned a unique case ID.

3.1.2. In the event that a reported case results in change request, the change request information shall be recorded in the Customer Call Log, i.e. the Change Request Form ID, priority, status and resolve date.

3.1.3. Project Manager shall review the Customer Call Log periodically to ensure all valid bug cases are formally reported to the project team for rectification.

3.2. Change Request Form (SQA-F-003)

3.2.1. ALL Change Request Form shall be uniquely identified as per company naming convention.

3.2.2. ALL change requests shall be duly assessed for implementation. Result of change request assessment shall be documented to justify implementation or non-implementation in a Change Request Form.

3.2.3. Change request cannot be implemented unless approved. All approved change request must be implemented.

3.2.4. Preparer of the document shall sign off as evidence of issuance.

3.2.5. Assessor of and person making recommendation for the change request shall sign off for accountability.

3.2.6. Decision of CCB on the change request shall be recorded in the Change Request Form, traceable to the CCB meeting minutes.

3.3. Change Log (SQA-F-004)

3.3.1. A Change Log shall be created for each project, identified by project code and project name.

3.3.2. All defects rectification or modifications to a system shall be deployed in batches, at predetermined interval. The decision shall be recorded in the Change Log. (Exception applies for emergency defect rectification, i.e. urgency level is assessed to be critical.)

3.4. Test Plan (SQA-F-005)

3.4.1. Test Plan shall be prepared to specify the test strategy for EACH release.

3.4.2. Test Plan shall be uniquely identified as per company naming convention.

3.4.3. Test Plan shall comprise ALL the test case specifications for the release.

3.4.4. Test Plan shall be approved prior to change request implementation.

3.5. Test Case Specification (SQA-F-006)

3.5.1. Preliminary test case specification shall be prepared during change impact assessment as documented in Change Request Form.

3.5.2. Test Case Specification shall be revised for finalisation prior to change request implementation. Preparer and reviewer shall sign off for accountability.

3.5.3. Test Case Specification shall be uniquely identified as per company naming convention.

3.5.4. Quality Assurance should have access to the Test Case Specifications prior to change request implementation. Additional Test Case Specifications shall be prepared as deemed fit.

3.6. Test Form (SQA-F-007)

3.6.1. Test result must be documented. No screen test is allowed.

3.6.2. Failed test must be reperformed after amendment to the coding.

3.6.3. Test Form shall be signed off by tester and reviewer for accountability.

3.6.4. All implemented change request must be tested by Quality Assurance before release.

3.7. Release Note (SQA-F-008)

3.7.1. Release Note shall be uniquely identified as per company naming convention.

3.7.2. Bug fix shall be stated in the Release Note with relevant Change Request Form ID, files affected and created from the change implementation.

3.7.3. Preparer of Release Note shall ensure all the implemented change requests stated in the document have been tested by Quality Assurance.

3.7.4. Release Note shall be reviewed and approved by Project Manager before issuance.

3.7.5. The mode of issuing Release Note is at the discretion of Project Manager.

3.8. Work Breakdown Structure and Project Schedule (SQA-F-009)

3.8.1. Project Schedule must be prepared for every release.

3.8.2. All the approved Change Requests Forms, the assigned person (task owner) and the estimated time for implementation shall be recorded in the WBS/Project Schedule.

3.8.3. A copy shall be shared with ALL the team members and Helpdesk with READ access for coordination and clear assignment of duties.

3.9. Release Checklist (SQA-F-010)

3.9.1. Release Checklist shall be prepared for EACH release.

3.9.2. Release project is only considered completed after completion of the tasks stated in the document and approved by Project Manager.

3.10. Others

3.10.1. Decision made by CCB (on implementation) and Project Manager (on timing of release) shall be communicated to customers formally, for change request from customers.

3.10.2. The method adopted for software / patch release is subject to the condition and environment as at the time of release. Project Manager is to decide and approve based on recommendation of the project team for the most appropriate method.

3.10.3. The master repository for software system / application must be backed up with access protected for each software and patch release. Version control shall apply where version number be revised / incremented sequentially.

4. Quality Objectives

Identify quality objectives that are "measurable, consistent with quality policy, relevant to conformity of goods and services, able to meet customer's expectation". Examples:

4.1. Customer change request must be responded within 48 hours with priority rating.

4.2. 100% on-time deployment, i.e. release as per plan.

4.3. Customer satisfaction rating of "meet expectation" for implemented change request.

5. Roles and Responsibilities

Define the authorities and responsibilities that will implement and operate the QMS. Examples are shown below.

5.1. Project team shall be set up formally with clearly assigned team roles documented in the Project Team Roles (SQA-F-001).

5.2. At the discretion of Project Manager, certain project roles can be fulfilled by a team member simultaneously, e.g. Change Control Coordinator, to allow for multi-tasking.

5.3. Quality Assurance role to be played by members of other project teams to ensure independence. Project Manager shall consider the experience and skill of the person to fulfil the role.

5.4. Board of Director (BOD)

5.4.1. Responsible for the establishment and control of the change control management as per ISO 9001 Standards requirements for the purpose of setting up a QMS.

5.4.2. Conducts management review on a quarterly basis to assess the suitability, adequacy and effectiveness of the QMS.

5.4.3. Ascertains needs for improvement and make improvements recommendations accordingly.

5.5. Change control board (comprises company director and project manager)

5.5.1. Develops, reviews and approves change control policy and procedure.

5.5.2. Reviews and approves change request.

5.6. Project Manager

5.6.1. Ensures change control policy and procedure are established, understood and followed by team members.

5.6.2. Reviews and recommends change request for the Change Control Board's final approval.

5.6.3. Works together with the project team members to identify the change implementation to be included in each release.

5.6.4. Reviews and approves change project scheduling and task assignment.

5.6.5. Reviews and approves test plans, test case specification.

5.6.6. Reviews and approves Release Note.

5.6.7. Works together with Software Quality Assurance to address any issues raised.

5.6.8. Provides updates to customers on project or software products development.

5.6.9. Reviews Release Checklist to ensure change project is completed in compliance with established policies and procedures.

5.6.10. Conducts post implementation review to identify improvement opportunities.

5.6.11. Reports the performance of change control management process, including any exceptions from complying with the established process and the related action plan for rectification, to the BOD periodically.

5.6.12. Reviews Change Log at minimum, on fortnightly interval, to monitor the progress of change implementation.

5.6.13. Reviews Customer Call Log, at minimum, on fortnightly interval, to ensure all bug related incidents are duly reported with Change Request Form raised.

5.7. Project Lead

5.7.1. Assigns change request to appropriate project team members for analysis.

5.7.2. Reviews change request analysis result and submit for the approval of Project Manager.

5.7.3. Plans project scheduling and propose task assignments for the approval of Project Manager.

5.7.4. Monitors change implementation via Change Log.

5.7.5. Reviews test plan for each change request and consolidate all individual test plans into a master test plan for one release.

5.7.6. Reviews and approves test case specification and test forms.

5.7.7. Creates release branch to store all committed changes for one release for quality assurance tests.

5.7.8. Ensures issues identified by Quality Assurance are resolved satisfactorily prior to UAT test, if any.

5.7.9. Arranges and performs for UAT with relevant stakeholders.

5.7.10. Backs up repository with correct versioning.

5.7.11. Prepares Release Note for approval of Project Manager.

5.7.12. Prepares Release Pack and ensures all affected files are stored by checking to the CR Forms (where affected files are stated).

5.7.13. Send customer satisfaction survey to seek customer feedback.

5.7.14. Prepares Release Checklist for project closure.

5.8. Project Team Members (Programmers, Analysts, etc)

5.8.1. Understand and follow the SDLC and change control policy and procedure.

5.8.2. Performs change request analysis as assigned.

5.8.3. Prepare test plan and test case specification for change request assigned.

5.8.4. Implement and test the change request assigned.

5.8.5. Resolve issues arising from Quality Assurance testing.

5.9. Change Control Board Coordinator

5.9.1. Arranges CCB meeting.

5.9.2. Prepares and distributes meeting agenda.

5.9.3. Records CCB's decision in the Change Request Forms.

5.9.4. Prepares CCB meeting minutes for the approval of CCB.

5.10. Helpdesk

5.10.1. Records customer's report in the Customer Call Log and assign sequential unique ID number following company's defined naming convention.

5.10.2. Raises Change Request Form for cases require changes and submit to relevant Project Lead.

5.10.3. Updates Customer Call Log of change request information and status, if applicable.

5.10.4. Informs customer of change request decision, priority and implementation status.

5.11. Quality Assurance

5.11.1. Review change control process forms and templates and recommend for approval of use.

5.11.2. Review adequacy of test case after assessing the impact of change request to affected areas / modules.

5.11.3. Prepare test case specifications to supplement those prepared by the project team, as deemed fit.

5.11.4. Conduct tests and highlight issues for rectification prior to release.

5.11.5. Conduct audits to ensure change control management of projects is carried out as per company policies and procedures.

6. Authority

6.1.1. Documents preparer and approver / reviewer must be separate person. For projects where team lead is not assigned, the project document preparation responsibilities of team lead shall be assigned to other team members, while the review responsibilities be assumed by Project Manager. Project Manager cannot review and approve task / document prepared by himself.

6.1.2. Project Manager recommends change request for approval.

6.1.3. Change Control Board has the authority to approve change request. The authority can be delegated to Project Manager as deemed fit, but shall be guided by defined criteria such as change impact and formally documented.

6.1.4. Project Manager has the authority to assign the approved change request to appropriate team member for execution and testing.

6.1.5. Post implementation review shall be carried out by Project Manager who approves the release of the change.

7. Change Control Procedure

P1: Change Request Issuance and Analysis Process

P1.1 User / customer reports incident about bug issue.

P1.2 Helpdesk records the incident report into Customer Call Log (SQA-F-002) [*refer to Appendix C*] and assigns a Log ID. The following information must be completed by Helpdesk in the Customer Call Log:

- Log case ID
- Log date
- Customer name
- Contact person for customer
- Contact phone and email
- Brief description of incident
- Service type (select from predefined options)
- Nature of request (select from predefined options)

P1.3 Helpdesk / Project Team Members (for internally detected bugs) to raise Change Request Form (SQA-F-003) [*refer to Appendix D*] and complete with sign off. Requester to state the following details:

- Change request ID and request date,
- Project code
- Project name
- System version
- Description and justification of change
- Type of change

Change request ID shall be created in sequential number with reference to the project Change Log, following company's naming convention: CR/Type of Change/ Sequential Number-Customer Reference

CR	Type of Change	Sequential Number	Customer Reference
The name of form. CR for Change Request	E.g. B for Bug E for Enhancement	Digit	Customer code.

P1.4 Submit Change Request Form to Project Lead who will then:

- Assign appropriate Project Team Member to conduct change analysis.
- Record the change form into Change Log (SQA-F-004) [*refer to Appendix E*].

P1.5 Assigned Project Team Member assesses the change impact and ascertain the priority of change.

P1.6 Assigned Project Team Member estimates resource requirement, including the duration and cost required to implement the change.

P1.7 Assigned Project Team Member identifies affected files, functions and components of the software products.

P1.8 Assigned Project Team Member determines the possible tests to be performed on implementing the change. Test Case Specification (SQA-F0006) [*refer to Appendix G*] shall be prepared as support.

P1.9 Assigned Project Team Member records work performed in P1.5 to P1.8 in the Change Request Form, signs off, and submits to Project Lead.

P1.10 Project Lead reviews Change Request Form for completeness prior to submitting to Project Manager.

P2: Change Request Approval Process

P2.1 Project Manager reviews change request and makes recommendation to Change Control Board (CCB) Coordinator:

- Approval – route to Change Control Board / Emergent Change Authority for approval
- Pending – for low impact change that is kept in view, considering the resources constraint. [Go to step P3.6. Helpdesk to notify customers of decision, if applicable]
- Reject – Change is rejected. [Go to step P3.6. Helpdesk to notify customers of decision, if applicable]

Change Request Forms with "Pending" status are kept by Project Lead who then updates the Change Log. A list of all the pending Change Request shall be prepared and submitted to Project Manager for reconsideration in the next system / patch release.

P2.2 For emergency bug fixes, CCB Coordinator to seek approval from Emergent Change Authority.

[CCB Coordinator to submit approved urgent change request to Project Manager who shall then assign the implementation task (Project Lead to assign Project Team Member to carry out the change, following steps in P4: Change Request Execution Process).]

P2.3 CCB Coordinator arranges Change Control Board meeting.

P2.4 CCB Coordinator to prepare meeting agenda, including information on executed urgent changes, along with all the Change Request Forms (duplicate copy) to be distributed to Change Control Board members.

P2.5 Change Control Board convenes meeting to review and decide on change request.

P2.6 Change Control Coordinator fill in the Change Request Forms with decision of Change Control Board. Completed Change Request Forms are returned to Project Manager.

P2.7 Project Manager passes the Change Request Forms to Project Lead for next course of action: go to P3: Change Request Scheduling and Assignment Process

P2.8 CCB Coordinator prepares meeting minutes for the Change Control Board meeting for distribution.

P3: Change Request Scheduling and Assignment Process

P3.1 Project Lead updates status of Change Request Form into Change Log (SQA-F-004) [*refer to Appendix E*] and determines the release based on defined release criteria (to be determined by organisation).

P3.2 Project Lead prepares the Work Breakdown Structure (WBS) (SQA-F-009) [*refer to Appendix J*] and the project schedule for upcoming release. The effort estimated by Team Member during change analysis shall be revised if necessary.

P3.3 Project Lead proposes task assignment, i.e. the project team member suitable to carry out the change request task, and submit for the approval of Project Manager.

P3.4 Project Manager reviews the proposed release date, WBS, the relevant project schedule and assigned team member for approval.

P3.5 Project Lead assigns change task to project team member and notifies Helpdesk of the change request status via email or meeting, whichever deemed appropriate. A copy of the WBS and project schedule and all the affected CR Forms are stored in Project File in the shared server for the reference of team members and Helpdesk. The WBS and project schedule must be password protected by Project Lead to disallow changes by others.

P3.6 Helpdesk, upon receipt of notification from Project Lead, notifies customers on change request status via email. Reference has to be made to the Change Log to obtain the status information for all Change Request Forms raised (to identify rejected request). Customer Call Log is updated with Change Request Form ID, priority of change and status.

P4: Change Request Execution Process

P4.1 Programmer designs change required to fix the reported bug.

P4.2a Programmer prepares all the relevant test plans, supported with Test Case Specifications (revised and finalised from the earlier version prepared during change analysis), and submits for the review of Project Lead. Test Case

Specification shall be assigned identification number following the naming convention: TC-Change Request Form ID-Sequential Number

TC	Change Request Form ID	Sequential No.
The name of the form. TC for Test Case Specification	E.g. CR/B/0002-OF	Digit

Test Case Specification must state clearly the following information and be signed off by Programmer:

- Description and test type
- Requirement to be tested
- Environmental needs
- Test items, input specifications, procedural steps and expected result

P4.2b Quality Assurance reviews the test case specifications prepared by programmers, assess for adequacy and check if any other areas that will be affected by the change are also covered in test case. Quality Assurance to prepare additional test case specifications to supplement, if necessary.

P4.3 Project Lead reviews all the proposed test plans and the supporting Test Case Specification. Revision to be made by Programmers if needed. Approval of the Test Case Specifications shall be evidenced with sign off on the forms.

P4.4 Project Lead consolidates all the test plans into a single Master Test Plan (SQA-F-005) [*refer to Appendix F*] for all the changes for the current release, and submit for the approval of Project Manager. Master Test Plan shall be name following this convention: TP-Project Name-Sequential Number.

TP	Project Name	Sequential No.
The name of the form. TP for Test Plan	E.g. CRestOF	Digit

The version of the system, the type of release and the number must be stated for good referencing. Both Project Lead and Project Manager to sign off on the Master Test Plan as evidence of preparation and approval.

P4.5 Programmer obtains files required to carry out the change from repository. Reference is made to the CR Form to ensure correct and complete program files are checked out. [(For distributed version control system) Programmer clones a

single version of the project, i.e. a copy of the origin / master repository containing all the project files, to local working directory OR (For centralised version control system) checks out affected files from central repository to local workspace or branch].

P4.6 Programmer makes the necessary changes to the affected files and produces new files if needed.

P4.7 Programmer commits or stores all the affected files in the develop branch, ready for formal unit test. [Programmer who works in more than 1 branch must ensure proper merging and resolving any conflicts prior to committing. Logical lines of conflict shall be resolved with programmers involved in the changes along with Project Lead]

P4.8 Programmer performs unit test as per approved test plan and Test Case Specification.

P4.9 Programmer records the test results in a Test Form (SQA-F-007) [*refer to Appendix H*] and submit for the review and approval of Project Lead.

P4.10 Project Lead reviews tests performed for approval. For disapproved test form, Programmer has to repeat steps P4.6 to P4.9. Steps P4.6 to P4.9 are performed for different types of test as planned, e.g. integration test and system test.

***Test Forms with failed result must not be discarded. The forms shall be kept in the project file.**

P4.11 Project Lead / Team Member creates release branch and moves the affected files (committed changes) into the branch. Code freeze is declared for SQA test to take place.

P4.12 SQA personnel tests full and complete codes prior to release.

P4.13 SQA personnel records the test in the test forms and signs off as evidence of test performed.

P4.14 SQA Manager reviews and approves test if he is satisfied with the results, and sign off as evidence of check and approval.

P4.15 Programmer to resolve any bugs arising from SQA test (to be fixed by the programmers responsible for the change), in the release branch.

[Any minor bug fixes in release branch must be merged back to develop branch. No major change is permitted in the release branch]

P4.16 Project Lead / Project Manager arranges for User Acceptance Testing (UAT) to be performed, applicable for changes arising from customers. Users / representative to sign off on the test form as evidence of acceptance.
[Project Manager to decide if UAT can be exempted or deemed not necessary]

P4.17 Project Lead prepares patch release pack by saving a copy of all the affected and newly created files that have passed SQA tests into a zip folder.
Project Lead shall ensure accuracy and completeness by taking files from the release branch and verify the files to the Change Request Forms that state affected files and new files created.

P4.18 Project Lead prepares Release Checklist (SQA-F-010) [*refer to Appendix K*] and Release Note (SQA-F-008) [*refer to Appendix I*], for the approval of Project Manager. Both documents must be signed off for accountability.

P4.19 Project Manager reviews, requests amendments if deemed fit, and approves the Release Note. Project Manager determines if a README is required and assigns the task to appropriate personnel.

P4.20 Project Manager notifies all the stakeholders / affected parties of the planned release via communication mode deemed appropriate such as email and publication on portal and website.

P4.21 Project Lead issues patch release pack and Release Note / README to customers after final addressing Project Manager's review.

P4.22 Project Lead updates (pushes) the develop branch to the origin / master repository and increment the version number for the repository.

P4.23 Project Lead creates a duplicate copy of the repository as back up.

P5: Change Request Close Process

P5.1 Project Lead updates Change Log and project schedule with latest status.

P5.2 Helpdesk notifies customer of deployed changes, closes the case and updates Customer Call Log.

P5.3 Project Lead sends customer satisfaction survey to obtain customer feedback. Customer satisfaction rating shall form part of the key performance indicators' result to all the individual project team member's annual appraisal.

P5.4 Project Lead finalises Release Checklist for the review and approval of Project Manager. Project Lead ensures Project File is completed with all the project documentation for future SQA review (i.e. internal audit).

P5.5 Project Manager reviews Release Checklist to ensure necessary steps taken to release patch, repository back up and complete project documentation.

P5.6 Project Manager performs post implementation review with the project team. Lessons learned and actions to be taken shall be documented for future project reference.

8. Performance Evaluation

Assessing the performance of QMS for its effectiveness in meeting quality objectives is critical to ensure quality and to promote improvements. The Standard (clause 9.1.1) requires companies to monitor (via continuous observation and inspection), measure, analyse (via techniques to examine trends, etc) and evaluate (against given criteria) the quality elements to achieve the performance assessment objective. In addition to determining what to measure, companies are also required to determine the methods and interval to do so. The results shall be analysed and evaluated according to the methods decided by companies. The analysis and evaluation shall enable companies to conclude if the QMS is effective. While the details on how this requirement is to be implemented is not provided in this paper due to time constraint, some key policy statements regarding to performance evaluation are suggested below.

8.1. Post implementation review shall be conducted after each system / patch release, to identify lessons learned and learning opportunities. Performance targets shall be set and communicated by Project Manager to the project team at the beginning of project.

8.2. Customers satisfaction is a critical measurement of performance for any service-oriented companies like software companies. Customer feedback shall be sought on each patch release and be documented in the post implementation review report.

8.3. In addition, formal customer satisfaction survey to assess overall service performance shall be conducted annually. The customer survey and feedback results must be analysed and evaluated. Correction and improvement actions shall be proposed, with

assigned responsibility, tracked for closure. A report shall be prepared and presented to the Board of Directors during board meetings.

8.4. Customer satisfaction shall be one of the key performance indicators of individual employee's annual performance review. He / she will be measured on the rating obtained from customers for the projects he / she is a team member.

9. Risks and Controls Matrix for Change Control Management

The revised version of ISO 9001 introduces the risk-based thinking that aims to develop a proactive approach to identify the potential pitfalls and undesired effects and establish a QMS that can reduce or prevent those effects and eventually achieve improvement. Risk management practices shall come into place, like risk analysis, risk evaluation, design of control action. The result of the risk exercise shall be documented as proof of such activity taken place. The following is an example of documenting the risk analysis and the action plan / controls which are embedded in the change control management.

No.	Risk Description	Control Description	Ref.
1.	System failure.	System modifications are scheduled and carried out in batches, reducing the frequency of change and therefore likelihood of system crashes.	Steps P3.1 and P3.4
2.	Erroneous coding is introduced into production, resulting from incomplete or incorrect testing.	(a) Test case specification and test plans are prepared, reviewed and signed off, prior to coding for changes.	Steps P4.2 – P4.4
		(b) Test results are documented, reviewed and signed off for all changes made.	Steps 4.8 – P4.10
		(c) Tests are performed by person independent from programmer to the changes made.	Steps 4.12 – P4.14
3.	Repeated bugs report / unresolved bugs due to missing	(a) Release pack is prepared by a focal person who checked against CR	Steps P4.17 – P4.19

		program file in release pack.	Form and Release Notes for completeness.	
			(b) Release pack preparation and validation are documented in Release Checklist for accountability.	Step P4.18, Steps P5.4
			(c) Release Checklist is reviewed by Project Manager to ensure proper execution of control action.	Step P5.5
	4.	Repeated bugs report / unresolved bugs due to wrong check out of program file.	(a) Required program files for bug fix are determined during change impact analysis and documented in CR Form.	Step P1.7, Step P1.9
			(b) Assigned programmer refers to CR Form to check out program file for change implementation.	Step P3.5, Step P4.5
	5.	Bugs reported were not found at programmers' PC	(a) No screen test is allowed. Test results are documented, reviewed and signed off for all changes made.	Steps 4.8 – P4.10
			(b) Tests are performed by person independent from programmer to the changes made.	Steps 4.12 – P4.14
	6.	Incomplete testing due to missing test scenario	All test case specification and test plans are documented, reviewed and signed off, prior to coding for changes.	Steps P4.2 – P4.4
	7.	Dissatisfied customers due to lack of information / communication on bug case reported.	(a) Change request implementation decision and status are notified to customers.	Step P3.6 and Step P5.2
			(b) Conduct customer satisfaction survey to seek feedback from customers.	Step P5.3
	8.	Bug case reported was not escalated to technical team.	Project Manager reviews the Customer Call Log periodically to ensure all valid	Policy 3.1.3

		bug cases are formally reported to the project team for rectification	
9.	Wasted resources spent on fixing bugs that have very insignificant impact to the system.	(a) All change requests must be analysed and documented.	Steps P1.5 – P1.9
		(b) Approval of Change Control Board / Emergent Change Authority must be sought for before change can be implemented.	Steps P2.2 – P2.5

10. Forms and templates

10.1. Project Team Roles (SQA-F-001) [*refer to Appendix B*]

10.2. Customer Call Log (SQA-F-002) [*refer to Appendix C*]

10.3. Change Request Form (SQA-F-003) [*refer to Appendix D*]

10.4. Change Log (SQA-F-004) [*refer to Appendix E*]

10.5. Test Plan (SQA-F-005) [*refer to Appendix F*]

10.6. Test Case Specification (SQA-F-006) [*refer to Appendix G*]

10.7. Test Form (SQA-F-007) [*refer to Appendix H*]

10.8. Release Note (SQA-F-008) [*refer to Appendix I*]

10.9. WBS and Project Schedule (SQA-F-009) [*refer to Appendix J*]

10.10. Release Checklist (SQA-F-010) [*refer to Appendix K*]

5.9 Software Change Control Management: In Practice

In real life, a lot of IT companies face the challenge of implementing software change control process formally. First the identification of the logical and sequential steps, the responsibility for each step and how evidence the whole process. Then the challenge of putting down all these in writing and finally the confusion of taking the first step of executing the process.

With the change control process already outlined in term of SDLC and PLC as shown in Section 5.6, the process flow presented pictorially in Section 5.7 and also the SOP written in the Quality Manual in Section 5.8, the author would like to demonstrate how the process would be like in practice to enhance the confidence in potential adopters the feasibility of this proposed change control management process.

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5.9.1 Capturing the Process and Evidence It

P1: Change Request Issuance, Analysis and Approval Process and P2: Change Request Approval Process

Customer Call Log

Log Case ID	Log Date	Customer	Contact Person	Contact Phone	Contact Email	Incident Description	Service Type[1]	Nature of Request[2]	Project Details: Code	Project Details: Name	Applicable if Change Management Triggered: Change Request ID	Applicable if Change Management Triggered: Priority[3]	Applicable if Change Management Triggered: Status[4]	Resolve Date
CL-1812-0001	9/12/2018	Offspring Sdn. Bhd.	Hafizah Zaukefli	03-56738990	hafizah.z@off.com.my	Log out of the system due to wrong password	Accounts and Access	Incident	OF-CRM-2018	CRestOF				19/12/2018
CL-1812-0002	12/12/2018	Yellowbook	Aw Meng Feng	016-9902389	awmf@yellow.com.my	Network down	Network, Voice & Connectivity	Incident	YP-ERP-2017	YERP				20/12/2018
CL-1812-0003	20/12/2018	Offspring Sdn. Bhd.	Hafizah Zaukefli	03-56738990	hafizah.z@off.com.my	Customer Feedback Form cannot be submitted without filling all the fields	Enterprise Applications	Bug / Fault	OF-CRM-2018	CRestOF	CR/B/0002-OF	Medium	Open	16/1/2019
CL-1812-0004	21/12/2018	Offspring Sdn. Bhd.	Hafizah Zaukefli	03-56738990	hafizah.z@off.com.my	Customer Feedback Form cannot be displayed using Microsoft Edge	Enterprise Applications	Bug / Fault	OF-CRM-2018	CRestOF	CR/B/0004-OF	Medium	Open	16/1/2019

Record bug reported & assign case ID (P1.1. & P1.2)

Tracing record of CR Form raised in respect to the case lodged (P3.6)

Figure 5.11: Capture bug case reported for monitoring

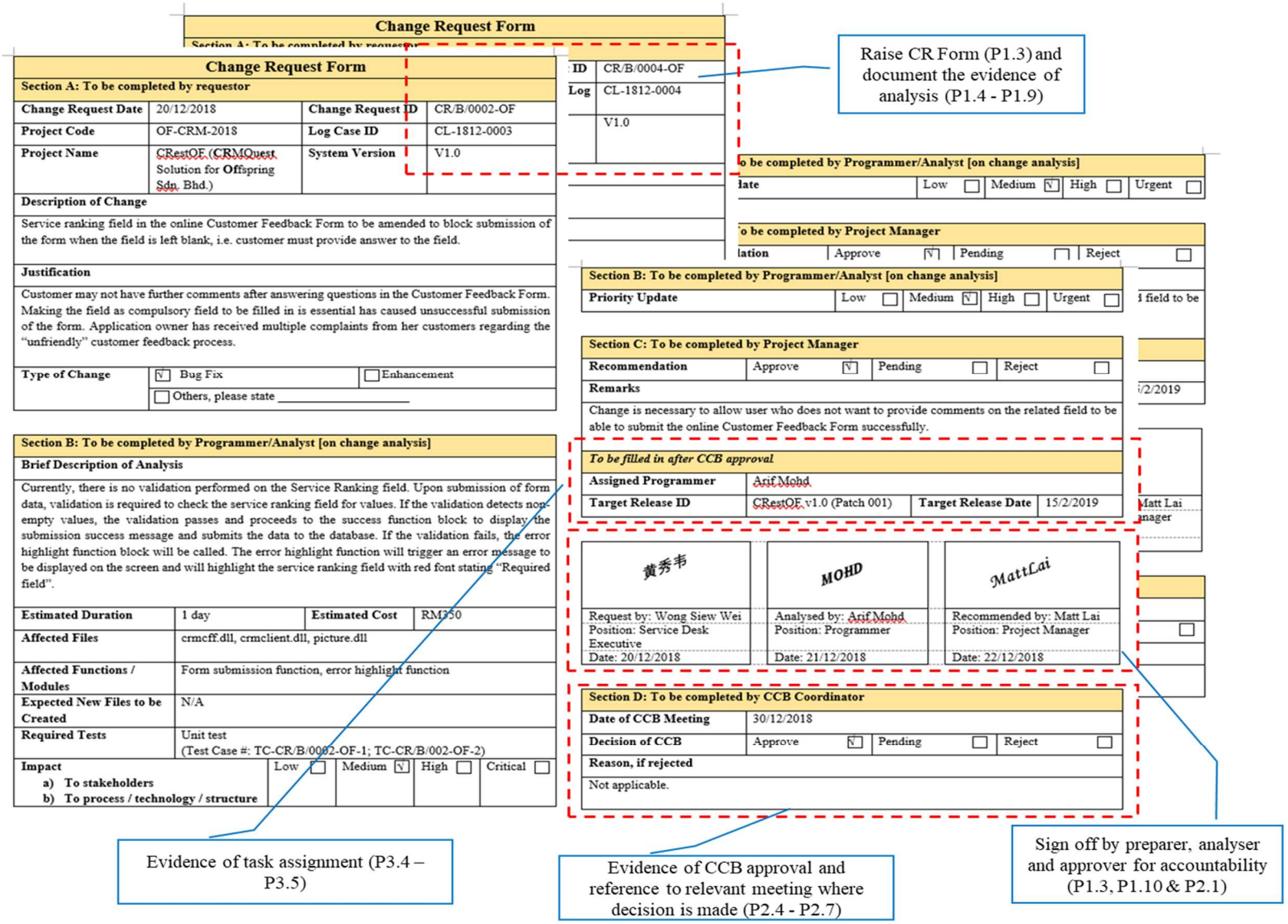


Figure 5.12: Capture change request analysis, the review activities and accountability

P3: Change Request Scheduling and Assignment Process

Add change request into Change Log for monitoring (P3.1)

Project scheduling and task assignment (P3.2 – P3.5)

Change Log

Project Code:	OF-CRM-2018
Project Name:	CRestOF

Change Request ID	Change Request Date	Brief Description of Change	Change Type[1]	Impact Summary	Impact Level[2]	Priority Level[3]	Status[4]	Release / Patch		
								ID	Plan Date	Actual Date
CR/E/0001-OF	10/01/2018	Customer Feedback Form to be available in Chinese Language	Enhancement	The requirement does not affect majority of the users.	Low	Low	Pending			
CR/B/0002-OF	20/12/2018	To ensure service ranking as a compulsory field in the online Customer Feedback Form prior to submission.	Bug Fix	The form can still be submitted albeit the missing of important information.	Medium	High	Open	CRestOF v1.0 (Patch 001)	15/2/2019	16/2/2019
CR/E/0003-OF	21/12/2018	Authorisation of multiple new account users	Enhancement	The change increase flexibility and user friendliness but minimal impact to current operation.	Medium	Medium	Open	CRestOF v1.0 (Patch 001)	15/2/2019	16/2/2019
CR/B/0004-OF	21/12/2018	Customer Feedback Form to display in Microsoft Edge	Bug Fix	The form cannot be open in the platform, causing interruption to users	Medium	High	Open	CRestOF v1.0 (Patch 001)	15/2/2019	16/2/2019

WORK BREAKDOWN STRUCTURE

PROJECT CODE	OF-CRM-2018
PROJECT NAME	CRestOF
RELEASE ID	CRestOF v1.0 (Patch 001)
PLAN RELEASE DATE	15/2/2019

WBS NUMBER	TASK TITLE	TASK OWNER	START DATE	DUE DATE	DURATION	% of TASK COMPLETE	WEEK 1					WEEK 2					WEEK 3					WEEK 4				
							M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F
1.0	**Project Initiation**																									
1.1	Receive change requests	Project Lead	15/12/2018	25/12/2018	9	0%																				
1.2	Assign change request analysis tasks	Project Lead	16/12/2018	28/12/2018	9	0%																				
2.0	**Project Planning**																									
2.1	Perform and document change request analysis	Programmer / Analyst	16/12/2018	29/12/2018	10	0%																				
2.2	Submit change requests for recommendation approval	Project Lead	17/12/2018	30/12/2018	10	0%																				
2.3	Approve recommendation for change requests	Project Manager	18/12/2018	31/12/2018	10	0%																				
2.4	Hold CCB meeting and make decision																									
	- Compile and distribute change requests	CCB Coordinator	4/1/2019	5/1/2019	2	0%																				
	- Prepare and distribute agenda	CCB Coordinator	4/1/2019	5/1/2019	2	0%																				
	- Hold meeting	CCB	11/1/2019	11/1/2019	1	0%																				
2.5	Document CCB decision and distribute CRs	CCB Coordinator	12/1/2019	12/1/2019	1	0%																				
2.6	Assign Task and Scheduling																									
2.6.1	- Update Change Log	Project Lead	13/1/2019	13/1/2019	1	0%																				
2.6.2	- Prepare WBS & Schedule, propose assignment	Project Lead	13/1/2019	13/1/2019	1	0%																				
2.6.3	- Approve task assignment and project schedule	Project Manager	13/1/2019	13/1/2019	1	0%																				
2.7	Notify customer of change request status	Helpdesk	13/1/2019	13/1/2019	1	0%																				
3.0	**Project Execution**																									
3.1	Design change					0%																				
3.1.1	CR/B/0002-OF	Programmer 1	14/1/2019	14/1/2019	0.5	0%																				
3.1.2	CR/E/0003-OF	Programmer 2	14/1/2019	15/1/2019	2	0%																				
3.1.3	CR/B/0004-OF	Programmer 3	14/1/2019	16/1/2019	3	0%																				

Figure 5.13: Capture approved change request task scheduling and assignment

P4: Change Request Execution Process

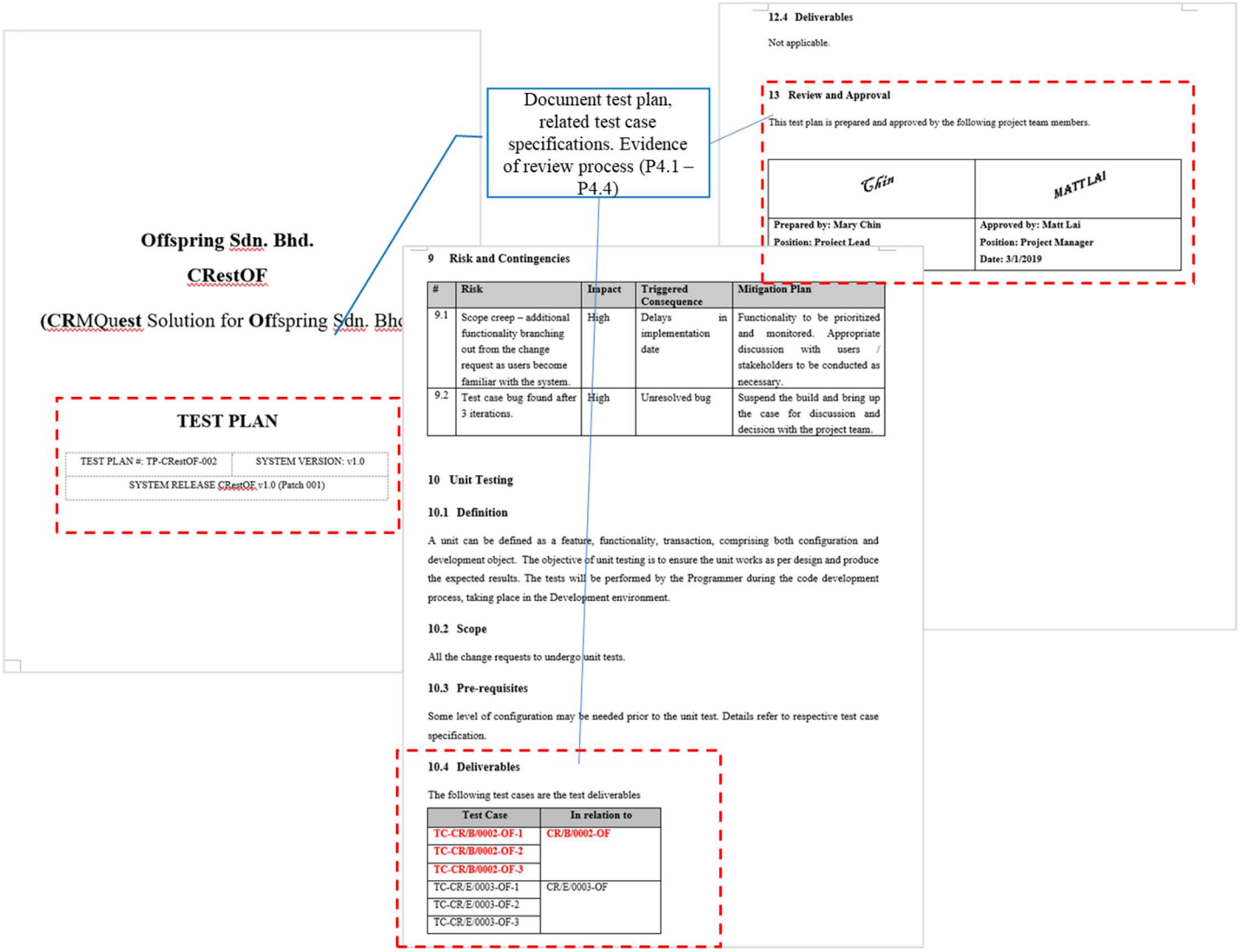
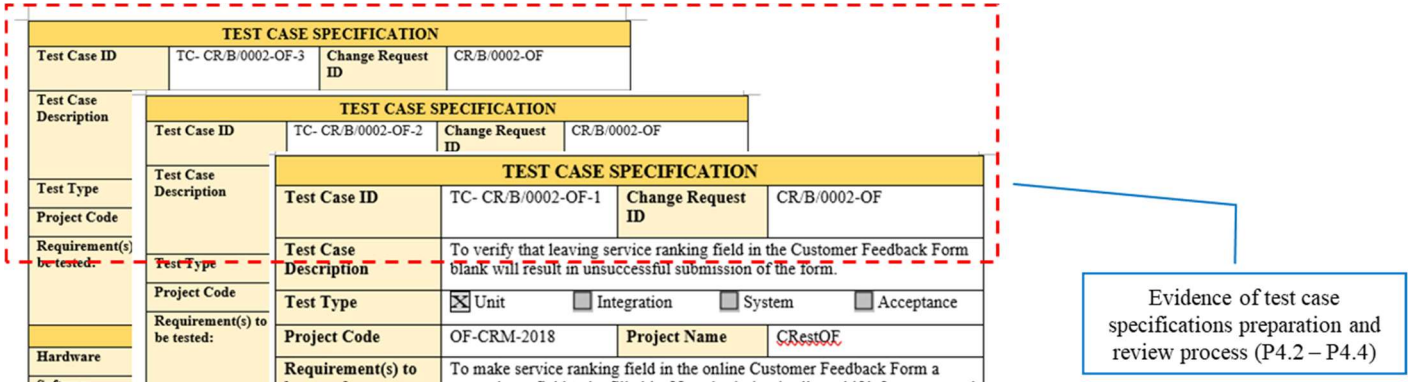


Figure 5.14: Capture change request test planning, the review activities and accountability



TEST CASE SPECIFICATION

Test Case ID	TC- CR/B/0002-OF-1	**Change Request ID**	CR/B/0002-OF
Test Case Description	To verify that leaving service ranking field in the Customer Feedback Form blank will result in unsuccessful submission of the form.		
Test Type	☒ Unit ☐ Integration ☐ System ☐ Acceptance		
Project Code	OF-CRM-2018	**Project Name**	CRestOF
Requirement(s) to be tested:	To make service ranking field in the online Customer Feedback Form a compulsory field to be filled in. No submission is allowed if left unanswered or in the event more than 1 answer is given.		
ENVIRONMENTAL NEEDS			
Hardware	PC or laptop		
Software	Operating system: Microsoft Window 10 Browser: Google Chrome or Microsoft Edge		
Other	None		
Procedural Requirements	Open the online Customer Feedback Form via the link sent through email invitation to customer (user).		
TEST			
Test Items and Features	Customer Feedback Form		
Input Specifications	Service ranking = blank, Other fields with valid input.		
Procedural Steps	1. Click the invitation link to go to the online Customer Feedback Form 2. Fill in the Customer Feedback form and leave the service ranking question unanswered, i.e. do not click on any of the options listed. 3. Click the "Submit" button at the bottom of the form.		
Expected Results of Case	Error message is displayed showing "Incomplete Response". Service ranking field is highlighted with red font.		
TEST SCRIPT APPROVAL			
MOHD		Chin	
Prepared by: Arif Mohd **Position: Programmer** **Date: 2/1/2019**		**Approved by: Mary Chin** **Position: Project Lead** **Date: 3/1/2019**	

Evidence of test case specifications preparation and review process (P4.2 – P4.4)

Figure 5.15: Capture test case preparation, the review activities and accountability

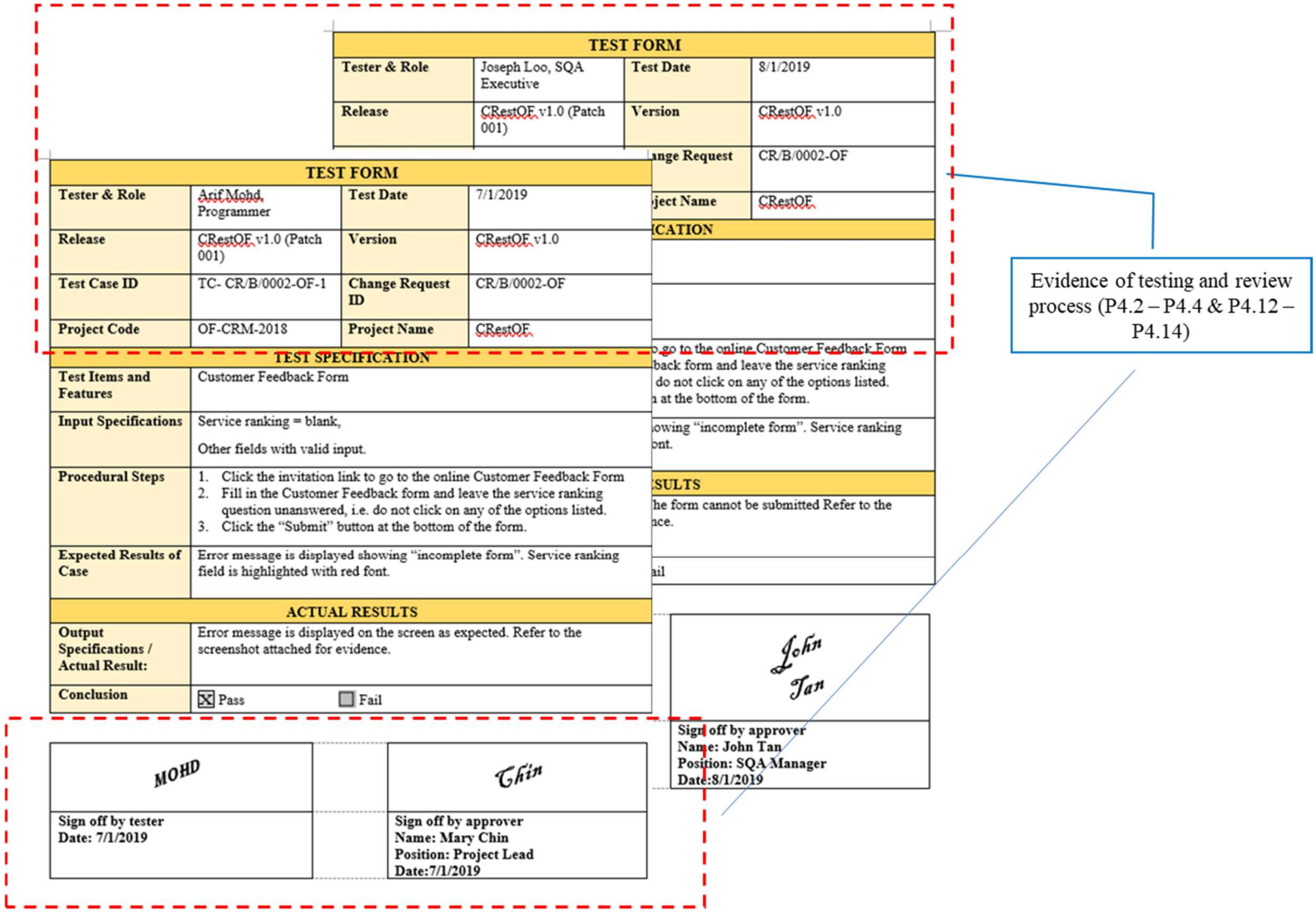


Figure 5.16: Capture the testing and review activities and the accountability

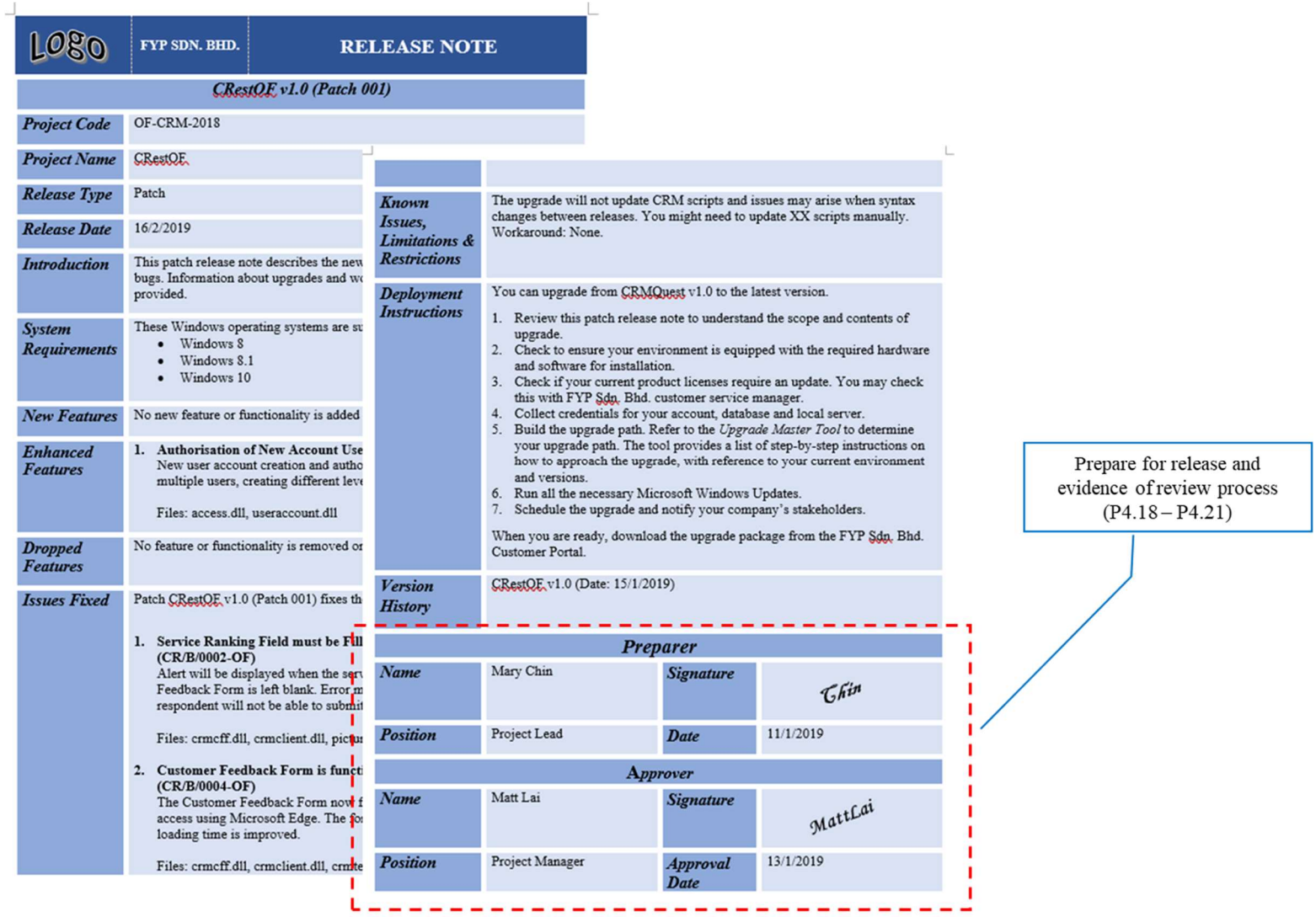


Figure 5.17: Capture the release preparation work

```
CRMQuest Solution for Offspring Sdn. Bhd
Release 1.0 (Patch 002)
16-02-2019

Production README
================================================================================


Contents Of This Release
------------------------

For all platforms:

  [CRMQuest_HOME]/ucp/lib contains:

  - ucp.jar
    Classes for use with CRM 5.0 and CRM 6. It contains the CRMQuest
    Solution classes, as well as the built-in Pool Adapter
    classes for standalone CRM applications.

  Javadoc / Documentation / Demo:

    The above are available for download on https://FYP.com.my/crmq/


Installation
------------

The CRMQuest Installer puts the CRMQuest Solution files in the
[CRMQuest_HOME]/ucp directory.
```

A Readme Text as an alternative for formal announcement (P4.18 – P4.21)

```
Setting Up Your Environment
---------------------------

On Windows platforms:
  - Add [CRMQuest_HOME]\ucp\lib\ucp.jar to your CLASSPATH.

On all Unix platforms:
  - Add [CRMQuest_HOME]/ucp/lib/ucp.jar to your CLASSPATH.


New Feature Added in This Release
---------------------------------

No new feature or functionality is added in this patch.


Enhanced Features Made in This Release
--------------------------------------

CR/E/0003-OF
   New user account creation and authorisation level can be performed on
   multiple users, creating different levels of access rights at one time.


Problems/Limitations Fixed in This Release
------------------------------------------

CR/B/0002-OF
    Customer Feedback Form can be submitted without response to the
    service ranking question.

CR/B/0004-OF
    Improper display of Customer Feedback Form on Microsoft Edge.
```

Figure 5.18: README as a form of release communication

P5: Change Request Closure Process

Change Log

Project Code:	OF-CRM-2018									
Project Name:	CRestOF									
Change Request ID	**Change Request Date**	**Brief Description of Change**	**Change Type[1]**	**Impact Summary**	**Impact Level[2]**	**Priority Level[3]**	**Status[4]**	**Release / Patch**		
								ID	**Plan Date**	**Actual Date**
CR/E/0001-OF	10/01/2018	Customer Feedback Form to be available in Chinese Language	Enhancement	The requirement does not affect majority of the users.	Low	Low	Pending			
CR/B/0002-OF	20/12/2018	To ensure service ranking as a compulsory field in the online Customer Feedback Form prior to submission.	Bug Fix	The form can still be submitted albeit the missing of important information.	Medium	High	Closed	CRestOF v1.0 (Patch 001)	15/2/2019	16/2/2019
CR/E/0003-OF	21/12/2018	Authorisation of multiple new account users	Enhancement	The change increase flexibility and user friendliness but minimal impact to current operation.	Medium	Medium	Closed	CRestOF v1.0 (Patch 001)	15/2/2019	16/2/2019
CR/B/0004-OF	21/12/2018	Customer Feedback Form to display in Microsoft Edge	Bug Fix	The form cannot be open in the platform, causing interruption to users	Medium	High	Closed	CRestOF v1.0 (Patch 001)	15/2/2019	16/2/2019

Update Change Log and Customer Call Log (P5.1 – P5.2)

Customer Call Log

									Project Details		**Applicable if Change Management Triggered**			**Resolve Date**
Log Case ID	**Log Date**	**Customer**	**Contact Person**	**Contact Phone**	**Contact Email**	**Incident Description**	**Service Type[1]**	**Nature of Request[2]**	**Code**	**Name**	**Change Request ID**	**Priority[3]**	**Status[4]**	
CL-1812-0001	9/12/2018	Offspring Sdn. Bhd.	Hafizah Zaukefli	03-56738990	hafizah.z@off.com.my	Log out of the system due to wrong password	Accounts and Access	Incident	OF-CRM-2018	CRestOF	[redacted]			19/12/2018
CL-1812-0002	12/12/2018	Yellowbook	Aw Meng Feng	016-9902389	awmf@yellow.com.my	Network down	Network, Voice & Connectivity	Incident	YP-ERP-2017	YERP				20/12/2018
CL-1812-0003	20/12/2018	Offspring Sdn. Bhd.	Hafizah Zaukefli	03-56738990	hafizah.z@off.com.my	Customer Feedback Form cannot be submitted without filling all the fields	Enterprise Applications	Bug / Fault	OF-CRM-2018	CRestOF	CR/B/0002-OF	Medium	Resolved	16/1/2019
CL-1812-0004	21/12/2018	Offspring Sdn. Bhd.	Hafizah Zaukefli	03-56738990	hafizah.z@off.com.my	Customer Feedback Form cannot be displayed using Microsoft Edge	Enterprise Applications	Bug / Fault	OF-CRM-2018	CRestOF	CR/B/0004-OF	Medium	Resolved	16/1/2019

Figure 5.19: Capture the update of monitoring log with closure information

Release Checklist	
CRestOF v1.0 (Patch 001)	
Project Code	OF-CRM-2018
Project Name	CRestOF
Release Type	Patch
Release Date	16/2/2019

Task	Done
Preparing for Release	
1. Block the master repository from patches not included in the current release.	☑
2. Check that all the affected files and newly created files for target change request are saved in the Release Pack. [*Important: Perform your check by making reference to ALL the related Change Request Forms*]	☑
3. Prepare Release Note. [*Important: Check to ensure all implemented change requests are included by referring to Change Log*]	☑
4. Seek approval for Release Note.	☑
Post Release	
5. Merge develop branch with the master repository.	☑
6. Name master repository with increment version number.	☑
7. Back up master repository and store in department's server.	☑
8. Release the master repository for future patches.	☑
9. Update Change Log with release information	☑
10. Notify Helpdesk on patch release.	☑
11. Update Project Schedule for finalisation.	☑
12. Send customer survey form to collect feedback.	☑
13. Review the Project File to ensure team members have duly completed and filed all the project documents.	☑

Completed by:	**Review by:**
Chin	MattLai
Name: Mary Chin	Name: Matt Lai
Position: Project Lead	Position: Project Manager
Date: 20/1/2019	Date: 21/1/2019

Perform closure procedure and finalise Release Checklist (P5.3 – P5.5)

Figure 5.20: Capture the finalisation procedures for closure purpose

5.9.2 Traceability – Key to Monitoring and Control

Customer Call Log

Log Case ID	Log Date	Customer	Contact Person	Contact Phone	Contact Email	Incident Description	Service Type[1]	Nature of Request[2]	Project Details: Code	Project Details: Name	Applicable if Change Management Triggered: Change Request ID	Applicable if Change Management Triggered: Priority[3]	Applicable if Change Management Triggered: Status[4]	Resolve Date
CL-1812-0001	9/12/2018	Offspring Sdn. Bhd.	Hafizah Zaukefli	03-56738990	hafizah.z@off.com.my	Log out of the system due to wrong password	Accounts and Access	Incident	OF-CRM-2018	CRestOF				19/12/2018
CL-1812-0002	12/12/2018	Yellowbook	Aw Meng Feng	016-9902389	awmf@yellow.com.my	Network down	Network, Voice & Connectivity	Incident	YP-ERP-2017	YERP				20/12/2018
CL-1812-0003	20/12/2018	Offspring Sdn. Bhd.	Hafizah Zaukefli	03-56738990	hafizah.z@off.com.my	Customer Feedback Form cannot be submitted without filling all the fields	Enterprise Applications	Bug / Fault	OF-CRM-2018	CRestOF	CR/B/0002-OF	Medium	Open	16/1/2019
CL-1812-0004	21/12/2018	Offspring Sdn. Bhd.	Hafizah Zaukefli	03-56738990	hafizah.z@off.com.my	Customer Feedback Form cannot be displayed using Microsoft Edge	Enterprise Applications	Bug / Fault	OF-CRM-2018	CRestOF	CR/B/0004-OF	Medium	Open	16/1/2019

Change Request Form

Section A: To be completed by requestor			
Change Request Date	20/12/2018	Change Request ID	CR/B/0002-OF
Project Code	OF-CRM-2018	Log Case ID	CL-1812-0003
Project Name	CRestOF (CRMQuest	System Version	V1.0

iback Form to be amended to block submission of must provide answer to the field.

iwering questions in the Customer Feedback Form. in is essential has caused unsuccessful submission iple complaints from her customers regarding the

☐ Enhancement

ialyst [on change analysis]

Service Ranking field. Upon submission of form iking field for values. If the validation detects non- ds to the success function block to display the a to the database. If the validation fails, the error

Change Log

Project Code: OF-CRM-2018
Project Name: CRestOF

Change Request ID	Change Request Date	Brief Description of Change	Change Type[1]	Impact Summary	Impact Level[2]	Priority Level[3]	Status[4]	Release / Patch: ID	Release / Patch: Plan Date	Release / Patch: Actual Date
CR/E/0001-OF	10/01/2018	Customer Feedback Form to be available in Chinese Language	Enhancement	The requirement does not affect majority of the users.	Low	Low	Pending			
CR/B/0002-OF	20/12/2018	To ensure service ranking as a compulsory field in the online Customer Feedback Form prior to submission.	Bug Fix	The form can still be submitted albeit the missing of important information.	Medium	High	Open	CRestOF v1.0 (Patch 001)	15/2/2019	16/2/2019
CR/E/0003-OF	21/12/2018	Authorisation of multiple new account users	Enhancement	The change increase flexibility and user friendliness but minimal impact to current operation.	Medium	Medium	Open	CRestOF v1.0 (Patch 001)	15/2/2019	16/2/2019
CR/B/0004-OF	21/12/2018	Customer Feedback Form to display in Microsoft Edge	Bug Fix	The form cannot be open in the platform, causing interruption to users	Medium	High	Open	CRestOF v1.0 (Patch 001)	15/2/2019	16/2/2019

1

Figure 5.21: Tracing reported change request from Customer Call Log to CR Form and Change Log

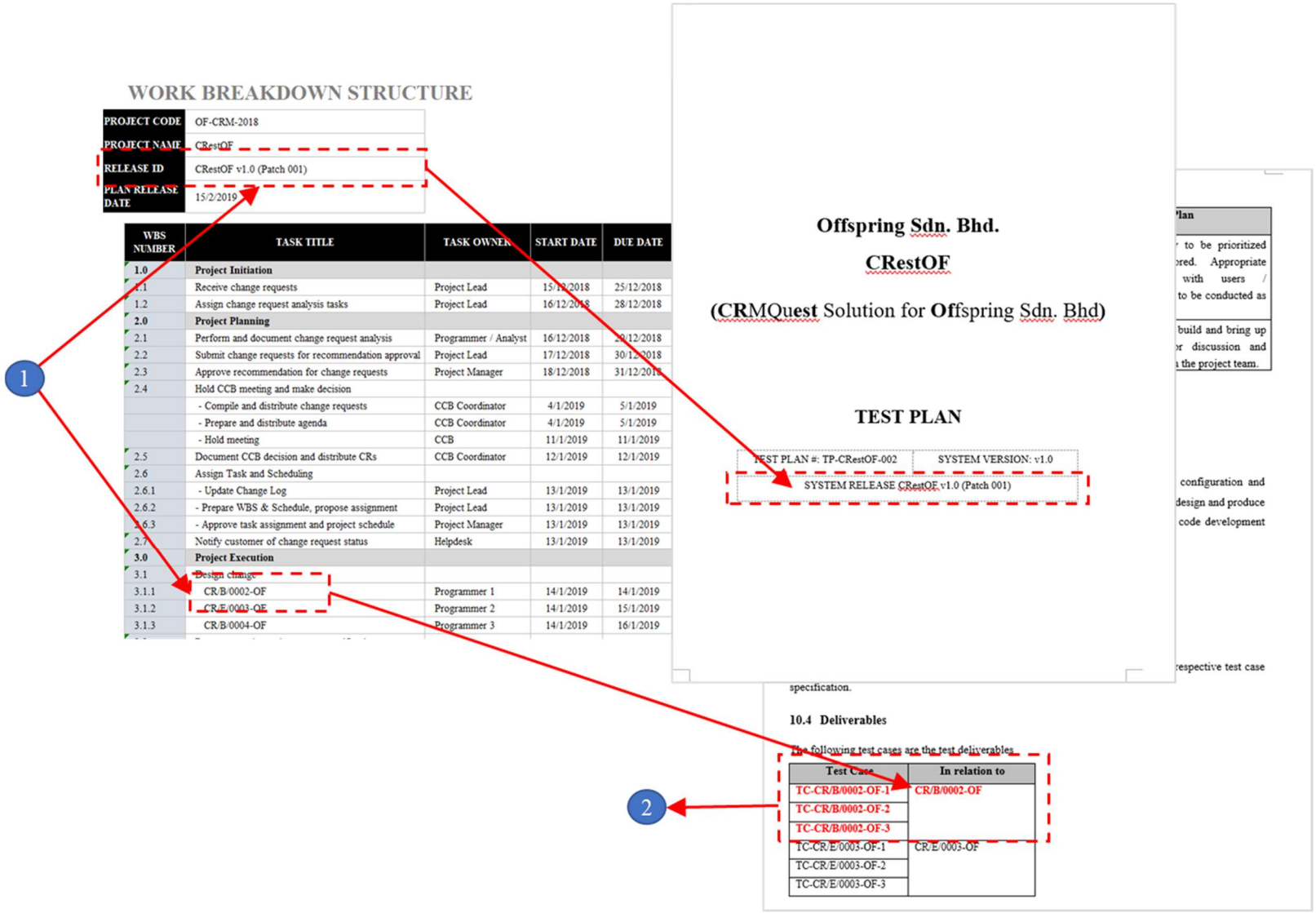


Figure 5.22: Tracing change request from Change Log to WBS and Project Schedule and Test Plan

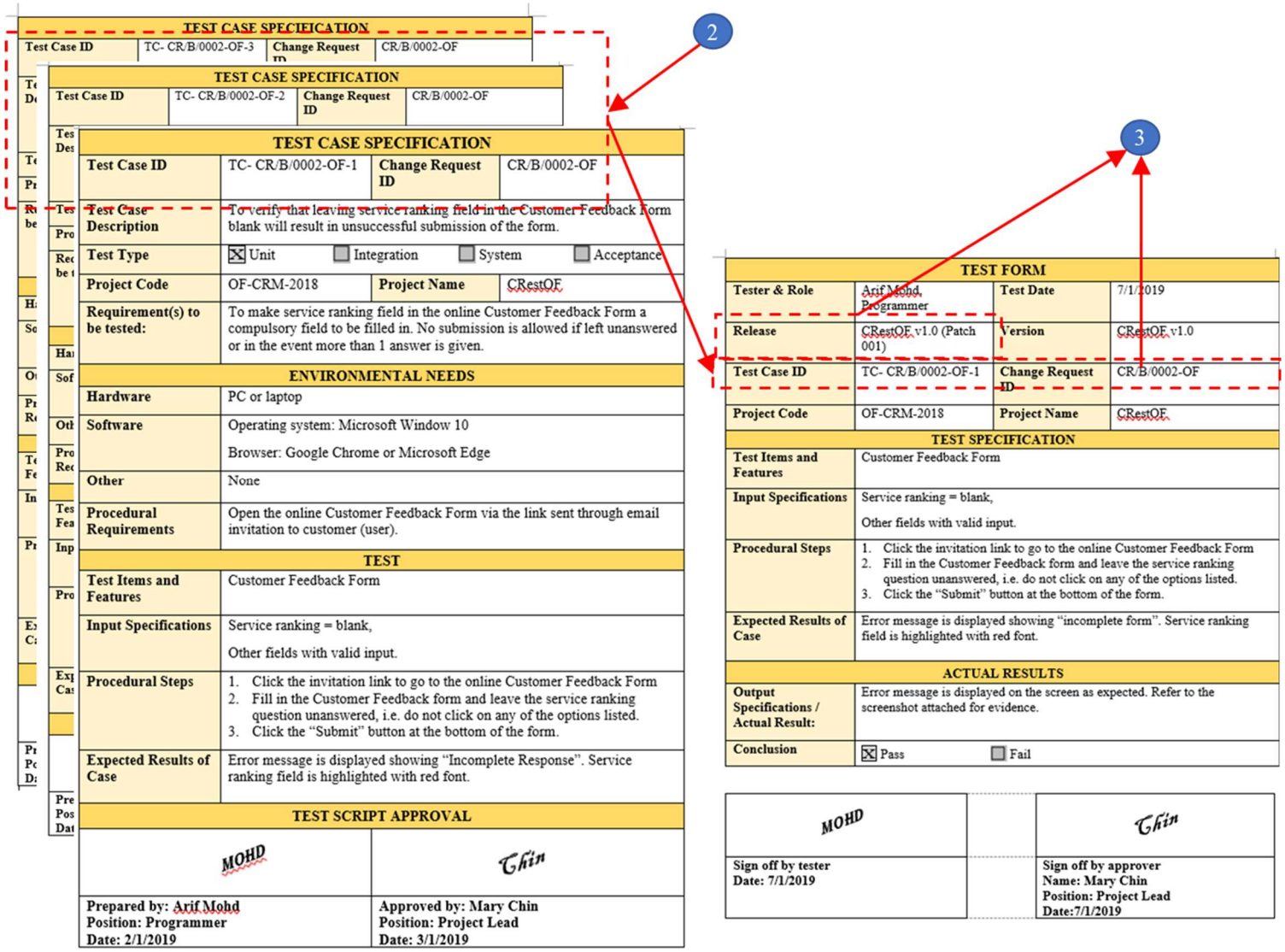


Figure 5.23: Tracing change request from Test Plan to Test Case Specification and Test Form

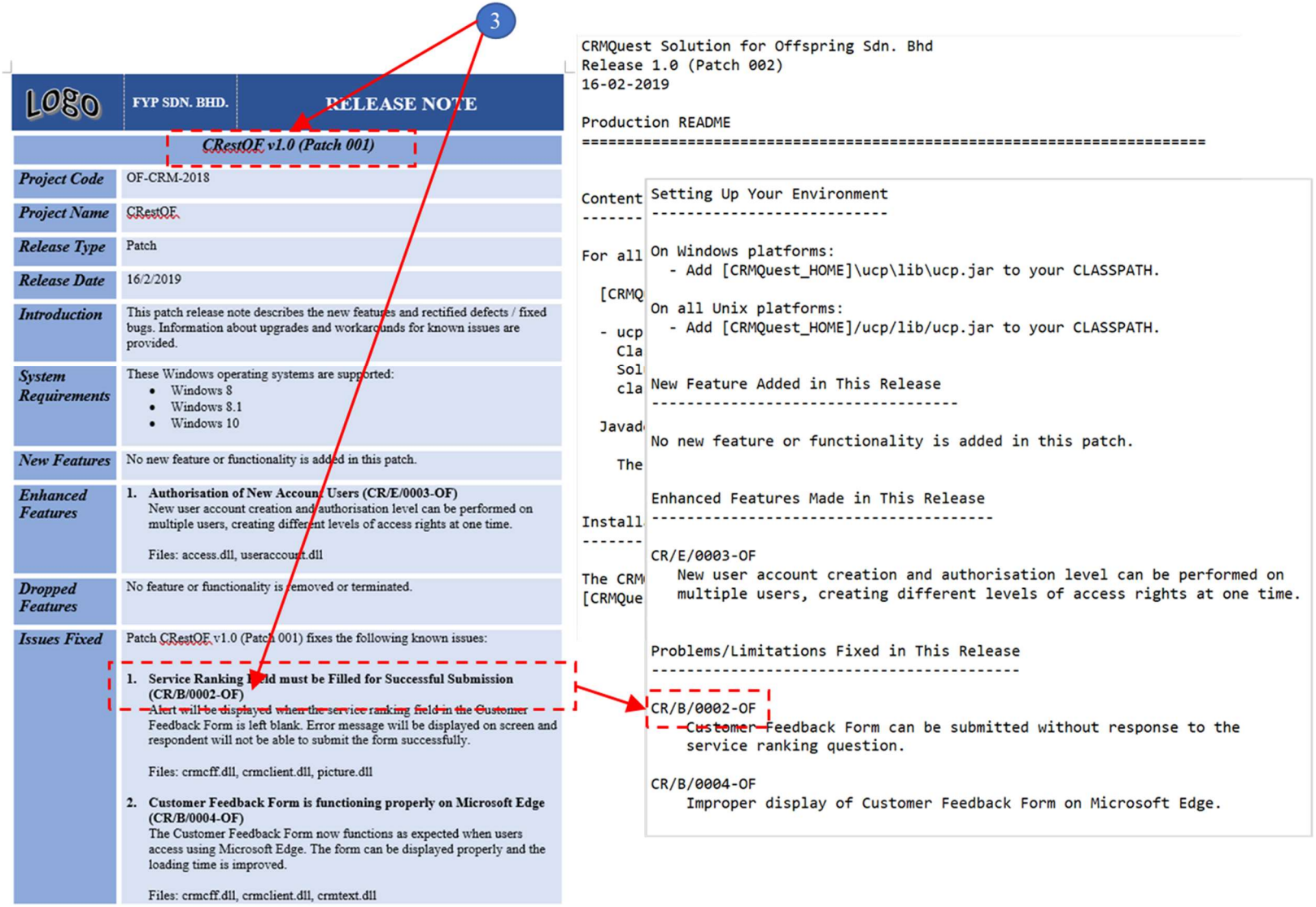


Figure 5.24: Tracing change request from test documents to release documents

5.10 Mapping the Proposed Roadmap to the ISO 9001 Requirement

Interpreting the requirements and mapping a company's QMS to the Standards have always been a challenge. With the detailed description of software change control management in the previous sections, if left without reference to the relevant requirements in the Standards may not serve the readers well on the compliance level of the proposed software change control process with the Standards.

This section aims to provide an overview of mapping of the process to the requirements, clause by clause or paragraph by paragraph. Brief explanation is stated, with reference mainly drawn from the material published by Abuhav (2017) and Bamford and Deibler (2004). As shown in the table below, some clauses could not be covered in this proposal / report, due to limitation of time and other factors like irrelevant to the software change control management proposed.

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
4. Context of the organisation	
4.1 Understanding the organisation and its context *Explanation: Organisation shall first understand and define its context, considering internal and external issues related to its purpose, scope of QMS and strategies, in order to establish a QMS. Organisation can evaluate itself using analysis like SWOT (strengths, weaknesses, opportunities and threats) and PEST (political, economic, social and technological factors) to achieve this aim.*	Determination of organisation context and interested parties is unique and varies according to the organisation in question. Due to the uniqueness on of organisation's context and also time constraint, no guideline is provided in the proposed change control process for this purpose.
4.2 Understanding the needs and expectations of interested parties *Explanation: Organisation to identify interested parties that can affect its ability in providing its service, their expectations and requirements. The understanding is imperative as a foundation in determining*	

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
its scope of QMS, quality objectives and quality activities.	
4.3 Determining the scope of the quality management system *Explanation: Organisation to ascertain the scope, i.e. the boundaries and applicability of the QMS it is going to establish. Examples are like the areas, lines of products, processes or activities.*	The change control process, being one of the key business processes in any IT company, is the chosen scope to which this research paper focuses on for the purpose of setting up a QMS. The change control process is limited to bug fix. The rationale of selecting this process is justified in **Section 5.5 Software Change Control Process for Bug Fix: The Chosen Scope to Begin the ISO Journey.** The activities or procedures in carrying out change control in IT company are illustrated in **Section 5.6 Software Change Control Process: From the Perspectives of Project Management Life Cycle and System Development Life Cycle, Section 5.7 Software Change Control Process Flow and Section 5.8 Quality Manual**.
4.4 Quality management system and its processes *Explanation: A QMS must be set up to deliver products and services that meet the customers' requirements and interested parties' expectations. The QMS shall* - *Be based on the principles of ISO 9001 Standards;* - *Be planned, implemented and monitored;* - *Be customer focus;*	The change control process is the identified process for quality management system. The application of this process throughout an IT company is illustrated as follows: a) The input is the change request for bug fixing; output is the implemented change to rectify the issue. b) The sequence and interaction of the process are shown in **Section 5.6 Software Change Control Process:**

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
- *Meet interested parties' expectations;* - *Have clear interrelations among the processes;* - *Have properly planned, allocated and controlled resources;* - *Be constantly analysed, for fact-based decision making;* - *Support improvements;* - *Be top management leadership-driven;* - *Be communicated to create awareness in the organisation.*	**From the Perspectives of Project Management Life Cycle and System Development Life Cycle, Section 5.7 Software Change Control Process Flow.** c) Monitoring to ensure effective operation via post implementation review and internal audit (due to time constraint, details as to how these are carried out are absent in this paper). d) Resources needed, responsibilities and authorities to carry out the process are stated in the Section 5.5 and 5.7, with the roles provided. Details on the responsibilities and authorities are also stated in **Clause 5 and 6** under **Section 5.8 Quality Manual.**
5 Leadership	
5.1 Leadership and commitment **5.1.1 General** **5.1.2 Customer focus** *Explanation: Top management to demonstrate leadership, commitment and accountability in QMS, should:* - *Show leadership by promoting and involve in QMS;* - *Practice managerial activities like review the objectives and performance of QMS; Promote and engage in improvement initiatives including performance feedback;* - *Ensure effectiveness of QMS such as defining quality objectives,*	Top management's leadership and commitment can be demonstrated via their involvement in the change control process by becoming a member of Change Control Board (Refer to **P2: Change Request Approval Process, Section 5.8 Quality Manual**)

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
control process and activities and addressing risk; - *Promote communication and awareness to the QMS and risk-based thinking;* - *Ensure adequate resources for effective operation of QMS.* - *Remain customer focus (detail requirements include Clause 4.2, 5.1.2, 5.3, 6.2, 8.2.1, 8.2.2)*	
5.2 Policy **5.2.1 Establishing quality policy** **5.2.2 Communicating quality policy** *Explanation: Establish quality policy which is written suitably to the organisation purpose, context and nature, providing the vision and plan for setting the quality objectives, demonstrating organisation's commitment to meeting requirement and continuous improvement. The documented quality policy shall be distributed and communicated to all levels of organisation and interested parties.*	Refer to **Clause 2, Quality Policy of Section 5.8 Quality Manual.** The proposed quality policy is with respect to change control management, specifically on bugs fix.
5.3 Organisation roles, responsibilities and authorities *Explanation: Top management is to assign authorities and responsibilities to representative(s) who ensure the establishment of QMS and its conformance to ISO 9001 Standards, interaction of processes of QMS and its ability to deliver intended outputs. The representative(s) shall report the performance of the QMS and the*	The roles and responsibilities of company's personnel in the change control management are defined in the **Section 5.8 Quality Manual**. Refer to **clause 5 Roles and Responsibilities**. All the project team members (assigned representatives) share the responsibilities in change control management.

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
improvement required, in addition, promoting awareness and maintaining the integrity of the system in the event of changes.	
6 Planning	
6.1 Actions to address risks and opportunities *Explanation: This requirement lays the fundamental new concept in the latest version, introducing the risk-based thinking that will be applied throughout the standard. It aims to develop a proactive approach to identify the potential pitfalls and undesired effects, establish a QMS that can reduce or prevent those effects and eventually achieve improvement. Risk management practices shall come into place, like risk analysis, risk evaluation, design of control action.*	Potential risks are identified with corresponding controls designed and embedded in the change control process. Risk and control matrix are proposed to be included in the Quality Manual, with references made to change control process. Refer to **clause 9 Risk and Control Matrix for Change Control Management, Section 5.8 Quality Manual**. Changes to the matrix, i.e. change or update of risk events and controls shall be ongoing that shall be reflected to the quality manual accordingly.
6.2 Quality objectives and planning to achieve them *Explanation: Quality objectives are means to assess if a product, service or process fulfils its requirement. They have a strategic role to ensure quality policy is implemented in the QMS. The Standard requires quality objectives to be planned and assigned to relevant processes, and are measurable, consistent with quality policy, relevant to conformity of goods and services, able to meet customer's expectation, be monitored, communicated and updated as appropriate.*	Quality objectives specific to change control management are identified and stated in **clause 4 Quality Objectives under Section 5.8 Quality Manual**. Examples are suggested in the Quality Manual. Organisation needs to ensure the quality objectives are communicated, monitored and updated as and when needed.

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
The actions, resources, responsible parties, timeline for implementation and result evaluation shall be defined.	
6.3 Planning of changes *Explanation: The planning activities here refer to those related to establishing QMS and the changes thereof. It requires organisation to consider the purpose of change, to maintain integrity of the system, and ensure sufficient resources and allocation of responsibilities and authority to carry out the change.*	Planning changes to the change control management **is not covered** due to time constraint.
7 Support	
7.1 Resources **7.1.1 General** **7.1.2 People** **7.1.3 Infrastructure** **7.1.4 Environment for the operation of processes** **7.1.5 Monitoring and measuring resources** **7.1.6 Organizational knowledge** *Explanation: Organisation is to provide necessary enabling tools, i.e. the resources that include human resource, knowledge, process environment and infrastructures, for the implementation, maintenance and improvement of QMS. Organisation shall assess its capabilities, abilities and limitation in provision of the resources, and to determine if they are to be sought externally.*	This standard refers to the provision of people resources, infrastructure and work environment necessary for an effective QMS, to achieve conformance of products and services requirement. These are the supporting factors to implement and maintain the proposed change control process. This work **is not covered** due to time constraint. However, the change control process shall form the basis for organisation to assess its resource capability in implementing QMS.

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
7.2 Competence *Explanation: Organisation is to determine the competence necessary to carry out the task or responsibilities in relation to the quality activities. The competence of person shall be assessed based on his education, training and experience. Training and hiring are among the actions to acquire the competence.*	Organisation is to define the necessary competence to implement the change control process which can be documented in job description or project requirement. Examples are like the level of education, certification, years of experience. Assessment can be made during performance review to which training requirement can be ascertained. This exercise **is not covered** due to time constraint, but the defined roles and responsibilities, tasks and documentation requirement contained in the change control process shall form the basis for organisation to carry out its competency assessment.
7.3 Awareness *Explanation: Assigned personnel working under the QMS are required to be aware of the organisation quality policy and its relevance to the quality objectives. Such awareness is essential for the personnel to link their knowledge with information about activities and quality objectives. Knowing why they are performing certain activities help position the personnel to identify and prevent flaws, suggest improvement to the process and QMS as a whole.*	To ensure personnel involved in the QMS are aware of its quality policy and quality objectives and relate their knowledge and responsibilities to it, organisation may take actions such as explaining the policy and objectives to the team, the structure and process of the proposed change control process, potential implications of dos and don'ts, etc. Constant communication is key. The specific guideline as to implement the awareness **is not covered** in this proposal due to time constraint.
7.4 Communication *Explanation: To ensure quality objectives are meet, information must reach the right person at the right time and right place. In the QMS perspective, communication is*	Communication and information sharing activities take place throughout the Change control process, in the following methods:

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
the activity for exchanging information among the parties for the QMS operation. Organisation needs to define what will be communicated, the events for communication, with whom to communicate, the communication channels and who to communicate.	a) Documents: Customer Call Log (**Appendix C**); Change Request Form (**Appendix D**); Change Log (**Appendix E**); Test Plan (**Appendix F**); Test Case Specification (**Appendix G**); Test Form (**Appendix H**); Release Note (**Appendix I**) and Work Breakdown Structure and Project Schedule (**Appendix J**). b) Meetings and associated communication: Change Control Board Meeting (step **P2.5, P2: Change Request Approval Process, Section 5.7**); Meeting minutes (Step **P2.8, P2: Change Request Approval Process, Section 5.7**); Post implementation review and review report (step **P5.6, P5: Change Request Close Process, Section 5.7**) c) Notification: inform customer of change status (step **P3.6, P3: Change Request Scheduling and Assignment Process** and step **P5.2, P5: Change Request Close Process, Section 5.7**)
7.5 Documented information **7.5.1 General** **7.5.2 Creating and updating** **7.5.3 Control of documented information** *Explanation: Documented information is those needed for QMS planning and operation, from any source, in any form or medium. The key principle in defining an organisation's documented information is*	The documented information of the change control management for the purpose of establishing a QMS is provided in all other sections in this table, for better reference and clear indication which are the "necessary" documents required by the Standard and an organisation striving to set up a QMS in change control management.

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
"relevant to the intended outcomes of the QMS". The Standard specifies that documented information shall include those required by the Standard and those determined as needed by an organisation for an effective QMS. Unlike ISO 2001:2008 where documents were specified, organisations are left to decide what is necessary. *The Standard requires documented information to be clearly defined and identified, in an appropriate format media. Reviews and approvals of the documents shall apply. Organisation shall determine the availability, distribution, storage, retrieval of these documents and to ensure protection and preservation of the records.*	Briefly, the structure of documents is categorised from strategic to operational level, as follows: 1. The first (strategic) level is the quality policy and objectives (as outlined in **Section 5.8 Quality Manual**) 2. The second level is the overview of change control process in **Section 5.6, Figure 5.3**. 3. The third level comprises the process flows, giving details to the core processes and acting as the quality procedure in **Section 5.7, Figure 5.4 to Figure 5.8**. 4. The fourth level is the process policies and standard operating procedures, including the relevant forms and templates (as contained in the **clause 3 Change Control Policies, clause 7 Change Control Procedures, under Section 5.8 Quality Manual**) for the change control management process. 5. The fifth (operational) level is the operational record. Example, the forms and templates filled with process data which are also the evidence of QMS operation (**Appendix B** to **Appendix K**). While the latest Standard no longer requires Quality Manual, it is used by the author as a frame for needed documentation. Revision to the Quality Manual and templates is to be documented on the historical record on first page of these documents, along with the evidence of review and approval by authorised

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
	quality personnel. Refer to relevant appendices for details. The format is suggested by the author. However, the control of documentation is left for organisation to decide.
8 Operation	
8.1 Operational planning and control *Explanation: Organisation is required to plan and develop processes needed to meet the products and services requirement, considering the objectives, processes, documents, resources required, monitoring and controls. Documented information is needed to demonstrate the process execution and proper maintenance of the documents thereof.*	Operational planning and control are the master plan in the realisation of products and services, which in our case, implementing a change request to software application. The objective is to plan, control and provide instructions to the parties involved in the realisation process. The proposed change control process, detailed process flows and supporting forms (see **Figure 5.4 to 5.8**) are the quality plan being proposed, showing the required activities, inputs, outputs, resources (personnel with defined responsibilities), validation and verification (tests), criteria for acceptance (expected result of test case in the Test Case Specifications), and the review and approval process.
8.2 Requirements for products and services **8.2.1 Customer communication** *Explanation: Organisation is required to have effective arrangements on communication with the customers,*	Communication with customers is demonstrated in the Work Flows: Customers' request for change (handling of enquiries) is managed by Helpdesk or Project Team and recorded in a Customer Call Log (**P1: Change Request Issuance and Analysis Process (see Figure 5.4**)

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
including exchange and sharing of information relating to the products and services, handling of enquiries and feedback, customer's property. Specific requirements shall be established in handling contingencies. Organisation shall maintain the records of how the information is communicated, managed and maintained.	involving activities where bug is reported (step **P1.1**), recorded in Call Log (step **P1.2**)). Status of change request is notified by Helpdesk to customers (example, via email or phone call) and updated to the Customer Call Log (**P3: Change Request Scheduling and Assignment Process,** step **P3.6, Section 5.7**). Impending release of changes is notified to stakeholders by Project Manager while formal deployment (**P4: Change Request Execution Process,** step **P4.20**). **Release Note** and **Readme text** (see **Appendix R and S**) is the medium of communicating changes made to the software in a software release. Helpdesk will notify the customer again of deployed change (**P5: Change Request Close Process,** step **P5.2, Section 5.7**).
8.2.2 Determining the requirements for products and services *Explanation: This clause involves gathering of requirement from customer or internally within the organisation, which shall be defined.*	The requirement for change is captured in process **P1: Change Request Issuance and Analysis Process (see Figure 5.4**) involving activities where bug is reported (step **P1.1**), recorded in Call Log (step **P1.2**) and issuance of Change Request Form (step **P1.3**). For internally raised request, P1.1 and P1.2 steps/activities are not applicable. The specific details of change request are to be recorded in the **Change Request Form** under "Description of change". Refer to **Appendix M** for case sample.

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
8.2.3 Review of the requirements for products and services *Explanation: The Standard requires organisation to review the requirement, to ensure its ability to meet the requirement, prior to committing to supply the products and services. The approval of the requirement shall be obtained before realisation to avoid non-conformity and waste of resources.*	Analysis of change request is conducted to determine among others, estimation of resources required to perform the tasks (refer **P1: Change Request Issuance and Analysis Process** (see **Figure 5.4**), step P1.4 to P1.9. Result of analysis is documented in Section B of **Change Request Form** (see **Appendix M**). Change request analysis is reviewed and recommended by Project Manager for the approval of Change Control Board prior to execution (**P2: Change Request Approval Process,** step **P2.1 to P2.6**). Approval is documented in the Change Request Form and meeting minutes.
8.2.4 Changes to requirements for products and services *Explanation: Changes to requirement is to be made known to relevant persons with proper updates of all relevant documented information.*	Changes or updates to the change request are communicated to customers by Helpdesk. It is a procedure embedded in **P3: Change Request Scheduling and Assignment Process (step P3.6) and P5: Change Request Close Process (step P5.2) in Section 5.7.**
8.3 Design and development of products and services **8.3.1 General** **8.3.2 Design and development planning** *Explanation: The clause states that "organisation shall establish, implement and maintain a design and development process that is appropriate to ensure the subsequent provision of products and services". And in determining the stages, to consider the nature, duration and complexity of the activities, the stages, required verification and validation,*	The proposed change control process fulfils the following specific requirement: a) Nature and complexity of the activities are put in simplified step-by-step procedure as demonstrated in the work flows. b) Process stages: the process is a mapping of system development life cycle to the project development life cycle, with 5 stages, initiation, planning, execution, monitoring and closure. (see **Figure 5.4 to 5.8**) c) Verification and validation activities: see **P4: Change Request**

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
defined roles and responsibilities, resources required, interfaces between parties involved, expected controls, and importantly the documentation to demonstrate this requirement is met.	**Execution Process step P4.8, P4.9, P4.12, P4.13 in Section 5.7.** d) Responsibilities and authorities: refer to vertical swim lane in **work flows** (in **Section 5.7**) for pictorial display of responsibilities and **Section 5.8 Quality Manual (clause 5 and 6)** for description of responsibilities and authorities, also the assigned responsibilities in executing the change request, see **Section 5.7, P3: Change Request Scheduling and Assignment (step P3.2, P3.3, P3.4)** e) Resources and interface between parties involved: refer to **Section 5.7 Software Change Control Process Flows** for human resources required and interactions between the parties involved in the process. f) Involvement of customers: performing of user acceptance test (**see Section 5.7**, **P4: Change Request Execution Process step P4.16)** g) Documented information: the operation of the change control process is demonstrated with following documents and records: Customer Call Log (**Appendix C**); Change Request Form (**Appendix D**); Change Log (**Appendix E**); Test Plan (**Appendix F**); Test Case Specification (**Appendix G**); Test Form (**Appendix H**); Release Note (**Appendix I**) and Work Breakdown Structure and Project Schedule (**Appendix J**).

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
8.3.3 Design and development inputs *Explanation: Organisation needs to ascertain the requirements and inputs for a product or service to be developed. The inputs can be previous works performed, regulatory requirement, standards of practices and information from previous designs. These inputs shall be reviewed for adequacy, complete, unambiguous, and not in conflict.*	Reviewing the change request by conducting change request analysis (refer **P1: Change Request Issuance and Analysis Process** (see **Figure 5.4**), **step P1.4 to P1.9**), helps to identify hence resolve conflicting request or requirements. Through the analysis, programmer or analyst identify affected files, functions and modules (i.e. input). This information is documented in the Change Request Form (**Appendix D**) and is reviewed by Project Manager.
8.3.4 Design and development controls *Explanation: Organisation needs to implement controls where review, verification and validation activities are conducted evaluate ability to meet requirements, to ensure products and services meet the input requirements and intention of use. Necessary actions shall be taken to address any issues or problems identified from these activities.* *Project management reviews (e.g. milestone, progress reviews) and technical reviews which are also a form of verification (e.g. inspection, prototype review, peer review), are representatives of review activities. Verification activities cover the planning, selection and result, where outputs are verified against inputs. Examples are prototyping, walk through, unit testing, integration testing, regression testing.* *Validation activities are to ensure delivered products meet the specified capabilities to specified users in specified*	Reviews activities are carried out by different personnel throughout the change control process: review change request (step **P1.10, P2.1 & P2.2**); review project schedule (step **P3.4**); review test plans (step **P4.3**); review release note (step **P4.19**); review release checklist and conduct post implementation review (step **P5.6**), all in **Section 5.7.** Verification activities in the proposed change control process are unit testing, integration testing, etc (refer **P4: Change Request Execution Process steps P4.8, P4.9**) Test Plan (**Appendix F**); Test Case Specification (**Appendix G**) identify the characteristics of change request and the requirements that form the basis for verifications. Results are recorded in test forms (**Appendix H**). Validation activities in the proposed change control process are quality assurance testing and user acceptance testing (refer **P4: Change Request**

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
environment. Quality assurance testing and acceptance testing are representatives of validation activities.	**Execution Process step P4.12, P4.13, P4.16, Section 5.7**)
8.3.5 Design and development outputs *Explanation: Outputs shall represent the products and services specification like the characteristics, be adequate for subsequent process, include the monitoring and measuring activities and acceptance criteria. Outputs enable evaluation of conformance to requirement, and the team shall know what outputs are required, in what form.*	The output generated along the realisation process, i.e. the change control process: a) P1: Change request issuance and analysis process – Customer Call Log (**Appendix C**) and Change Request form with completed analysis (**Appendix D**). b) P2: Change request approval process – updated Change Request form with approval decision. c) P3: Change request scheduling and assignment process – approved Work Breakdown Structure and Project Schedule (**Appendix J**). d) P4: Change request execution process – test plan (**Appendix F**), test case specification (**Appendix G**) test form (**Appendix H**) and release note (**Appendix I**). e) P5: Change request close process – Release Checklist (**Appendix K**) and post implementation review.
8.3.6 Design and development changes *Explanation: The Standard requires organisation to "identify, review, and control changes made during, or subsequent to the design and development of products and services". The results shall form part of the documented information.*	Due to time constraint, this **clause is not covered.**

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
8.4 Control of externally provided processes, products and services **8.4.1 General** **8.4.2 Type and extent of control** **8.4.3 Information for external providers** *Explanation: These Standard's requirements cover the purchase of items or services for inclusion in the product realisation process.*	This clause is related to acquiring resources from outside the organisation. No external resources are required based on the proposed change control process on the assumption that the process is wholly carried out by internal staff.
8.5 Production and service provision **8.5.1 Control of production and service provision** *Explanation: Organisation is required to plan for activities for the production and service provision under controlled condition, i.e. defining and determining the conditions necessary to realise the product. The first condition being the availability of information in relation to* - *product characteristics such as identification of product and component, status and expected components.* - *required activities like process flows and tasks, giving participants of the process the access to information that enables them to carry out their tasks and responsibilities.*	In the context of the proposed Change control process, the "product characteristics" are found in the Change Request Form (**Appendix M**), section B where analysis result is documented with details on the expected outcome, affected files (where lines of codes are stored, which are the components of a software function). Unlike other business such as manufacturing where information of product characteristic seldom changes until improvement is made, product characteristics for each change request are different. However, the components (software files that made up the affected function) can be referred to the master Software Requirement Specification document. The detailed process flows of the change control process (**Figure 5.4 to Figure 5.8**) and the standard operating procedures contained in the Quality Manual (**Section 5.8)** shall comprise the documented

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
	information for "activities to be performed".
The second condition is the use of suitable monitoring and measuring resources, at appropriate stages. This is related to the next condition of using suitable infrastructure.	Organisation that carries out the change control process shall ensure the availability and suitability of process equipment (hardware and software). Suitability of equipment is relative, which cannot be defined in absolute term and may be influenced by the type of software being developed and programming language used, etc. Due to these factors, this requirement **is not covered** in the proposed change control process.
Other conditions include implementation of release, delivery and postdelivery activities; selection of competent person and performing validation activities.	Release activities are discussed in Clause 8.6 while validation activities are discussed in Clause 8.3.4 Design and development controls. Delivery activities consider how the release package is transferred to the customers. The decision is left to organisation implementing the QMS. While it is provided in the process flow (step **P4.21**) that release package be issued to customers, no specific method such as via email, download is determined. File transfer protocol, if any, is also left to the interested organisation to decide. The policy suggestion in this respect is reflected in **clause 3.7 of Change Control Policy under Section 5.8 Quality Manual.** Post-delivery activities are typical support and maintenance service to customers

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
	after deployment of a software application. The change control process for bug fixing, being the subject for QMS, is already the "postdelivery activity". No other specific implementation considerations are discussed in the change control process.
8.5.2 Identification and traceability *Explanation: Organisation needs to use unique identification to identify, control and trace its outputs and the status for monitoring and measurement requirement purpose. The means, the granularity and the degree of permanence of identification is left to organisation to decide. The key purpose is to ensure items do not miss specified monitoring and measurement hence will not advance to next stage with high likelihood of nonconformity.*	The critical requirement an organisation has to fulfil is the ability to trace the history and application of the change request implemented. One important thinking or mechanism in the proposed change control process is the bidirectional traceability. Unique identification number is used for all the outputs (forms and templates) while version control is applied to repository. Refer to **Figure 5.11 to Figure 5.20** to see how the change control process is captured and evidenced with the use of suggested templates and forms, distinguished using unique identification number. For demonstration of traceability, key requirement of this standard, refer to **Figure 5.21 to Figure 5.24**. Version control policy is suggested reflected in clause **3.10 Change Control Policy** of the **Quality Manual** (**Section 5.8**) while version control activities in the process flow are reflected in **P4.22 and P4.23 (P4: Change Request Execution Process, section 5.7).**

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
8.5.3 Property belonging to customer or external providers *Explanation: Organisation shall take care of the properties, including among others the materials, tools, equipment, intellectual property and personal data, that belongs to its customers.*	Author is of the opinion that the change control management process has minimal exposure to this condition, hence this requirement **is not covered**.
8.5.4 Preservation *Explanation: Organisation needs to preserve the outputs produced in the production and service provision process. Outputs include the software components and records created in the internal processing and delivery process, which shall be protected. The method of protection may include identification, handling and storage.*	The identification of outputs and versioning control are discussed in 8.5.2 Identification and Traceability above. Storage, i.e. back up and access control, is a suggested policy which is reflected in **clause 3 Change Control Policy** in the **Quality Manual (Section 5.8)** and a step to perform (**P4.23**) in **P4: Change Request Execution Process, Section 5.7**.
8.5.5 Post-delivery service *Explanation: Organisation is to meet the requirements of post-delivery activities such as statutory and regulatory requirements, potential undesired consequences, nature and intended lifetime of products and services, customer requirement and feedback.*	This **is not covered** due to time constraint.
8.5.6 Control of changes *Explanation: This requirement deals with changes that occur in the conditions of the realisation process. Organisation needs to identify and manage the changes and ensure continued conformity with the Standard's requirements. The changes*	The change control process documentation, including the work flows, forms and templates that can be referred to and used for records purposes as evidence of QMS operation and effectiveness, are controlled documents. Changes to these documentations require approval and are recorded in the "Records of Past

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
shall be documented, describing the change, person authorising the change and any necessary actions.	Revision". See any **appendices** of forms and template contained in this report for reference.
8.6 Release of products and services *Explanation: Organisation is to ensure that the products and services meet requirement, via verification at appropriate stages in the product realisation process. Release of the products or services shall be approved. Documented information that satisfies this requirement includes "evidence of conformity with acceptance criteria" and "traceability to the person authorising the release". The key principle in this clause is the designated person who has the authority to approve a release, including granting of waiver.*	Verification requirement is associated with clause 8.3.4 Design and development control, refer to the above section for discussion and evidence of fulfilling the requirement – conformity with acceptance criteria. For non-conformity identified through the process, clause 8.7 Control of nonconforming outputs shall be referred for invoking of corrective actions. In software development process, it is not uncommon where defects are rectified in subsequent process, or even remain for the life of product if determined as not critical. The key will be who has the authority to approve release of the software or a component of it. This decision is placed on Project Manager and the Change Control Board (CCB) in our proposed change control management. First, Project Manager decides if a change request is to be submitted for the approval of CCB (**see Section 5.7, P2: Change Request Approval Process, step P2.1, P2.2 and P2.5**). After obtaining the approval of CCB, Project Manager has the final say when a change request to be implemented then release (see **Section 5.7, P3: Change Request Scheduling and Assignment Process step P3.4**) On completion of change request, the release thereof requires the approval of Project Manager (see **Section 5.7, P4: Change Request Execution Process, step P4.19**).

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	The information on authorisation is documented in Change Request Form and Release Note. Refer to **Appendix M** and **Appendix R** for information and demonstration of traceability.
8.7 Control of nonconforming outputs *Explanation: Organisation needs to put in place mechanism to identify and control nonconforming outputs "to prevent its unintended use or delivery". Actions to be taken by organisation to address the nonconformance covers products in any stages of realisation including after delivery of products. Ways of dealing with nonconformance are provided: correction, preclude the use, informing customers or use it anyway but under concession with authorisation.*	The key mechanism employed is problem reporting and tracking to ensure correction. The change control process itself is a bug reporting, tracking and resolving mechanism. Bug is first reported to the project team, tracked using Change Request Form **(step P1.3, Appendix M)** and Change Log (**P3.1, Appendix N**). The execution process (see **P3: Change Request Scheduling and Assignment Process and P4: Change Request Execution Process, Section 5.7**) (i.e. internal processing) to resolve the problem, comprises various testing (**step P4.8, P4.12, P4.16**) aiming to detect nonconformity. Results are recorded (**step P4.9, P4.13**) in Test Form (**Appendix Q**) where nonconformity, if any, is documented. Results are reviewed and approved by authority for next course of actions such as rectification. For better understanding of the tracking and documenting process, refer to **Section 5.9 Software Change Control Management: In Practice**. Nonconformity detected after deployment will be reported to which the entire change control process is again triggered.

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
9 Performance Evaluation	
9.1 Monitoring, measurement, analysis and evaluation **9.1.1 General** **9.1.2 Customer satisfaction** **9.1.3 Analysis and evaluation** *Explanation: Organisation is required to plan and implement improvement process including monitoring, measurement and analysis. The items and timing of monitoring and measurement, the analysis of the result thereof shall be determined. Evaluation of the overall effectiveness of QMS is also required.* *Ensuring conformity of QMS and evaluation of QMS overall effectiveness are achieved through internal audit (with detail requirements in 9.2).* *Organisation is required to obtain, monitor and review customers' feedback to assess if their expectations or requirements are satisfied. This information is important, it allows organisation to conduct analysis and evaluation, to which results generated will act as the input for management review (clause 9.3) and continual improvement (clause 10).* *Examples provided by the Standard on method to obtain customers perceptions are "customer surveys, customer feedback on delivered products, meetings with customers, market-share analysis, compliments, warranty claims and dealer reports".*	The proposed change control process contains various level of testing (**see Section 5.7, P4: Change request execution process, step P4.8 to P4.9, 4.12 to P4.14)** designed to monitor the change request implementation outcome, followed by necessary evaluation of cause and correction actions. Timing of these activities is determined to ensure only successful changes made are deployed. Further, post implementation review (**see Section 5.7, P5: Change request close process, step P5.6**) which includes requirement to seek customer feedback on the patch / system release, is another performance evaluation tool proposed (see **clause 8 Performance Evaluation under Section 5.8 Quality Manual**). However, due to time constraint, specific guide, measurement metrics and template, are **not covered**.

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
9.2 Internal audit *Explanation: Organisation is required to conduct audits at planned intervals ensure its QMS conforms to the requirement for its own QMS as well as ISO 9001:2015 requirements. Considerations include the criteria and scope, objectivity of auditors, reporting of results and corrective actions.*	This requirement **is not covered** due to time constraint.
9.3 Management review **9.3.1 General** **9.3.2 Management review inputs** **9.3.3 Management review outputs** *Explanation: Top management's review is a demonstration of management's commitment towards the QMS and its effectiveness. By performing the management review, top management has the opportunity to assess the QMS periodically.* *The Standard requires the review to take place at planned intervals, and to ensure effectiveness (planned results or objectives achieved), suitability (QMS characteristics are appropriate for its purpose), and adequacy (sufficient to achieve objective). The Standard defines a list of inputs and outputs of review, for the consideration of organisation implementing a QMS.*	This requirement **is not covered** due to time constraint.

ISO 9001:2015 Quality Management Systems - Requirement	Reference and Remarks
10 Improvement **10.1 General** **10.2 Nonconformity and corrective action** **10.3 Continual improvement** *Explanation: Organisation is to identify improvement opportunities to meet customers' requirements and to enhance customers' satisfaction. The actions planned shall consider addressing undesired effects caused by quality issues; and improving QMS, on factors such as the process activities, inputs, outputs and resources.* *Awareness shall be created across all levels of operation in the organisation with regard to improvement commitment and culture and to ensure its significance is communicated.* *In term of nonconformity, corrective actions are required to deal with it, including causes identification, evaluation of actions, implementation and effectiveness review. Consequent changes QMS and update of risk and opportunities shall be made accordingly.* *Continual improvement is a recurring learning activity, with organisation constantly evaluating its QMS, make improvement decisions and actions based on monitoring and measurement analysis.*	Process to identify nonconformity is embedded in the work flow, with considerations of independent review to prevent conflict where the person uncovers the nonconformity does not report the problem and take corrective actions. Various tests conducted must be recorded and submit for approval (**P4.8 to P4.9 and approval step, P4: Change Request Execution Process, Section 5.7**). Nonconformity will have to go through the process of development again (step **P4.6 to P4.9, P4: Change Request Execution Process, Section 5.7**). Another level of checking to uncover nonconformity overlooked is performed by Quality Assurance (**step 4.12 to P4.14, P4: Change Request Execution Process, Section 5.7**). The process flows and procedures, when introduced to all levels of operation via training and publication on organisation's portal, for example, shall create necessary awareness and compliance. Continual improvement is achieved through the various sections in the Standard. First, quality policy and objectives are set (clause **2, Section 5.8 Quality Manual)**; followed by audit results and data analysis; taking corrective and preventive actions and management review. However, detailed guides on how to approach internal audit **is not covered** in this report due to time constraint.

5.11 Conclusion

In this chapter, we have presented an overview of the ISO 9001, its development, evolution, benefits of adoption along with the criticisms. A roadmap to ISO 9001 certification is also presented, with the focus and detailed demonstration on the set up of a QMS based on software change control management. This is the most resource-demanding segment of the roadmap where potential adopters tend to get stuck in. A step-by-step approach has been shown, from outlining the software change control (for bug fix) process to the development of change control policies, standard operating procedures, flowcharts and forms and templates. Readers are finally shown how the proposed roadmap and QMS fit in the ISO 9001 requirements.

CHAPTER 6

VALIDATION OF THE PROPOSED ROADMAP

6.1 Introduction

It is of utmost importance that the proposed roadmap to be validated for its feasibility and applicability. Many views that academic proposals are theorical-driven and a lot of times cannot withstand the practicality challenge and put into use. To avoid the proposed roadmap being reduced to a textbook theory, interviews were conducted to collect empirical data and findings, that focused on the **software change control management and process**. This chapter presents the result of these interviews.

6.2 Interviewees Selection and Background

Three interviews were conducted with three representatives of different backgrounds, to allow author to collect views from different perspectives.

The first interviewee (Interviewee 1) is a freelance consultant who has rich experience in developing ISO 9001-compliant ERP system for SME in Malaysia. He was also involved in the design and implementation of an e-Government platform with Ministry of Science, Technology and Innovation (the ministry that governs Department of Standards Malaysia), that is used to assist certifier in checking compliance level of adopters with ISO 9001.

The second interviewee (Interviewee 2) is a developer of a SME software companies involved in developing ERP system. Working on change requests is his day-to-day work routine. The company is a Microsoft Gold Certified partner and is also ISO-certified, albeit not ISO 9001. The company is certified with ISO/IEC 20000, a standard for IT Service Management and ISO 27001 for Information Security Management.

The last interviewee (Interviewee 3) is a quality assurance manager working in the IT department of a foreign bank. While the department is not ISO-certified, the IT processes are periodically audited based on COSO framework. His opinion is given from the perspective of risk and control, which is nevertheless valuable in view of the new development in ISO 9001 to be risk-based driven.

6.3 The Key Take-Aways

Below is the summary of the interview results, grouped into 3 aspects, manpower requirement, documentation requirement and review and approval process. For detailed interview records, see Appendix V, W and X.

6.3.1 Requirement of Different Roles in the Software Change Control Process

The view was consistent among the interviewees in term of the need of those project roles defined in the process.

Interviewee 1 commented that one needs to have "these people in carrying out the change control" and Interviewee 2 agreed that these were the standard roles defined in his company in managing their process. While Interviewee 2 informed that his company actually has a few project teams comprising these roles, Interviewee 1 doubted that if many SMEs can fulfil this requirement as they were quite resource-constrained based on his consulting experience. However, they both were of the view that the role of project manager and project lead might be combined into one. Interviewee 2 explained that having 2 persons to carry out the 2 roles subjected to the size of project. "If the project is big, consists of many modules, then a team lead will be assigned to each module or a few modules, otherwise, will be just the project manager leading the project", as explained.

Interviewee 3 opined that, in addition to the manpower strength, the skill set and competency of the IT personnel also play an important role in ensuring effectiveness of the change control process. However, he did not think that the process is suitable to the small IT department setting as his company.

6.3.2 Requirement to Document the Process Activities

All the three interviewees commented favourably on the comprehensiveness of the documentation requirement of the proposed change control process.

Interviewee 1, based on his experience working on ISO 9001, did not think that the documentation can be further streamlined. He was of the view that any company that seek to be ISO 9001-certified had to fulfil this documentation requirement.

Interviewee 2 and 3, while agreed that the documentation was good, helping the company in logging the actions and activities of the change control process, beneficial for control purpose and equipped with an audit trail, were overwhelmed by

the number of forms and records to be filled in. Interviewee 3 opined that such a documentation requirement may slow down the performance of the project delivery especially when project timeline was tight. However, both were optimistic that it was still feasible if the process can be automated or tracked using system tool. Interviewee 2 commented that his company was developing solutions that help customer to automate work flow, triggering a process for review and approval.

[The interviewees were informed by the author that the change control process can be implemented using system instead of manual-based, or even semi-automated subject to each company's discretion, as long as the necessary documentation and review process were in place. For the purpose of this proposal, it was presented using hardcopy documents based on a manual process.]

6.3.3 Requirement of Reviews and Approvals Activities

Three interviewees have different views on the review and approval process or activities. Interviewee 1 had no further comments to what has already been designed in the process. He did not see the benefit of, say, reducing certain tasks for certain roles as it meant someone else had to assume the tasks.

Interviewee 2 opined that change requests arising from bug were implemented without the need to seek the approval of CCB. CCB solely reviewed and approved enhancement-related requests, where agreement was normally made based on the number of existing customers that needed the enhancement or would benefit from the enhancement. Change requests in the company were all implemented without charging the customers. Bugs may affect functionality hence were largely fixed while enhancement would be "kept in view" as decision was usually not urgent.

Regarding the review of test case specifications by team lead as proposed in the change control process, Interviewee 3 commented that such review was not a practice in his company. Test case specifications would be reviewed by quality assurance personnel for the purpose of ensuring the comprehensiveness of test cases or test scenarios. They would complement the test cases prepared by the programmers with additional ones if deemed fit. But these additional cases would only be performed by the quality assurance personnel. Quality assurance personnel do not instruct the project team to perform additional tests. The quality assurance personnel in his company were always more familiar with the company's products. They were

generally more experienced and were able to assess and identify the affected areas of a change.

Interviewee 3 agreed on the review and approval process, as he viewed that segregation of duties in change control management process was important, to ensure integrity and quality of product to be delivered to end users. However, as per our proposed change control management, top management i.e. the BOD, is robed into the process intended as a measure to involve top management as required by ISO 9001, is not in line with the interviewee's expectation. He informed that his company's BOD was not involved in change management. The role of BOD was to approve IT policy and to govern the project at a strategic level, i.e. approving project funding, evaluate project return of investment to company, rather than to approve change request. This is understood from the background of the interviewee who is working in an IT department of a foreign bank. Even though the department is small, with manpower strength less than a medium size company, the top management is nevertheless the group of senior management that governs thousands of people.

6.4 Conclusion

The proposed roadmap and change control management is largely implementable based on the feedback received from these interviewees. The constructive comment that is considered to be able to strengthen the control and quality assurance of the process yet do not contravene the ISO requirements or spirit, is taken.

The proposed change control management has been revised accordingly to reflect that the review of test case specifications by quality assurance team and design additional test case specifications as deemed fit, prior to the commencement of coding by programmers. This opinion was provided by Interviewee 2 and is included as step P4.2(b) in the process P4: Change Request Execution Process.

However, the feedback from Interviewee 2 on the waiver of seeking approval from CCB for change request is not accepted by the author. As per clause 8.2.3.1, it is stated that "the organisation shall ensure that it has the ability to meet the requirements for products and services to be offered to customers. The organisation shall conduct a review before committing to supply products and service to customer". Removing this step may lead to non-fulfilment of this requirement.

In addition, Interviewee 3's comment that change control management does not involve BOD is also not accepted. Top management is to demonstrate their involvement in the QMS (in this case, made up by the change control process) by taking accountability of the system, periodical reviewing its effectiveness and adequacy as required under clause 5.1 Leadership and Commitment and clause 9.3 Management Review.

CHAPTER 7

CONCLUSION AND RECOMMENDATION

7.1 Introduction

This chapter covers the discussion on the research works performed with reference to the objectives and research questions defined at the start of this research. The discussion is guided by the objectives, along with the research questions of which, the answers relate to the objective in question.

7.2 Discussion on Research Objectives and Questions

7.2.1 ISO 9001 Requirements

Objective 1 and research question 1 were set in relation to ISO 9001's requirements and related aspects, shown below:

Objective 1:

To conduct comprehensive literature review of ISO 9000 and ISO 9001, its principles and requirements, implementation, including the challenges and critical success factors.

Research Question 1:

What are the key principles and requirements of the revised ISO 9001 and how they affect the implementation of the QIM in IT companies and their projects?

Objective 1 is achieved by literature review, on journal papers, conference papers and books. The details on ISO 9001 framework, approach, applicability, benefits and challenges are presented in Chapter 2 (section 2.3.2 and 2.4) and information on the Standards' evolution and motivational faction in adopting are explained in Chapter 5 (section 5.2 and 5.3). In addition, the key principles and requirements of the revised ISO 9001:2015, paragraph by paragraph, along with the mapping of the proposed change control process to these requirements, are outlined in Chapter 5 (section 5.10).

ISO 9001's principles on QMS surround on being customer focus, process-driven, people-oriented (leadership involvement and people engagement), making fact-based decision and continuous improvement. The effectiveness of the QMS

hinges on the risk-based thinking in its set up and continuous management, which is the fundamental difference or change from previous versions of the Standards. Besides outlining these spirits, ISO 9001 listed the requirements on how it defines a QMS, from understanding the organisation purpose, to participation of top management in the QMS, planning and supporting the QMS, the operation of QMS and the evaluation thereof for continuous improvement. The comprehensiveness of the coverage makes it a confidence-enhancing tool to customers, but nevertheless proves to be a tall order to small and medium size software companies if they wish to adopt the Standards.

7.2.2 Conceptualised Roadmap

Objective 2 is about conceptualisation of a roadmap for ISO implementation and research question 2 aims to provide clues on SME characteristics and its impact on implementation.

Objective 2:

To conceptualise a roadmap to software quality assurance of change control management for ISO initiative suitable for adoption by small and medium size software companies. The change control management shall start from business requirement (i.e. the change request requirement) to system/changes roll-out and lesson learnt event.

Research Question 2:

What are the characteristics of small and medium size companies that distinguish them from large companies hence the impact on approach in implementation of ISO 9001 in change control management, the critical process in IT companies?

The proposed roadmap to ISO 9001 certification is presented in Chapter 5 (section 5.4). It is a 2-level roadmap, first level being the high-level phases from deciding to adopt ISO to obtaining the certification. Second level of the roadmap brings us deeper to the key process of QMS, software change control management, where the author guides the reader to implement the process in step-by-step approach. The author completes the roadmap particularly the software change control management with policies and standard operating procedures (in section 5.8 Quality

Manual), process flow charts (in section 5.7 Software Change Control Process Flows) and forms and templates (see appendix C to K).

The characteristics of SME, where employees can perform multiple roles, and tend to show strong team spirit, means that the manpower constraint faced by SME shall not pose a problem to implementing the defined software change control process as control project roles can be fulfilled by fewer staff. Besides, the project team is left to decide the best communication approach as quick communication and high responsiveness in decision making are among the hallmarks of SME. Nevertheless, to prevent breaches of ISO requirements, specific policies are recommended such "Multi-tasking shall be practiced with proper segregation of duties", formally written policies and procedures, compulsory documentation of important information such as customers' requests.

7.2.3 Change Control Management

Objective 3 represents the focal contribution of this paper, by providing a preliminary set of guidance and documentation in relation to change control management, that can facilitate the process of implementing ISO-compliant QMS. Answers to research question 3 and 4 are important input to the achievement of this objective.

Objective 3:

To develop and formulate policy, procedures, guidelines and flowcharts, if necessary, to support the change control management.

Research Question 3:

What are the basic elements of a change control management?

Research Question 4:

What are the key elements, principles and best practice in change control management that can be implemented by small and medium size companies to fulfil ISO requirement?

Policies, procedures, roles and authorities are outlined in Section 5.8 Chapter 5. Process flow charts are presented in Section of 5.7. The basic elements of change control management are the change control policies, defined roles and responsibilities, change requirements, change analysis, verification and validation, review and approval. All these elements are reflected in the process flow charts, quality manual (on policies,

roles and responsibilities and standard operating procedures) and forms and templates. ISO principles and best practices of software change control management are reflected in these documents.

7.2.4 Validation of Proposed Roadmap

This objective aims to bring the theoretical roadmap into practical world.

Objective 4:

To validate the proposed roadmap via interview, also as part of the data collection process (i.e. interview, questionnaire, brainstorming etc.), with selected software companies' representative to ensure the feasibility of the roadmap, with any revision necessary based on feedback obtained.

This objective was partially achieved by conducting 3 interviews. Validation of the entire proposed roadmap was not performed. Instead, the focus of the validation was on the software change control management which is the key section of this paper. Questions were raised particularly on the manpower requirement, documentation requirement, review and approval process, with reference made to the process, standard operating procedures, forms and templates. The results of the validation are presented in Chapter 6.

The feasibility of the software change control management was affirmed by the 3 interviewees. Constructive comment on quality assurance's preparation of test case specification in addition to and independent from those prepared by programmer was adopted and reflected in the change control process (see P4, P4.2(b)). Other comments that relate to change request approval and the authority to do so, were not accepted by the author as these are the requirements of ISO (see second level of the roadmap, Figure 5.1(b)).

7.2.5 Reporting the Research Work

This research has to materialise in the form of a project report for submission to UTAR, hence as reflected in objective 5. The ambition of producing a journal paper or conference paper, however, proves overly ambitious. Due to time constraint, such paper is not prepared. The objectives are as follows:

Objective 5

To prepare a final year project in accordance with UTAR format requirement.

Objective 6

To prepare a report of 10–15 pages of journal paper or summary report of 6-8 pages of conference paper.

7.3 Limitation and Recommendations for Future Work

While most of the respondents have chosen ISO 9001 as their preferred primary QIM, we are mindful that none of the respondents have actually achieved any quality certification in their QMS. Importantly, the survey conducted in this study had a rather poor response rate, compounding the risk that the result is not representative, and the author is very well aware of the potential bias that exists in the result. The author gained the confidence of the survey result validity solely due to the fact that it is largely similar to the one conducted by Wong et al (2014). To gain a better perspective of the overall QIM adoption pattern in Malaysia IT industry, a more meaningful survey i.e. one with higher response rate shall be considered, probably via a paper and pencil approach.

Due to time constraints, many of the ISO's requirements were not covered in this study, especially on the support and tools aspect for the QMS, such as the provision of competence and adequacy of people resources, infrastructure and work environment necessary for an effective QMS. Besides, while the author highlights the need for performance evaluation and audit, detailed guidance is lacking in this study.

It is recommended that the second level of the roadmap namely the software change control management to be tested in a real environment as the next stage of this study, to validate the workability of the roadmap and to identify gaps that we cannot detect from interview-based validation. Empirically testing the roadmap via a case study shall be ideal. The study can then be extended to cover the next phase of the roadmap on evaluation and audit in more detail, ultimately to strengthen the overall roadmap feasibility.

7.4 Conclusion

Software quality assurance (SQA) is not only a trend in IT industry but a critical surviving tool to stay competitive among the many players. A well-structured QMS is a good demonstration tool to customers and competitors on a company's commitment to quality. For new comers to the field of SQA and QMS, starting small is beneficial to gain first experience of bringing an organisation closer to quality status. Picking a core process, transforming it into a quality process that forms the base for a QMS will increase the likelihood of success and confidence in expanding the scope to the entire organisation as next course of actions.

The roadmap presented here offers a procedural process to implement a QMS that is in compliance with ISO 9001, starting small by focusing on the software change control management. The 7-phase process comprises high-level "what-to-do" on each phase, with the most essential second-level drilled down from the "Establish the QMS" phase where the author systematically guides the readers/companies through the implementation of a change control management for the ISO initiative. The second-level component of this roadmap represents the implementation of key quality process, laying the fundamental groundwork for the QMS. Companies nevertheless can adapt the roadmap to the context and needs of their organisation, with some modifications, but bearing in mind the impact to compliance with the ISO 9001 requirements after the amendments. This roadmap shall be a guidance for implementation and not be viewed as a prescription to a rigidly defined QMS.

Further enhancement of the QMS can be progressively carried out, expanding to other core processes of the IT companies once the proposed change control management for bug fix process is stabilised and the team garners sufficient experience, capabilities and confidence to managing a QMS that covers the entire operation of the IT companies.

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APPENDICES

APPENDIX A: Survey Questionnaire

Title: Software Quality Improvement Methodology (QIM) in Malaysia: Evolution, Objectives and Resistance Factors: Your Perspective

Dear valued respondent,

My name is Tai Wan Wah, a postgraduate student pursuing a master programme at Universiti Tunku Abdul Rahman (UTAR). I am currently conducting a research study to investigate the various Quality Improvement Methodologies (QIM) adopted in Malaysia IT industry, the objectives of adopting QIM and the resistance faced in the adoption process.

As a contributing player in the Malaysia IT industry, your views and experiences on this topic will be of great value to the research. To show my appreciation to your valuable sharing, a copy of the survey report shall be sent to you on completion of the survey.

The questionnaire shall take approximately 5 minutes to complete. It will be open until 15 November 2018.

Please click the “Fill Out Form” button below to participate. All responses will be treated anonymously.

Thank you for taking part!

Section 1: Company and Respondent Background

1. The nature of your company business
   - ☐ Software house
   - ☐ IT consulting service
   - ☐ Hardware manufacturer or retailer
   - ☐ Software distributor
   - ☐ Inhouse IT department
   - ☐ Others, please describe _____

2. Number of years of operation
   - ☐ 0-2 years
   - ☐ 3-5 years
   - ☐ 6-10 years
   - ☐ 11-15 years
   - ☐ 16-20 years
   - ☐ > 20 years

3. The size of your company / department
   - ☐ Up to 5 employees
   - ☐ 6 - 30 employees
   - ☐ 31 – 75 employees
   - ☐ > 75 employees

4. The company's revenue
   - ☐ < RM300K
   - ☐ RM300K > RM3 million
   - ☐ Not applicable (for IT department)
   - ☐ RM3 million > RM20 million
   - ☐ > RM 20 million

5. Respondent job role
   - ☐ Quality Manager
   - ☐ Software Engineer
   - ☐ System Analyst
   - ☐ Business Owner
   - ☐ Project Manager
   - ☐ Software Developer
   - ☐ IT Consultant
   - ☐ Others, please describe _____

6. Respondent's years of relevant experience in IT project or IT operation
   - ☐ Up to 2 years
   - ☐ 2 – 4 years
   - ☐ 5 – 8 years
   - ☐ 8 – 10 years
   - ☐ > 10 years

Section 2: Company Characteristics

1. Please rate how strongly you agree or disagree with the following description of your company's current operation, structure and culture.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
a) Simple structure.	☐	☐	☐	☐	☐
b) Entrepreneurial and direct supervision.	☐	☐	☐	☐	☐
c) Close, highly informal interaction among employees.	☐	☐	☐	☐	☐
d) Strong team spirit demonstrated by a single team with common goals.	☐	☐	☐	☐	☐
e) Communication is quick and wide reaching (within days and to multiple levels).	☐	☐	☐	☐	☐
f) High responsiveness with decision made within a day.	☐	☐	☐	☐	☐
g) Flexibility in making changes and corrective actions.	☐	☐	☐	☐	☐
h) Everyone understands the process chain and operation of the company.	☐	☐	☐	☐	☐
i) Heavy reliance on limited few individuals / specialists for decision making.	☐	☐	☐	☐	☐
j) Most employees carry out different roles or job functions.	☐	☐	☐	☐	☐
k) Specialist skills are sometimes sought from third-party supplier.	☐	☐	☐	☐	☐

Section 3: Quality Improvement Methodology Implementation

1. Please indicate the quality management system (QMS) in your company / department.

Informal ☐ Formal* ☐ Formal* with ☐ certification.
Please state the certification obtained:
_____

*A formal quality management system shall have the following elements:

- *Quality Manual with high-level policy statement on organisation objectives, quality policies, responsibilities, document control procedures, etc.*
- *Written core business processes that describe product conformance to customer requirements, the responsibilities and resources required to complete the process.*
- *Internal communication on the requirements of QMS, evidenced by team meetings, in-house journal or other form of e-communication.*
- *Customer feedback process, monitored and recorded.*
- *Product and process quality metrics are defined and monitored. E.g. post-delivery defects, responsiveness to customer complaint.*
- *Written procedure to identify and control non-conforming products, including change control, corrective and preventive actions, approval, etc.*
- *Audit on process and product performance and compliance, with corrective actions and resolution tracking.*
- *Employee performance evaluation with formal records.*

2. If quality management system has been implemented and/or certification has been completed, please indicate the number of years for implementation / obtaining the certification.

☐ Within one year ☐ 1 to 2 years ☐ 2 to 3 years
☐ More than 3 years ☐ Not applicable

3. What is your objective in implementing quality management system?

No.	Objectives	Yes	No	Maybe
a.	To improve organisational efficiency and effectiveness			
b.	To improve products and / or services			
c.	To improve operation process			
d.	To increase customers' satisfaction / to fulfil customers'			
e.	To gain competitive advantage / market share			
f.	To cut cost			
g.	To reduce response time and improve cycle time			
h.	To increase productivity			
i.	To improve financial performance / increase profitability			
j.	To strengthen team work and team spirit			

4. What is your **primary** choice of quality improvement methodology (QIM) in the past, current and future?

   Note:
   ISO: ISO 9001
   ITIL: Information Technology Infrastructure Library
   CMMI: Capability Maturity Model Integration
   SPICE: Software Process Improvement and Capability Determination

Primary QIM	ISO	ITIL	CMMI	Lean Sigma	Six Sigma	Balance Scorecard	SPICE
Past	O	O	O	O	O	O	O
Current	O	O	O	O	O	O	O
Future	O	O	O	O	O	O	O

5. What is your **secondary** choice of quality improvement methodology (QIM) in the past, current and future?

Secondary QIM	ISO	ITIL	CMMI	Lean Sigma	Six Sigma	Balance Scorecard	SPICE
Past	O	O	O	O	O	O	O
Current	O	O	O	O	O	O	O
Future	O	O	O	O	O	O	O

6. Please rate how strongly you agree or disagree with the following resistance faced in quality improvement methodology (QIM) implementation.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Lack of skill, knowledge and experience in software process improvement.	☐	☐	☐	☐	☐
Lack of consistent support and understanding from senior management.	☐	☐	☐	☐	☐
Unclear goals and objectives in software improvement project and clarity in the progress milestones.	☐	☐	☐	☐	☐
Employees are not trained on software process improvement.	☐	☐	☐	☐	☐
High cost of implementation.	☐	☐	☐	☐	☐
Company is not clear on the quality policies and standards.	☐	☐	☐	☐	☐

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Insufficient assessment of current software process.	☐	☐	☐	☐	☐
Insufficient assessment of company's need with respect to quality initiative implementation.	☐	☐	☐	☐	☐
Implementation causes lack of focus on core business or distraction from urgent need.	☐	☐	☐	☐	☐
Lack of teamwork.	☐	☐	☐	☐	☐
Lack of commitment and participation from ALL levels of the company.	☐	☐	☐	☐	☐
Unrealistic expectations of software process improvement project, including the goals, deadlines and results.	☐	☐	☐	☐	☐
Lack of focus or low priority on the software process improvement project.	☐	☐	☐	☐	☐
Excessive documentation requirement of software process improvement.	☐	☐	☐	☐	☐

APPENDIX B: Project Team Roles Template

LOGO	FYP SDN. BHD.		
Document No.:	**SQA-F-001**	**Document Name:**	**Project Team Roles**
Revision No.:	1	Revision Date:	1 January 2019
Prepared by:	Choong Soo Ching, SQA Executive	Reviewed by:	John Tan, Project Manager
Approved by:	Ali Abdullah, CEO		

Record of Past Revisions

Revision	Date	Summary of Change	Preparer	Reviewer	Approver
1	1/1/2019	Initial version	*Signature* Mary Chin, IT Executive	*Signature* John Tan, SQA Manager	*Signature* Ali Abdullah, CEO

LOGO	FYP SDN. BHD.		
Document No.:	**SQA-F-001**	**Document Name:**	**Project Team Roles**
Revision No.:	1	Revision Date:	1 January 2019
Prepared by:	Choong Soo Ching, SQA Executive	Reviewed by:	John Tan, Project Manager
Approved by:	Ali Abdullah, CEO		

Project Team Roles					
Project Code:					
Project Name:					
Project Role	**Name**	**Mobile Number**	**Email**	**Assignment Date**	
				Start	**End**

APPENDIX C: Customer Call Log Template

Logo	FYP SDN. BHD.		
Document No.:	**SQA-F-002**	**Document Name:**	**Customer Call Log**
Revision No.:	1	Revision Date:	1/1/2019
Prepared by:	Mary Chin, IT Executive	Reviewed by:	John Tan, SQA Manager
Approved by:	Ali Abdullah, CEO		

Record of Revisions:

Revision	Date	Details of Change	Preparer	Reviewer	Approver
1	1/1/2019	Initial version	***Signature***	***Signature***	***Signature***
			Mary Chin, IT Executive	John Tan, SQA Manager	Ali Abdullah, CEO
2					

								Project Details		Applicable for Change Request			
Log Case ID	**Log Date**	**Customer**	**Contact Person**	**Contact Phone**	**Contact Email**	**Incident Description**	**Type[1]**	**Code**	**Name**	**Change Request ID**	**Priority[2]**	**Status[3]**	**Resolve Date**

Definition:

(1) Type of log case is to be selected with reference to IT Service Catalogue, as follows:

Accounts and Access
Device Support
Email, Calendar & Collaboration
Enterprise Applications
Network, Voice & Connectivity
System & Data Infrastructure
Web Development & Hosting
Security

(2) Priority Level is determined by Project Team after assessment of the change request. Customer must be notified of the case priority after change request is approved.

Priority Level	
Low	The change leads to improvements, such as in workflow or configuration, while having little or no impact on day-to-day operations. This change can be scheduled.
Medium	The change addresses operational issues to which there are available work-arounds. Can be scheduled at least one month in advance.
High	The change addresses operational issues that must be addressed immediately (within 1 week). The system is functioning but at reduced efficiency.
Emergency	The change addresses operational issues that requires urgent response to a situation causing interruption to the business and to be implemented swiftly.

(3) Status - user is to select from the following status:

Status	Description
Pending	Pending decision by Change Control Board
Open	Approved by CCB and in progress of implementation
Resolved	Change implemented and deployed
Cancelled	Change is determined to have very insignificant impact and will be not implemented / change is no longer required.

APPENDIX D: Change Request Form

LOGO	FYP SDN. BHD.		
Document No.:	**SQA-F-003**	**Document Name:**	**Change Request Form**
Revision No.:	1	Revision Date:	1 January 2019
Prepared by:	Mary Chin, IT Executive	Reviewed by:	John Tan, SQA Manager
Approved by:	Ali Abdullah, CEO		

Records of Past Revisions

Revision	Date	Details of Change	Preparer	Reviewer	Approver
1	1/1/2019	Initial version	*Signature* Mary Chin, IT Executive	*Signature* John Tan, SQA Manager	*Signature* Ali Abdullah, CEO

LOGO	FYP SDN. BHD.		
Document No.:	SQA-F-003	Document Name:	Change Request Form
Revision No.:	1	Revision Date:	1 January 2019
Prepared by:	Mary Chin, IT Executive	Reviewed by:	John Tan, SQA Manager
Approved by:	Ali Abdullah, CEO		

Change Request Form			
Section A: To be completed by requestor			
Change Request Date		**Change Request ID**	
Project Code		**Log Case ID**	
Project Name			
Application Name			
Description of Change			
<Provide details on the change required>			
Justification			
<State the reason for change>			
Type of Change	☐ Bug Fix	☐ Enhancement	☐ Urgent
	☐ Others, please state _____		

Section B: To be completed by Programmer/Analyst [on change analysis]			
Brief Description of Analysis			
<Explanation on analysis performed>			
Estimated Duration		**Estimated Cost**	
Affected Files			
Affected Functions / Modules			
Expected New Files to be Created			

LOGO	FYP SDN. BHD.		
Document No.:	SQA-F-003	Document Name:	Change Request Form
Revision No.:	1	Revision Date:	1 January 2019
Prepared by:	Mary Chin, IT Executive	Reviewed by:	John Tan, SQA Manager
Approved by:	Ali Abdullah, CEO		

Section B: To be completed by Programmer/Analyst [on change analysis]			
Required Tests			
Impact **a) To stakeholders** **b) To process / technology / structure** *<The measure of how critical it is to the overall functionality of software. Consider the effect of a change on the software, the business benefits or the extent of damages if the change goes wrong.>*	Low ☐	Medium ☐	High ☐
Priority Update *<The necessary speed of resolving an incident. Consider the impact on affected functionality and the acceptable implementation change delay.>*	Low ☐	Medium ☐	High ☐

Section C: To be completed by Project Manager			
Recommendation	Approve ☐	Pending ☐	Reject ☐
Remarks			
<State comments considered necessary to explain recommendation made>			
To be filled in after CCB approval			
Assigned Programmer			
Target Release ID		**Target Release Date**	

Signature	***Signature***	***Signature***
Request by:	Analysed by:	Recommended by:
Position:	Position:	Position:
Date:	Date:	Date:

LOGO	FYP SDN. BHD.		
Document No.:	**SQA-F-003**	**Document Name:**	**Change Request Form**
Revision No.:	1	Revision Date:	1 January 2019
Prepared by:	Mary Chin, IT Executive	Reviewed by:	John Tan, SQA Manager
Approved by:	Ali Abdullah, CEO		

Section D: To be completed by CCB Coordinator			
Date of CCB Meeting			
Decision of CCB	Approve ☐	Pending ☐	Reject ☐
Reason, if rejected			
<Provide brief explanation on decision to reject the change request>			

Section E: To be completed by assigned Development Team Member	
Test Case ID	
Test Conclusion	

APPENDIX E: Change Log

Logo	FYP SDN. BHD.		
Document No.:	**SQA-F-004**	**Document Name:**	**Change Log**
Revision No.:	1	Revision Date:	1/1/2019
Prepared by:	Mary Chin, IT	Reviewed by:	John Tan, SQA Manager
Approved by:	Ali Abdullah, CEO		

Record of Revisions:

Revision	Date	Details of Change	Preparer	Reviewer	Approver
1	1/1/2019	Initial version	*Signature*	*Signature*	*Signature*
			Mary Chin, IT Executive	John Tan, SQA Manager	Ali Abdullah, CEO

Change Log												
Project Code:												
Project Name:												
Change Request ID	**Change Request Date**	**Brief Description of Change**	**Change Type[1]**	**Impact Summary**	**Impact Level[2]**	**Priority Level[3]**	**Status[4]**	**Test Case ID**	**Pass/Fail**	**Release / Patch**		
										ID	**Plan Date**	**Actual Date**

Definition:

(1) Type of Change

Bug Fix	For fixes to bug / defects
Enhancement	Enhancement made to the application / system, including addition, removal or amendment to the features / functionality
Urgent	
Others	Any other reasons not stated above. Details refer to Change Request Form

(2) Impact level measures the business criticality, the effect of a change on the business. Consider the benefits or the extent of damages if the change goes wrong.

Low	Little impact to current operation. No users are affected and business is as usual.
Medium	Moderate disruption to resources and/or system. Overall business operation is functioning albeit at reduced efficiency.
High	Interruption to critical business processes; affecting many users; and no work around available.

(3) Priority Level is determined by Project Team in term of necessary speed of resolving an incident. Considering the acceptable implementation delay, and the impact on business.

Low	The change leads to improvements, such as in workflow or configuration, while having little or no impact on day-to-day operations. This change can be scheduled.
Medium	The change addresses operational issues to which there are available work-arounds. Can be scheduled at least one month in advance.
High	The change addresses operational issues that must be addressed immediately (within 1 week). The system is functioning but at reduced efficiency.
Emergency	The change addresses operational issues that requires urgent response to a situation causing interruption to the business and to be implemented swiftly.

(4) Status:

New	New change request raised which has yet to be reviewed by Project Manager.
Pending	Pending decision by Project Manager which has yet to be submitted for the approval of Change Control Board
Open	Approved by CCB and scheduled for implementation
Closed	Change request is rejected by Project Manager / CCB.
Resolved	Change implemented and released

APPENDIX F: Test Plan

LOGO	FYP SDN. BHD.		
Document No.:	**SQA-F-005**	**Document Name:**	**Test Plan**
Revision No.:	1	Revision Date:	1 January 2019
Prepared by:	Mary Chin, IT Executive	Reviewed by:	John Tan, SQA Manager
Approved by:	Ali Abdullah, CEO		

Record of Past Revisions

Revision	Date	Summary of Change	Preparer	Reviewer	Approver
1	1/1/2019	Initial version	***Signature*** Mary Chin, IT Executive	***Signature*** John Tan, SQA Manager	***Signature*** Ali Abdullah, CEO

LOGO	FYP SDN. BHD.		
Document No.:	**SQA-F-005**	**Document Name:**	**Test Plan**
Revision No.:	1	Revision Date:	1 January 2019
Prepared by:	Mary Chin, IT Executive	Reviewed by:	John Tan, SQA Manager
Approved by:	Ali Abdullah, CEO		

[Client / Organization Name]
[PROJECT NAME]

TEST PLAN

TEST PLAN #: [ID NUMBER]	VERSION: [Version Number]

Document Information
This document provides detailed information about test planning for [project name].

Revision History

Version number	Revision date	Summary of Changes	Updated By
1.0	dd/mm/yyyy	First version	

Document Preparer

Name	Title	Signature	Date

Document Approvers

Name	Title	Signature	Date

Table of Contents

1 Introduction

State the purpose of this document and the objective of test plan. A summary of items and features to be tested can be provided, including any references to software project documents such as project plan and applicable company policies and standards on project management and testing.

2 Scope

2.1 Items / Features Covered under the Test

State the software features to be tested in the current plan release and relate to the relevant test design specification / test case.

2.2 Items / Features to be Excluded

State the software features that will be not tested and the justification of doing so.

3 Test Approach

3.1 Approach

Describe the overall test approach, briefly explain the types of test to be conducted and the how the features are to be tested at different level of tests. The techniques and tools that will be utilised in the tests shall be specified. The involvement or level of participation by users and process owners can be specified.

3.2 Definitions of Tests

List and define the tests, including the relevant objectives, that will be carried out in the project.

3.3 Environment

Describe the testing environment for each different types of test. Example, the requirement regarding hardware, software, security and the name or path of test server, if any, which are necessary to support the tests. Identify if any special test tools or testing needs such as working space.

4 Testing Tasks

Describe the tasks necessary for the preparation and performance of testing, such as the definition of test case, test steps, test data, expected and actual results.

5 Pass / Fail Criteria

Define the criteria that determine if a test item / feature passes or fails a test.

6 Test Deliverables

Identify the list of test documents and test data such as test plan, test design specifications, test case, etc.

7 Test Schedule

Define the test milestones in the project schedule. Identify the estimated time and resources as needed.

8 Roles and Responsibilities

Identify and describe the various roles and the responsibilities in relation to the tests to be conducted. Examples of roles are project managers, testers, reviewers, end users, etc. and the responsibilities in managing, designing, executing, reviewing and preparation of data and environment.

9 Risk and Contingencies

Identify and list the risks of executing the test plan, providing contingency plan for each risk identified.

10 Unit Testing

10.1 Definition

Define the unit test to be performed for the project and how it will be conducted, e.g. use of white box testing.

10.2 Scope

Describe the scope of unit testing.

10.3 Pre-requisites

State any pre-requisites or pre-condition for test.

10.4 Deliverables

Identify the specific test deliverables resulting from unit test.

11 Integration Test

11.1 Definition

Define the integration testing that is required for the project. Identify the business processes / functions / modules that will need to be integrated and therefore can be affected by the change implemented by programmers. Provide a brief description of the affected the business processes / functions / modules.

11.2 Scope

Describe the scope of integration tests.

11.3 Pre-requisites

State any pre-requisites or pre-condition for the test.

11.4 Deliverables

Identify the specific test deliverables resulting from integration test.

12 User Acceptance Test (UAT)

12.1 Definition

Define the UAT and approach to be used, such as how end users will be involved.

12.2 Scope

Describe the scope of UAT.

12.3 Pre-requisites

State any pre-requisites or pre-condition for the test.

12.4 Deliverables

Identify the specific test deliverables resulting from integration test.

13 Review and Approval

This test plan is prepared and approved by the following project team members.

Signature	***Signature***
Prepared by: **Position:** **Date:**	**Approved by:** **Position:** **Date:**

APPENDIX G: Test Case Specification

LOGO	FYP SDN. BHD.		
Document No.:	**SQA-F-006**	**Document Name:**	**Test Case Specification**
Revision No.:	1	Revision Date:	1 January 2019
Prepared by:	Mary Chin, IT Executive	Reviewed by:	John Tan, SQA Manager
Approved by:	Ali Abdullah, CEO		

Record of Past Revisions

Revision	Date	Summary of Change	Preparer	Reviewer	Approver
1	1/1/2019	Initial version	*Signature* Mary Chin, IT Executive	*Signature* John Tan, SQA Manager	*Signature* Ali Abdullah, CEO

LOGO	FYP SDN. BHD.		
Document No.:	SQA-F-006	Document Name:	Test Case Specification
Revision No.:	1	Revision Date:	1 January 2019
Prepared by:	Mary Chin, IT Executive	Reviewed by:	John Tan, SQA Manager
Approved by:	Ali Abdullah, CEO		

TEST CASE SPECIFICATION			
Test Case ID		**Change Request ID**	
Test Case Description	*Provide a brief description of the functionality to be tested.*		
Test Type	☐ Unit ☐ Integration ☐ System ☐ Acceptance		
Project Code		**Project Name**	
Requirement(s) to be tested:	*Identify the requirements to be tested.*		
ENVIRONMENTAL NEEDS			
Hardware	*State the characteristics, qualities and configurations of the hardware required to execute the test case. E.g.*		
Software	*State system and application software required to execute the test case, including any software that the test case may interact with. E.g. the operating systems, test tools.*		
Other	*State any other requirements to execute the test case. E.g. trained tester of certain skill or experience, test location, etc.*		
Procedural Requirements	*Describe any constraints on the test procedures, e.g. pre-requisite procedures.*		
TEST			
Test Items and Features	*Identify and describe the items and features that will be exercised by the test case. Provide reference to the associated requirement source such as requirement specification, operations guide, etc.*		
Input Specifications	*Define the input required to execute the test case, e.g. values, tables, transaction files, etc.*		
Procedural Steps	*Describe the sequences of actions necessary to prepare and execute the test case, consider the following as applicable:* • *Set up procedure* • *Actions to begin and progress execution* • *Actions to suspend or stop testing* • *Restart procedure* • *Actions to deal with unexpected / exception events encountered*		
Expected Results of Case	*Describe the expected outcome of the test case.*		

LOGO	FYP SDN. BHD.		
Document No.:	**SQA-F-006**	**Document Name:**	**Test Case Specification**
Revision No.:	1	Revision Date:	1 January 2019
Prepared by:	Mary Chin, IT Executive	Reviewed by:	John Tan, SQA Manager
Approved by:	Ali Abdullah, CEO		

TEST CASE APPROVAL	
Signature	***Signature***
Prepared by: **Position:** **Date:**	**Approved by:** **Position:** **Date:**

APPENDIX H: Test Form

LOGO	FYP SDN. BHD.		
Document No.:	**SQA-F-007**	**Document Name:**	**Test Form**
Revision No.:	1	Revision Date:	1 January 2019
Prepared by:	Mary Chin, IT Executive	Reviewed by:	John Tan, SQA Manager
Approved by:	Ali Abdullah, CEO		

Record of Past Revisions

Revision	Date	Summary of Change	Preparer	Reviewer	Approver
1	1/1/2019	Initial version	*Signature* Mary Chin, IT Executive	*Signature* John Tan, SQA Manager	*Signature* Ali Abdullah, CEO

LOGO	FYP SDN. BHD.		
Document No.:	SQA-F-007	Document Name:	Test Form
Revision No.:	1	Revision Date:	1 January 2019
Prepared by:	Mary Chin, IT Executive	Reviewed by:	John Tan, SQA Manager
Approved by:	Ali Abdullah, CEO		

TEST FORM			
Tester & Role		**Test Date**	
Test Case ID		**Change Request ID**	
Project Code		**Project Name**	
TEST			
Test Items and Features	*Identify and describe the items and features that will be exercised by the test case. Provide reference to the associated requirement source such as requirement specification, operations guide, etc.*		
Input Specifications	*Define the input required to execute the test case, e.g. values, tables, transaction files, etc.*		
Procedural Steps	*Refer to the procedural steps specified in the test case specification.*		
Expected Results of Case	*Refer to the expected outcome specified in the test case specification.*		

ACTUAL RESULTS	
Output Specifications / Actual Result:	*Specify the outputs and features required of the test case / items, and the expected values. Describe the actual outcome and any discrepancies. Evidence required of the test output: Description of the visually observable outputs in the process of executing the test; screen print.*
Conclusion	☐ Pass ☐ Fail

Signature		*Signature*
Sign off by tester **Date:**		**Sign off by approver** **Name:** **Position:** **Date:**

APPENDIX I: Release Note

LOGO	FYP SDN. BHD.		
Document No.:	**SQA-F-007**	**Document Name:**	**Release Note**
Revision No.:	1	Revision Date:	1 January 2019
Prepared by:	Mary Chin, IT Executive	Reviewed by:	John Tan, SQA Manager
Approved by:	Ali Abdullah, CEO		

Record of Past Revisions

Revision	Date	Summary of Change	Preparer	Reviewer	Approver
1	1/1/2019	Initial version	*Signature* Mary Chin, IT Executive	*Signature* John Tan, SQA Manager	*Signature* Ali Abdullah, CEO

LOGO	FYP SDN. BHD.		
Document No.:	SQA-F-007	Document Name:	Release Note
Revision No.:	1	Revision Date:	1 January 2019
Prepared by:	Mary Chin, IT Executive	Reviewed by:	John Tan, SQA Manager
Approved by:	Ali Abdullah, CEO		

LOGO	FYP SDN. BHD.	RELEASE NOTE
Project Code		
Project Name		
Release Type		
Release Date	*dd/mm/yyyy*	
Introduction	*Provide some introduction to the current release.*	
System Requirements	*State the requirements of the system for an upgrade to be carried out.*	
New Features	*List the new features for the current release with brief overview about the new features.*	
Enhanced Features	*List the enhanced features for the current release with brief overview about the enhanced features.*	
Dropped Features	*List the features dropped or terminated for the current release with brief overview about these features.*	
Issues Fixed	*List the features where bugs are fixed for the current release with brief overview about the features' capability / function after the fix.*	
Known Issues, Limitations & Restrictions	*Explain the issues or limitations known but remain unresolved and other restrictions. Provide details such as issue number, brief problem overview, potential resolution, if available.*	
Deployment Instructions	*Provide step-by-step instruction on deployment or by use of default deployment.*	
Version History	*List the versions of historical patches.*	

LOGO	FYP SDN. BHD.		
Document No.:	**SQA-F-007**	**Document Name:**	**Release Note**
Revision No.:	1	Revision Date:	1 January 2019
Prepared by:	Mary Chin, IT Executive	Reviewed by:	John Tan, SQA Manager
Approved by:	Ali Abdullah, CEO		

Preparer			
Name		***Signature***	
Position		***Date***	
Approver			
Name		***Signature***	
Position		***Approval Date***	

APPENDIX J: WBS and Project Schedule

Logo	**FYP SDN. BHD.**		
Document No.:	**SQA-F-008**	**Document Name:**	**Work Breakdown Structure**
Revision No.:	1	Revision Date:	1/1/2019
Prepared by:	Mary Chin, IT Executive	Reviewed by:	John Tan, SQA Manager
Approved by:	Ali Abdullah, CEO		

Record of Revisions:

Revision	Date	Details of Change	Preparer	Reviewer	Approver
1	1/1/2019	Initial version	*Signature*	*Signature*	*Signature*
			Mary Chin, IT Executive	John Tan, SQA Manager	Ali Abdullah, CEO

WORK BREAKDOWN STRUCTURE

PROJECT CODE	
PROJECT NAME	
RELEASE ID	
RELEASE DATE	

WBS NUMBER	TASK TITLE	TASK OWNER	START DATE	DUE DATE	DURATION	% of TASK COMPLETE	WEEK 1					WEEK 2					WEEK 3					WEEK 4				
							M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F
						0%																				
						0%																				
						0%																				
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APPENDIX K: Release Checklist

LOGO	FYP SDN. BHD.		
Document No.:	**SQA-F-010**	**Document Name:**	**Release Checklist**
Revision No.:	1	Revision Date:	1 January 2019
Prepared by:	Mary Chin, IT Executive	Reviewed by:	John Tan, SQA Manager
Approved by:	Ali Abdullah, CEO		

Records of Past Revisions

Revision	Date	Details of Change	Preparer	Reviewer	Approver
1	1/1/2019	Initial version	*Signature* Mary Chin, IT Executive	*Signature* John Tan, SQA Manager	*Signature* Ali Abdullah, CEO

LOGO	FYP SDN. BHD.		
Document No.:	**SQA-F-010**	**Document Name:**	**Release Checklist**
Revision No.:	1	Revision Date:	1 January 2019
Prepared by:	Mary Chin, IT Executive	Reviewed by:	John Tan, SQA Manager
Approved by:	Ali Abdullah, CEO		

Release Checklist		
Release Title [*Project Name/System Version (Patch Number)*]		
Project Code		
Project Name		
Release Type		
Release Date		
Task		**Done**
Preparing for Release		
1. Block the master repository from patches not included in the current release.		☐
2. Check that all the affected files and newly created files for target change request are saved in the Release Pack. [*Important: Perform your check by making reference to ALL the related Change Request Forms*]		☐
3. Prepare Release Note. [*Important: Check to ensure all implemented change requests are included by referring to Change Log, supporting Change Request Forms and Test Forms by Quality Assurance*]		☐
4. Seek approval for Release Note.		☐
Post Release		
5. Merge develop branch with the master repository.		☐
6. Name master repository with increment version number.		☐
7. Back up master repository and store in department's server.		☐
8. Release the master repository for future patches.		☐
9. Update Change Log with release information		☐
10. Notify Helpdesk on patch release.		☐
11. Update Project Schedule for finalisation.		☐
12. Send customer survey form to collect feedback.		☐
13. Review the Project File to ensure team members have duly completed and filed all the project documents.		☐

Completed by:	**Review by:**
Signature	***Signature***
Name:	Name:
Position:	Position:
Date:	Date:

APPENDIX L: Customer Call Log (Case Sample)

Customer Call Log

Log Case ID	Log Date	Customer	Contact Person	Contact Phone	Contact Email	Incident Description	Service Type[1]	Nature of Request[2]	Project Details		Applicable if Change Management Triggered			Resolve Date
									Code	Name	Change Request ID	Priority[3]	Status[4]	
CL-1812-0001	9/12/2018	Offspring Sdn. Bhd.	Hafizah Zaukefli	03-56738990	hafizah.z@off.com.my	Log out of the system due to wrong password	Accounts and Access	Incident	OF-CRM-2018	CRestOF	[redacted]			19/12/2018
CL-1812-0002	12/12/2018	Yellowbook	Aw Meng Feng	016-9902389	awmf@yellow.com.my	Network down	Network, Voice & Connectivity	Incident	YP-ERP-2017	YERP				20/12/2018
CL-1812-0003	20/12/2018	Offspring Sdn. Bhd.	Hafizah Zaukefli	03-56738990	hafizah.z@off.com.my	Customer Feedback Form cannot be submitted without filling all the fields	Enterprise Applications	Bug / Fault	OF-CRM-2018	CRestOF	CR/B/0002-OF	Medium	Resolved	16/1/2019
CL-1812-0004	21/12/2018	Offspring Sdn. Bhd.	Hafizah Zaukefli	03-56738990	hafizah.z@off.com.my	Customer Feedback Form cannot be displayed using Microsoft Edge	Enterprise Applications	Bug / Fault	OF-CRM-2018	CRestOF	CR/B/0004-OF	Medium	Resolved	16/1/2019

APPENDIX M: Change Request Form (Case Sample)

Change Request Form			
Section A: To be completed by requestor			
Change Request Date	20/12/2018	**Change Request ID**	CR/B/0002-OF
Project Code	OF-CRM-2018	**Log Case ID**	CL-1812-0003
Project Name	CRestOF (**CR**MQuest Solution for **Off**spring Sdn. Bhd.)	**System Version**	V1.0
Description of Change			
Service ranking field in the online Customer Feedback Form to be amended to block submission of the form when the field is left blank, i.e. customer must provide answer to the field.			
Justification			
Customer may not have further comments after answering questions in the Customer Feedback Form. Making the field as compulsory field to be filled in is essential has caused unsuccessful submission of the form. Application owner has received multiple complaints from her customers regarding the "unfriendly" customer feedback process.			
Type of Change	☑ Bug Fix	☐ Enhancement	
	☐ Others, please state _____		

Section B: To be completed by Programmer/Analyst [on change analysis]			
Brief Description of Analysis			
Currently, there is no validation performed on the Service Ranking field. Upon submission of form data, validation is required to check the service ranking field for values. If the validation detects non-empty values, the validation passes and proceeds to the success function block to display the submission success message and submits the data to the database. If the validation fails, the error highlight function block will be called. The error highlight function will trigger an error message to be displayed on the screen and will highlight the service ranking field with red font stating "Required field".			
Estimated Duration	1 day	**Estimated Cost**	RM350
Affected Files	crmcff.dll, crmclient.dll, picture.dll		
Affected Functions / Modules	Form submission function, error highlight function		
Expected New Files to be Created	N/A		
Required Tests	Unit test (Test Case #: TC-CR/B/0002-OF-1; TC-CR/B/002-OF-2)		

Impact **a) To stakeholders** **b) To process / technology / structure**	Low ☐	Medium ☑	High ☐	Critical ☐

Section B: To be completed by Programmer/Analyst [on change analysis]				
Priority Update	Low ☐	Medium ☑	High ☐	Urgent ☐

Section C: To be completed by Project Manager			
Recommendation	Approve ☑	Pending ☐	Reject ☐
Remarks			
Change is necessary to allow user who does not want to provide comments on the related field to be able to submit the online Customer Feedback Form successfully.			
To be filled in after CCB approval			
Assigned Programmer	Arif Mohd		
Target Release ID	CRestOF v1.0 (Patch 001)	**Target Release Date**	15/2/2019

黃秀韦	MOHD	MattLai
Request by: Wong Siew Wei Position: Service Desk Executive Date: 20/12/2018	Analysed by: Arif Mohd Position: Programmer Date: 21/12/2018	Recommended by: Matt Lai Position: Project Manager Date: 22/12/2018

Section D: To be completed by CCB Coordinator			
Date of CCB Meeting	30/12/2018		
Decision of CCB	Approve ☑	Pending ☐	Reject ☐
Reason, if rejected			
Not applicable.			

APPENDIX N: Change Log (Case Sample)

Change Log										
Project Code:	OF-CRM-2018									
Project Name:	CRestOF									
Change Request ID	**Change Request Date**	**Brief Description of Change**	**Change Type[1]**	**Impact Summary**	**Impact Level[2]**	**Priority Level[3]**	**Status[4]**	**Release / Patch**		
								ID	**Plan Date**	**Actual Date**
CR/E/0001-OF	10/01/2018	Customer Feedback Form to be available in Chinese Language	Enhancement	The requirement does not affect majority of the users.	Low	Low	Pending			
CR/B/0002-OF	20/12/2018	To ensure service ranking as a compulsory field in the online Customer Feedback Form prior to submission.	Bug Fix	The form can still be submitted albeit the missing of important information.	Medium	High	Closed	CRestOF v1.0 (Patch 001)	15/2/2019	16/2/2019
CR/E/0003-OF	21/12/2018	Authorisation of multiple new account users	Enhancement	The change increase flexibility and user friendliness but minimal impact to current operation.	Medium	Medium	Closed	CRestOF v1.0 (Patch 001)	15/2/2019	16/2/2019
CR/B/0004-OF	21/12/2018	Customer Feedback Form to display in Microsoft Edge	Bug Fix	The form cannot be open in the platform, causing interruption to users	Medium	High	Closed	CRestOF v1.0 (Patch 001)	15/2/2019	16/2/2019

APPENDIX O: Test Plan (Case Sample)

Offspring Sdn. Bhd.

CRestOF

(CRMQuest Solution for Offspring Sdn. Bhd)

TEST PLAN

TEST PLAN #: TP-CRestOF-002	SYSTEM VERSION: v1.0
SYSTEM RELEASE CRestOF v1.0 (Patch 001)	

Document Information

This document provides detailed information about test planning for [project name].

Revision History

Version number	Revision date	Summary of Changes	Updated By
1.0	02/01/2019	First version	Mary Chin

Document Preparer

Name	Title	Signature	Date
Mary Chin	Project Lead		02/01/2019

Document Approvers

Name	Title	Signature	Date
Matt Lai	Project Manager		03/01/2019

Table of Contents

1 Introduction

The purpose of this document is to describe the scope, approach and testing strategy for changes made to the CRMQuest Solution, ready for the patch release CRestOF v1.0 (Patch 001). The document aims to act as a communication tool to all the stakeholders with respect to the tests to be carried out in relation to the upcoming release, offer all interested parties the information and transparency that aid in decision making.

The ultimate goal of the tests is to ensure the solution supports and meets the business requirements as specified in the System Requirement Specification and the change requests arising throughout the project life cycle. Specifically, the main objectives of the tests are as follows:

- ensure the system is functionally correct
- ensure the system integrates with related systems and modules
- ensure the system meet the requirements of the business

2 Scope

2.1 Items / Features Covered under the Test

All the change requests for defects / bug fixes and enhancement which are approved by the Change Control Board and are scheduled to be released in the patch release OF-CRM v1.1 will be tested.

2.2 Items / Features to be Excluded

All the change requests for defects / bug fixes and enhancement which are approved by the Change Control Board, but are scheduled to be released in the future patch releases, will not be included in this Test Plan.

3 Test Approach

3.1 Approach

Testing will be conducted as and when the build is ready to be tested. The tests will include unit tests and all other tests which are deemed necessary subject to the test items. For instance, the integration tests, system tests and user acceptance tests.

3.2 Definitions of Tests

Level	Description and Objectives	Led By
Unit Test	First level of testing to check individual parts of code logic and the core functionalities in a detailed manner, such as single transaction and screen. Normally cover direct scenarios only. The focus is on the individual module or program's functionality, including configurations and development objects.	Respective Programmers
Integration Test	Test of system dependencies across functional modules, transaction or work flows of interfaces to other applications. The focus is on the interaction between related programs and systems.	Development Team
System Test	The E2E (end-to-end) testing whereby all features are tested as per the business process flow. Special scenarios are to be covered. The aim is to determine if the feature is suitable for release to production.	Development Team
User Acceptance Test	The E2E testing of business requirements or scenarios to verify that the system meets the users' expectation and works as designed. The focus is on users' experience.	Key Users / Process Owners, supported by Development Team

3.3 Environment

The test environment needed for different type of test is detailed in the respective test case specification. A designated area with PCs or laptops with access to the CRMQuest system will be required for user acceptance testing (UAT).

There will be no automated testing software used for testing purpose. The standards and templates from previous similar systems development project may be used as a guide or reference in the preparation of templates for test scenarios, scripts, etc.

4 Testing Tasks

Programmer assigned for the change request is responsible for the unit test case development. He or she is to prepare the test scenario and test steps, to define the input specifications or test data and the expected result from the test. All these must be properly documented and be reviewed and approved by Project Lead before the execution of test. Executing of test cases shall be performed formally in

the presence of a reviewer, assigned based on resource availability. Test result must be properly documented and concluded. All the test cases must be duly signed off by the tester and the reviewer.

5 Pass / Fail Criteria

Test item or feature must pass all the test scenario to be considered "pass".

6 Test Deliverables

Test deliverables include this test plan and the test case specifications as detailed in Section 10, 11 and 12.

7 Test Schedule

The test milestone is defined or scheduled by the Project Lead as specified in the Work Breakdown Structure.

8 Roles and Responsibilities

Role	Responsibilities
Project Manager	• Primary contact for development team, quality assurance team and users. • Responsible for the overall project plan and schedule. • Responsible for the overall management and control of testing.
Project Lead	• Assists Project Manager in the preparation of project schedule, test plan and release. • Reviews and approves test case specification. • Leads and coordinates with all the team members in the development process and resolve issues faced. • Monitors the project progress and reports to Project Manager.
Programmer / Developer	• Prepares test case specification. • Builds / codes the approved change request. • Test the codes and record test results.
Analyst	• Analyses change request. • Plays the role of tester as appropriate.

9 Risk and Contingencies

#	Risk	Impact	Triggered Consequence	Mitigation Plan
9.1	Scope creep – additional functionality branching out from the change request as users become familiar with the system.	High	Delays in implementation date	Functionality to be prioritized and monitored. Appropriate discussion with users / stakeholders to be conducted as necessary.
9.2	Test case bug found after 3 iterations.	High	Unresolved bug	Suspend the build and bring up the case for discussion and decision with the project team.

10 Unit Testing

10.1 Definition

A unit can be defined as a feature, functionality, transaction, comprising both configuration and development object. The objective of unit testing is to ensure the unit works as per design and produce the expected results. The tests will be performed by the Programmer during the code development process, taking place in the Development environment.

10.2 Scope

All the change requests to undergo unit tests.

10.3 Pre-requisites

Some level of configuration may be needed prior to the unit test. Details refer to respective test case specification.

10.4 Deliverables

The following test cases are the test deliverables

Test Case	In relation to
TC-CR/B/0002-OF-1	CR/B/0002-OF
TC-CR/B/0002-OF-2	
TC-CR/B/0002-OF-3	
TC-CR/E/0003-OF-1	CR/E/0003-OF
TC-CR/E/0003-OF-2	
TC-CR/E/0003-OF-3	

Test Case	In relation to
TC-CR/B/0004-OF-1	CR/B/0004-OF
TC-CR/B/0004-OF-2	

For the details, review and approval of the test case, refer the individual test cases as filed in the project folders.

11 Integration Test

11.1 Definition

Integration testing is the testing of cross-functional integration points and also for the end-to-end business processes. As the CRMQuest Solution is a standalone (as of now) system, no integration testing is required for the changes made in this patch release.

11.2 Scope

Not applicable.

11.3 Pre-requisites

Not applicable.

11.4 Deliverables

Not applicable.

12 User Acceptance Test (UAT)

12.1 Definition

User Acceptance Testing is crucial to ensure the acceptance of the SAP system by the Process Owners/Key Users, so that the Go-Live milestone can be achieved. End to end business processes will be used as the basis for the UAT. The basic approach to be used for UAT will be for the key users/process owners to execute the agreed business scenarios as defined in a series of test scripts.

12.2 Scope

Not applicable.

12.3 Pre-requisites

Not applicable.

12.4 Deliverables

Not applicable.

13 Review and Approval

This test plan is prepared and approved by the following project team members.

Chin	MATT LAI
Prepared by: Mary Chin **Position: Project Lead** **Date: 3/1/2019**	**Approved by: Matt Lai** **Position: Project Manager** **Date: 3/1/2019**

APPENDIX P: Test Case Specification (Case Sample)

TEST CASE SPECIFICATION			
Test Case ID	TC- CR/B/0002-OF-1	**Change Request ID**	CR/B/0002-OF
Test Case Description	To verify that leaving service ranking field in the Customer Feedback Form blank will result in unsuccessful submission of the form.		
Test Type	☒ Unit ☐ Integration ☐ System ☐ Acceptance		
Project Code	OF-CRM-2018	**Project Name**	CRestOF
Requirement(s) to be tested:	To make service ranking field in the online Customer Feedback Form a compulsory field to be filled in. No submission is allowed if left unanswered or in the event more than 1 answer is given.		
ENVIRONMENTAL NEEDS			
Hardware	PC or laptop		
Software	Operating system: Microsoft Window 10 Browser: Google Chrome or Microsoft Edge		
Other	None		
Procedural Requirements	Open the online Customer Feedback Form via the link sent through email invitation to customer (user).		
TEST			
Test Items and Features	Customer Feedback Form		
Input Specifications	Service ranking = blank, Other fields with valid input.		
Procedural Steps	1. Click the invitation link to go to the online Customer Feedback Form 2. Fill in the Customer Feedback form and leave the service ranking question unanswered, i.e. do not click on any of the options listed. 3. Click the "Submit" button at the bottom of the form.		
Expected Results of Case	Error message is displayed showing "Incomplete Response". Service ranking field is highlighted with red font.		
TEST SCRIPT APPROVAL			
MOHD		Chin	
Prepared by: Arif Mohd **Position: Programmer** **Date: 2/1/2019**		**Approved by: Mary Chin** **Position: Project Lead** **Date: 3/1/2019**	

APPENDIX Q: Test Form (Case Sample)

TEST FORM			
Tester & Role	Arif Mohd, Programmer	**Test Date**	7/1/2019
Release	CRestOF v1.0 (Patch 001)	**Version**	CRestOF v1.0
Test Case ID	TC- CR/B/0002-OF-1	**Change Request ID**	CR/B/0002-OF
Project Code	OF-CRM-2018	**Project Name**	CRestOF
TEST SPECIFICATION			
Test Items and Features	Customer Feedback Form		
Input Specifications	Service ranking = blank, Other fields with valid input.		
Procedural Steps	1. Click the invitation link to go to the online Customer Feedback Form 2. Fill in the Customer Feedback form and leave the service ranking question unanswered, i.e. do not click on any of the options listed. 3. Click the "Submit" button at the bottom of the form.		
Expected Results of Case	Error message is displayed showing "incomplete form". Service ranking field is highlighted with red font.		
ACTUAL RESULTS			
Output Specifications / Actual Result:	Error message is displayed on the screen as expected. Refer to the screenshot attached for evidence.		
Conclusion	☒ Pass ☐ Fail		

MOHD	Chin
Sign off by tester **Date: 7/1/2019**	**Sign off by approver** **Name: Mary Chin** **Position: Project Lead** **Date:7/1/2019**

APPENDIX R: Release Note (Case Sample)

LOGO	FYP SDN. BHD.	RELEASE NOTE

CRestOF v1.0 (Patch 001)	
Project Code	OF-CRM-2018
Project Name	CRestOF
Release Type	Patch
Release Date	16/2/2019
Introduction	This patch release note describes the new features and rectified defects / fixed bugs. Information about upgrades and workarounds for known issues are provided.
System Requirements	These Windows operating systems are supported: • Windows 8 • Windows 8.1 • Windows 10
New Features	1. **Replication of Invoice** You can now replicate Invoices issued in the Finance Module into the CRMQuest, providing your customer service staff with more updated, transaction-specific information, to better serve your customers.
Enhanced Features	1. **Authorisation of New Account Users (CR/E/0001-OF)** New user account creation and authorisation level can be performed on multiple users, creating different levels of access rights at one time. 2. **Automatic Reminder for Pending Customer Feedback Form (CR/E/0002-OF)** User can now configure an automatic reminder to be sent to potential respondents who have yet to respond to an invitation to fill up the Customer Feedback Form. The reminder can be set in the process of creating a new Customer Feedback Form.
Dropped Features	No feature or functionality is removed or terminated.
Issues Fixed	Patch OF-CRM v1.1.0 fixes the following known issues: 1. **Customer Feedback Form is functioning properly on Microsoft Edge (CR/B/0001-OF)** The Customer Feedback Form now functions as expected when users access using Microsoft Edge. The form can be displayed properly and the loading time is improved. 2. **Service Ranking Field must be Filled for Successful Submission (CR/B/0002-OF)**

	Alert will be displayed when the service ranking field in the Customer Feedback Form is left blank. Error message will be displayed on screen and respondent will not be able to submit the form successfully.
Known Issues, Limitations & Restrictions	The upgrade will not update XX scripts and issues may arise when syntax changes between releases. You might need to update XX scripts manually. Workaround: None.
Deployment Instructions	You can upgrade from CRMQuest v1.0 to the latest version. 1. Review this patch release note to understand the scope and contents of upgrade. 2. Check to ensure your environment is equipped with the required hardware and software for installation. 3. Check if your current product licenses require an update. You may check this with FYP Sdn. Bhd. customer service manager. 4. Collect credentials for your account, database and local server. 5. Build the upgrade path. Refer to the *Upgrade Master Tool* to determine your upgrade path. The tool provides a list of step-by-step instructions on how to approach the upgrade, with reference to your current environment and versions. 6. Run all the necessary Microsoft Windows Updates. 7. Schedule the upgrade and notify your company's stakeholders. When you are ready, download the upgrade package from the FYP Sdn. Bhd. Customer Portal.
Version History	CRestOF v1.0 (Date: 15/1/2019)

Preparer			
Name	Mary Chin	***Signature***	
Position	Project Lead	***Date***	*11/1/2019*

Approver			
Name	Matt Lai	***Signature***	
Position	Project Manager	***Approval Date***	13/1/2019

APPENDIX S: Readme (Case Sample)

```
CRMQuest Solution for Offspring Sdn. Bhd
Release 1.0 (Patch 002)
16-02-2019

Production README
================================================================================


Contents Of This Release
------------------------

For all platforms:

  [CRMQuest_HOME]/ucp/lib contains:

  - ucp.jar
    Classes for use with CRM 5.0 and CRM 6. It contains the CRMQuest
    Solution classes, as well as the built-in Pool Adapter
    classes for standalone CRM applications.

  Javadoc / Documentation / Demo:

    The above are available for download on https://FYP.com.my/crmq/


Installation
------------

The CRMQuest Installer puts the CRMQuest Solution files in the
[CRMQuest_HOME]/ucp directory.
```

```
Setting Up Your Environment
---------------------------

On Windows platforms:
  - Add [CRMQuest_HOME]\ucp\lib\ucp.jar to your CLASSPATH.

On all Unix platforms:
  - Add [CRMQuest_HOME]/ucp/lib/ucp.jar to your CLASSPATH.


New Feature Added in This Release
---------------------------------

No new feature or functionality is added in this patch.


Enhanced Features Made in This Release
--------------------------------------

CR/E/0003-OF
   New user account creation and authorisation level can be performed on
   multiple users, creating different levels of access rights at one time.


Problems/Limitations Fixed in This Release
------------------------------------------

CR/B/0002-OF
    Customer Feedback Form can be submitted without response to the
    service ranking question.

CR/B/0004-OF
    Improper display of Customer Feedback Form on Microsoft Edge.
```

```
Deplayment Instructions
-----------------------

1. Review this patch release note to understand the scope and contents of
   upgrade.
2. Check to ensure your environment is equipped with the required hardware
   and software for installation.
3. Check if your current product licenses require an update. You may check
   this with FYP Sdn. Bhd. customer service manager.
4. Collect credentials for your account, database and local server.
5. Build the upgrade path. Refer to the Upgrade Master Tool to determine
   your upgrade path. The tool provides a list of step-by-step instructions
   on how to approach the upgrade, with reference to your current environment
   and versions.
6. Run all the necessary Microsoft Windows Updates.
7. Schedule the upgrade and notify your company's stakeholders.

When you are ready, download the upgrade package from the FYP Sdn. Bhd.
Customer Portal.


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```

APPENDIX T: WBS and Project Schedule (Case Sample)

WORK BREAKDOWN STRUCTURE

PROJECT CODE	OF-CRM-2018
PROJECT NAME	CRestOF
RELEASE ID	CRestOF v1.0 (Patch 001)
PLAN RELEASE DATE	15/2/2019

WBS NUMBER	TASK TITLE	TASK OWNER	START DATE	DUE DATE	DURATION	% of TASK COMPLETE	WEEK 1					WEEK 2					WEEK 3					WEEK 4				
							M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F
1.0	**Project Initiation**																									
1.1	Receive change requests	Project Lead	15/12/2018	25/12/2018	9	0%																				
1.2	Assign change request analysis tasks	Project Lead	16/12/2018	28/12/2018	9	0%																				
2.0	**Project Planning**																									
2.1	Perform and document change request analysis	Programmer / Analyst	16/12/2018	29/12/2018	10	0%																				
2.2	Submit change requests for recommendation approval	Project Lead	17/12/2018	30/12/2018	10	0%																				
2.3	Approve recommendation for change requests	Project Manager	18/12/2018	31/12/2018	10	0%																				
2.4	Hold CCB meeting and make decision																									
	- Compile and distribute change requests	CCB Coordinator	4/1/2019	5/1/2019	2	0%																				
	- Prepare and distribute agenda	CCB Coordinator	4/1/2019	5/1/2019	2	0%																				
	- Hold meeting	CCB	11/1/2019	11/1/2019	1	0%																				
2.5	Document CCB decision and distribute CRs	CCB Coordinator	12/1/2019	12/1/2019	1	0%																				
2.6	Assign Task and Scheduling																									
2.6.1	- Update Change Log	Project Lead	13/1/2019	13/1/2019	1	0%																				
2.6.2	- Prepare WBS & Schedule, propose assignment	Project Lead	13/1/2019	13/1/2019	1	0%																				
2.6.3	- Approve task assignment and project schedule	Project Manager	13/1/2019	13/1/2019	1	0%																				
2.7	Notify customer of change request status	Helpdesk	13/1/2019	13/1/2019	1	0%																				
3.0	**Project Execution**																									
3.1	Design change					0%																				
3.1.1	CR/B/0002-OF	Programmer 1	14/1/2019	14/1/2019	0.5	0%																				
3.1.2	CR/E/0003-OF	Programmer 2	14/1/2019	15/1/2019	2	0%																				
3.1.3	CR/B/0004-OF	Programmer 3	14/1/2019	16/1/2019	3	0%																				

3.2	Prepare test plan and test case specification					
3.2.1	CR/B/0002-OF	Programmer 1	14/1/2019	14/1/2019	0.5	0%
3.2.2	CR/E/0003-OF	Programmer 2	18/1/2019	19/1/2019	2	0%
3.2.3	CR/B/0004-OF	Programmer 3	17/1/2019	19/1/2019	3	0%
3.3	Review and approve test case specification					
3.3.1	CR/B/0001-OF	Project Lead	15/1/2019	15/1/2019	1	0%
3.3.2	CR/B/0002-OF	Project Lead	20/1/2019	20/1/2019	1	0%
3.3.3	CR/E/0001-OF	Project Lead	20/1/2019	20/1/2019	1	0%
3.4	Consolidate test plan	Project Lead	21/1/2019	21/1/2019	1	0%
3.5	Review and approve test plan	Project Manager	22/1/2019	22/1/2019	1	0%
3.6	Development and coding					0%
3.6.1	CR/B/0002-OF	Programmer 1	15/1/2019	15/1/2019	1	0%
3.6.2	CR/E/0003-OF	Programmer 2	22/1/2019	24/1/2019	3	0%
3.6.3	CR/B/0004-OF	Programmer 3	22/1/2019	24/1/2019	3	0%
3.7	Perform unit test and document result					
3.7.1	CR/B/0002-OF	Programmer 1	16/1/2019	16/1/2019	0.5	0%
3.7.2	CR/E/0003-OF	Programmer 2	25/1/2019	25/1/2019	1	0%
3.7.3	CR/B/0004-OF	Programmer 3	25/1/2019	25/1/2019	1	0%
3.8	Review and approve unit test result					
3.8.1	- by technical team	Project Lead	16/1/2019	28/1/2019	9	0%
3.8.2	- by SQA	SQA	28/1/2019	28/1/2019	1	0%
3.9	Perform UAT	Project Manager, Users	31/1/2019	31/1/2019	1	0%
3.10	Deploy patch	Project Lead	15/2/2019	15/2/2019	1	0%
4.0	**Monitoring and Closure**					
4.1	Prepare Release Note	Project Lead	4/2/2018	6/1/2018	3	0%
4.2	Approve Release Note	Project Manager	7/2/2019	7/2/2019	1	0%
4.3	Notify stakeholders on release	Project Manager	8/2/2019	8/2/2019	1	0%
4.4	Update Change Log	Project Lead	8/2/2019	8/2/2019	1	0%
4.5	Notify customer of latest status on change request	Helpdesk	11/2/209	11/2/209	1	0%
4.6	Prepare Release Checklist for approval	Project Lead, Project Manager	11/2/2019	11/2/2019	1	0%
4.7	Perform Post Implementation Review	Project Manager	22/2/2019	22/2/2019	1	0%

APPENDIX U: Release Checklist (Case Sample)

Release Checklist		
CRestOF v1.0 (Patch 001)		
Project Code	OF-CRM-2018	
Project Name	CRestOF	
Release Type	Patch	
Release Date	16/2/2019	
Task		**Done**
Preparing for Release		
1. Block the master repository from patches not included in the current release.		☑
2. Check that all the affected files and newly created files for target change request are saved in the Release Pack. [*Important: Perform your check by making reference to ALL the related Change Request Forms*]		☑
3. Prepare Release Note. [*Important: Check to ensure all implemented change requests are included by referring to Change Log, supporting Change Request Forms and Test Forms by Quality Assurance*]		☑
4. Seek approval for Release Note.		☑
Post Release		
5. Merge develop branch with the master repository.		☑
6. Name master repository with increment version number.		☑
7. Back up master repository and store in department's server.		☑
8. Release the master repository for future patches.		☑
9. Update Change Log with release information		☑
10. Notify Helpdesk on patch release.		☑
11. Update Project Schedule for finalisation.		☑
12. Send customer survey form to collect feedback.		☑
13. Review the Project File to ensure team members have duly completed and filed all the project documents.		☑

Completed by:		**Review by:**
Chin		MattLai
Name: Mary Chin		Name: Matt Lai
Position: Project Lead		Position: Project Manager
Date: 20/1/2019		Date: 21/1/2019

APPENDIX V: Interview Transcript - Interviewee 1

Interviewer	:	Tai Wan Wah (T)
Interviewee	:	Wong Keet Khiong (W)
Position	:	Company Director
Company	:	WBiZTech Sdn. Bhd.
Date	:	23 March 2019
Time and Duration	:	2 p.m., about 1 hour

Clean Verbatim Transcript

T : Can you briefly describe what your company does?

W : My company is an IT consulting company, providing business solution such as network solution, communication solution, ERP, etc.

We helped small and medium size company in Malaysia is implementing ERP solution. There are 3 tiers of ERP solution. Large scale companies that can afford sophisticated ERP may go for ERP solution offered by companies such as SAP and Microsoft. We are providing tier-3 types of ERP solution to small companies that want to implement ERP but with small budget.

My clients are mainly those from retail business, recreational clubs and F&B. The solution that I provided can help theses business to be ISO 9001 compliant. By implementing the ERP solution, the requirements of ISO 9001 are more or less fulfilled.

I have worked with another partner in the implementation of an e-service system at MOSTI* which is used to check compliance with ISO 9001. The framework we used is some sort like the Ecquaria SOP provided by a company in Singapore, but their engine is very expensive. Ours of course is at a cheaper price.

(*T's remarks: MOSTI stand for Ministry of Science, Technology and Innovation. The Department of Standards Malaysia, i.e. Malaysia's national standards and accreditation body, is an agency under the purview of MOSTI, ISO 9001 is adapted as MS ISO 9001 Quality Management System in*

Malaysia. The Department aims to be the one-stop centre in Malaysia to provide information resource on standards compliance.)

[T: So, you have experience working with ISO requirement. Can you explain more on this system about checking compliance with ISO?]
It is a very powerful engine. You just have to key in the required data and load the forms, those used by companies in their business processes, the system would tell you in minutes if the company has fulfilled the ISO requirements. Companies like Sirim, for example, are given user account who audit their clients, bring back relevant documents (clarified that to be photocopy), and load them into the system. In a very short time, the system will give you a report if requirements are met.

(*T: Checking compliance is that simple?*)
Yes. The requirements and logic have already been built in. The system is able to check the traceability of the documents, referring to the forms' ID. That's why it will only take a few days for Sirim to check. The system has automated lots of the work and cut the process short.

T : May I know the size of your company?

W : The company is a very simple set up. I previously worked with another partner in this company but currently working on my own. I would say that I am more of a freelance consultant nowadays.

T : Can you explain your current job scope?

W : Sad to say that ERP is a sunset industry. Now, people prefer to use open source, some goes for cloud. They think open source is good, mainly drawn by the financial attractiveness, but they don't know what issues they may face later with the use of open source.

Anyway, now we focus on develop security app that is used by residential units like condominium and guarded neighbourhood. With the app, they can

better manage visitors and guards, to improve security of their living compound. The security app itself is an ERP, making up by modules.

T : Given the different roles identified in the change control process, do you think that the human resource requirement can be met by your company current manpower strength? If not, what is your suggestion?

W : My company is a "one-man show". I will not go for ISO. But I can speak from my experience on ISO. The ERP system I developed is to help companies to meet the requirement of ISO. Like I said, those small-scale companies, although not from IT industry. The ERP system captures the process, can produce evidence and the linking.

Nowadays, people talk about quality, they like to be associated with ISO so can tell others their company or products are good, have quality. So, they want to go for ISO. But to be honest, they can implement one but maintaining it is not easy. After 2 or 3 years, they tend to slip, a lot of them cannot continue. Like Royal Selangor Club, (is) ISO certified. But now, my understanding is that they are struggling to comply. Their ISO manual is thick like a book. A lot of companies out there have already not been audited for some years.

Talking about the process you are working on, it is quite complete. The roles you identify in the process is very standard. You really need these people in carrying out the change control, but in reality, a lot of SME IT companies may not have these many people. Some are even getting the clerk to be part of the team, but doing mostly the documentation work. Certain roles, they may have the same person to do.

(*T: The idea is that for roles that do not conflict with each other, like preparing and reviewing which must be done by 2 separate persons, other roles can be played by same individual. Say for example, if there are 2 teams in the company, the team member from another team can be the quality assurance person for the other team*.)

Yes. That is what normally we do. Unlike big company, they have a QA team ready. But again, for companies who want to look for ISO, like it or not, they have to have these roles defined. I see that, probably the project manager role and project lead role can be combined.

T : What is your opinion regarding the documentation requirement throughout the whole change control process? Do you think the number of forms and templates used, and the required information to be documented is too resource-consuming for your company or something doable?

W : The documentation requirement for ISO is as such. I don't see that there is any form or template you can take out from your existing process documentation. Companies need to document the work, the content required in your forms has to be there. Again, companies that want ISO just have to do it. But I really doubt that most SME IT companies can really do it.

T : What do you think about the review and approval process? Is it reasonable? Is it reasonable in term of the frequency, level of seniority, where approvals have to be sought?

W : I don't any problem with that.

T : Do you have any recommendation with regard to these concerns, roles, documentation and approval process?

W : Your process is very complete and detailed already. If you want to reduce some tasks done by certain roles, you still have to assign it to another person to do, adding another column (in your flow chart). No point doing that.

I think overall your process is very comprehensive and clear. Companies must do it if they want to be ISO-certified.

APPENDIX W: Interview Transcript – Interviewee 2

Interviewer	:	Tai Wan Wah (T)
Interviewee	:	Joel Chur (J)
Position	:	Developer
Company	:	ViewPoint Research Corporation Sdn. Bhd
Date	:	27 March 2019
Time and Duration	:	9.00 to 10:30 p.m.

Clean Verbatim Transcript

T : Can you briefly describe what your company does?

J : The company develops ERP software, both desktop-based application and web-based application, covering areas such as accounting, operation, personnel management like timesheet recording. To certain business, there is no clock in and clock out by punching card. They keep staff working record by requiring them to maintain timesheet. The software serves such purpose. There are many modules and I am working under one of these modules, i.e. one of the teams, as developer.

T: Is your company certified to any quality related standards?

Yes. My company is ISO-certified, to ISO / IEC 20000 and ISO 27001.

T : May I know the size of your company?

J : Around 80 – 90.

T : Can you explain your current job scope?

J : My job scope covers maintenance and implementation, including bug fixes and enhancement. The software has already been rolled out. My job is on the maintenance stage mainly to solve defects and implement enhancements.

T: Who do you report to?

I report to a team leader.

T : Given the different roles identified in the change control process, do you think that the human resource requirement can be met by your company current manpower strength? If not, what is your suggestion?

J : There are few teams here. There is no issue in fulfilling these roles. However, not all the times project will have project manager and team lead. It depends on the size of the project. If the project is big, consists of many modules, then a team lead will be assigned to each module or a few modules, otherwise, will be just the project manager leading the project.

T : What is your opinion regarding the documentation requirement throughout the whole change control process? Do you think the number of forms and templates used, and the required information to be documented is too resource-consuming for your company or something doable?

J : I think the documentation in your proposed process is good, it helps to log every action. But I do think it is resource consuming because honestly there are quite a lot of forms. If the process, the use of forms, issuance, filling up the contents, is implemented using a system then that will be good. Such as automating the work flow, request, review and approval that will be much better. We will be dealing with electronic documents and don't see papers flying around. For example, my company's product allows users to trigger any work flow, sending request for approval and the process goes on.

T : What do you think about the review and approval process? Is it reasonable? Is it reasonable in term of the frequency, level of seniority, where approvals have to be sought?

J : We don't normally submit bug fix request to CCB for approval. All bugs reported are fixed. Only the enhancement will be assessed and approved by CCB. Helpdesk will assess if reported case is a bug, then submit to technical/ developer team to resolve.

For enhancement request made by customers, we will put into the “wish bucket”. We will then see if the enhancement is needed by most of the customers then only, we will implement. Otherwise, we will leave it.

T: The reason to submit change request for the approval of CCB if to prevent wastage of resources. Do you charge for these services?
Bug fixes and enhancement are done free of charge, so we have no obligation to do enhancements but for bug, we must fix. I will say we fix 99% of the bugs reported.

Besides, in my company, team lead does not review the test case prepared by the developers. Normally QA will look at the test case a that stage where developer has come out with their test case. QA will check if the test case is adequate to cover the bug fix, if other areas are affected and if the tests cover those areas. QA will normally come out will additional test cases as deemed fit and they will test it after the defect is rectified. I would say QA are even more familiar with the system than the developer. They know the system inside out. They can gauge if what the developers are doing are enough. But they will not request the developer to test those test case. They prepare their test case at the early stage and not wait till the ending stage to test what developers have prepared. Basically, they will not be guided by the developer in term of what to test. They will decide what they want to test.
However, they will not comment on the test case prepared by developer if they shall be made redundant. It is always better to test more than less.

Actually, in my company, the coding done by junior developers will be checked by senior developer before commit. Once the code is done, the junior developer will request the senior developer to review, this is all done in GIT, after review if it is ok then only will the junior developer commit the code.

All these are logged in GIT. We don't use hardcopy document to evidence this.

T : Do you have any recommendation with regard to these concerns, roles, documentation and approval process?

J : I do not have any additional comments.

APPENDIX X: Interview Transcript – Interviewee 3

Interviewer	:	Tai Wan Wah (T)
Interviewee	:	Goh Yap Hong (G)
Position	:	Audit Manager
Company	:	Sumitomo Mitsui Banking Corporation
Date	:	3 March 2019
Time and Duration	:	8.30 to 10.00 p.m.

Clean Verbatim Transcript

T : Can you briefly describe what your company/IT Department does?

G : The organization is a foreign corporate banking. The business model is different from retail banking where the system operating in the Bank are limited and doesn't have much processing channels. Thus, the IT department functions are limited to infrastructure management, in-house system development for intranet system, data management and security control management.

T : May I know the size of your company/IT Department?

G : Manpower of IT Department is around 20, which is around 4% of total headcount of the Bank operations located in Malaysia.

T : Is your IT Department / IT process certified to any quality standard? If yes, what is it?

G : No. We are not certified to any quality standard. However, our processes are built and assessed based on COSO framework*. So, our IT organisation structure and IT processes are designed to meet the framework's standard as much we can to ensure the effectiveness of our overall systems of internal control within our IT department.

*COSO stands for Committee of Sponsoring Organizations of the Treadway Commission. It defines an internal control model and the components that work to support an organisation's achievement of mission and objectives.

T : Can you explain your current job scope?

G : My role is quality assurance / audit. We carry out assurance projects to check the control design adequacy and operation effectiveness of our IT processes. We do risk assessments, design our work scope and plan to assess if the current controls are adequate to address or mitigate the risk. We check if the controls put in place are working and deliver the result as expected. Otherwise, we will recommend improvement actions to address any gaps we note.

T : Given the different roles identified in the change control process, do you think that the human resource requirement can be met by your company / IT department current manpower strength? If not, what is your suggestion?

G : It is not solely depending on manpower strength, it requires skill set and competency of the IT personnel to be familiar with the respective roles in the change control process.

This change control process may not be suitable for small scale bank like my place, but the process is suitable for larger organization like Maybank where segregation of duties in change management is mandatory to minimise the risk of fraud in banking system.

T : What is your opinion regarding the documentation requirement throughout the whole change control process? Do you think the number of forms and templates used, and the required information to be documented is too resource-consuming for your company or something doable?

G : It is doable for larger organization, but not for small scale corporate banking. The documentation prepared throughout the change control process are absolutely good control for auditing purpose and to ensure the integrity of the program running in Production. However, it might slow down the

performance of the project delivery especially in catching up project timeline and additional resources are required to prepare the project documentation. Unless, the project documentation can be simplified by tracking tool.

T : What do you think about the review and approval process? Is it reasonable in term of the frequency, level of seniority, where approvals have to be sought?

G : Agreed on the review and approval process, as Segregation of Duties in change management process is important to ensure integrity and quality of product to be delivered to end users.

However, in our company, BOD is not involved in change management. The role of BOD is to approve IT policy and govern the project development, i.e. approving project funding, evaluate project ROI to company, rather than to approve change request. Some company may call this as IT Steering Committee, no involvement of director. Usually it involves Senior Management (C* suite management) with project manager. Senior Management will be the project sponsor after getting project funding approval from BOD.

T : Do you have any recommendation with regard to these concerns, roles, documentation and approval process?

G : You may consider to add and define the role of Change Migrator.

After obtaining approval notification from Change Control Coordinator, the program file should be compiled by an independent person who is not involved in project development. We usually called him Change Migrator, who will move the program files from one environment to another, example from SIT (Programmer environment) to UAT and finally to production. This is security requirement to ensure integrity of program.

Besides, you can consider adding a fallback plan during the change management. The fallback plan is necessary if the program moves to

production environment but doesn't work as expected or required, the change can be reversed.

[Explanation was given to the interviewee that the change migrator role was not part of the proposed role due to the fact that the process was designed based on the assumption of using software tool in managing the coding. Changes, check out and check in were all logged by the software hence rendered the role redundant. Besides, back up of the repository was an activity / step that acted as a backup in the event of failed change implementation where previous program can be reinstalled.]