

# **Assessing capability maturity tools for process management improvement: A case study**

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Master of Computer and Information Science

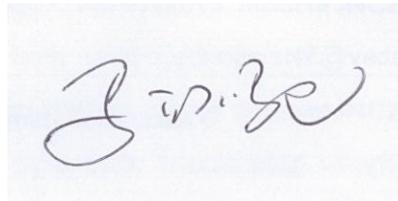
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## Declaration

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief. It contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the qualification of any other degree or diploma of a University or other institution of higher learning, except where due acknowledgement is made in the acknowledgements.

A photograph of a handwritten signature in black ink on a light-colored background. The signature is cursive and appears to read 'H. Ma'.

.....

Huanchi Ma

## Acknowledgements

This thesis was completed at the Faculty of Design and Creative Technologies in the School of Engineering, Computer and Mathematical Sciences at Auckland University of Technology, New Zealand under supervision from Dr Brian Cusack.

I thank my parents for their limitless support over many years of my journey pursuing in study. I would also like to thank my wife for her continuous support and courage and for being kind and tolerating over the times when I got into stress, and for her understandings my absence in domestic help and family events during my Master study. Especially, I would like to thank my 4 years old daughter for her forgiveness of my absence for companionship, and for her silent support, encouragement, and inspiration for the past year of my thesis study.

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In addition, I would like to thank my company for providing the work systems, documents, framework tools and other software for my research and for the support in allowing the time and resource conducting and documenting my experiments for the case study.

Lastly, being a returning student after almost a decade between my previous and current studies, I have not been my sharpest at the beginning, hence I would like to thank all my friends and classmates who have helped me, for being supportive in sharing information, challenges, and solutions, to bring me up to speed, and throughout my Master study path.

## Abstract

The motivation for the research came from my daily work stress, and years of observation of work processes and the project management of my work places. From my perspective there has always been too much resource wastage on account of mistakes being made and the lack of a dynamic and comprehensive status analysis and resource allocation control. The availability of capability maturity tools appears as a working solution for software driven work environments. The current work systems are depending on the simple tracking methods of the process and work experience gained by years of work and faults, rather than scientific measurement and assessment. Many companies implement CRM software but then do not get all the benefits because the quality management strategies are not fully implemented. My expectation is that by exploring the relationship between CMMI and a CRM corporate system, better knowledge can be gained regarding the relationship between a software system, management strategy, and performance. The implications of the study will be principally for project management in this type of situation.

The research is based on a case study, in real work systems for a software development environment. The design is to examine the current process approach and target the weak spots, collect the data and analyse the results in action. The use case is sampled from one extracted work process, and it is broken down to tasks and activities. Through evaluation of the current CRM system tracking method, flaws are found and corrected by inserting new CMMI practices. Then the results before and after the application are compared for open discussion and evaluation.

The research question is:

- What resource optimisation value has CMMI for IT services delivery?

The relevant sub questions are:

- How are IT services measured?
- What are the critical system attributes for measurement?
- What are the measurements used for?
- How are defects disclosed by CMMI assessment?

The working hypothesis is:

- CMMI gives quality improvement opportunities for IT services.

The overall result of the research is positive. It finds solutions to the questions and issues exposed in the research, and also opens more potential quality improvements for CRM software processes. The research has a direct contribution to the current CRM management platform with benefits to management for more precise decision making, project planning and resource management. Since the research is done directly in a real-life development house, with many sized teams, the findings have relevance in the context and potential for other CRM users to consider for critical reflection. The research has also included the implementation and application procedures and plans at a practical level, which enables guidance for someone wishing to test out these ideas.

Considerations for further research have also been made. During the research the scope of quality improvement for CRM has only just been started. Because one process was selected to make the project manageable, then there are many other things to be tested and tried, and the effects measured. The documented results show potential for other related future research. Some of these projects are:

- Ideal CMMI Cost to Outcome Balance
- Different Focus on Capacity and Maturity
- Further IT Quality Improvement Options
- CMMI in Software Quality Assurance
- Resource Optimisation for IT Service Automation

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## List of Abbreviations

CAB	Change Advisory Board
CMM	Capacity Maturity Model
CMMI	Capacity Maturity Model Integration
CRM	Customer Relationship Management
SAAS	Software as a Service
SDLC	Software Development Life Cycle
SOA	Service Oriented Architecture
QA	Software Quality Assurance

# Chapter 1

## Introduction

### 1.0 INTRODUCTION

Capability maturity is a concept that was developed in to improve the production of software. The focus of capability maturity tools is on to the processes through which software is built. The processes are assessed in terms of their capability to deliver an end product consistently for the satisfaction of the customer. Recently the concept has been used for business processes. Consequently, capability maturity tools are a central component of management practices across all business processes (Corsi and Neau, 2015; CMU, 2017). A business manager aims to optimise the productivity of processes that they may deliver the maximum value from the systems, capabilities, and available resources. Capability maturity tools provide a mechanism by which these performance-based attributes may be measured. The result of measurement and evaluation then feeds into quality improvement processes that include change management, learning, and planning.

This chapter is structured to introduce the thesis and to summarise its contribution. In section 1.1, I discuss my motivation for doing this work, and express a belief that the outcome will be improved industrial practices whereby the production and the testing of software will be more effective and efficient, and also provide greater customer satisfaction. In section 1.2 the research contribution is defined by identifying the problem, the research question, and the research approach. This section provides a full overview of the methodology and the findings that were achieved. In section 1.3 the structure of the thesis is outlined in order to make it easier to follow the way the research is presented.

### 1.1 MOTIVATION

I work every day in a large software development company and participate in the practices and processes for the production of software that must satisfy customer expectations. My thinking about process improvement is a daily critical reflection that comes from observing the processes and action. My strongest motivation is a belief that improvement can be made

to benefit effectiveness and efficiency, and also the customer satisfaction with the adoption and utilisation of quality processes. There are many different rule-based perspectives for the software production and delivery activities (Glazer et al., 2008; Karkkainen and Silventoinen, 2016). Each perspective has a view on the overall purpose of the company and also specific responsibilities for particular processes and their delivery. At one end of the supply chain there is procurement where projects are sourced and contracted, and then at the other end of the supply chain there is the delivery of the finished product to the customer. For my role my greatest concern is with the optimisation of resources that are required for the production of software. The implication of this role is that if inadequate resources and controls are used then the quality of the software can be compromised. In addition, if excessive resources are committed to the project then it will not be cost-effective, and the business will suffer financial loss.

My greatest concern is to find a balancing trade-off between the customer requirements and the business capability to satisfy those requirements. The utilisation of capability maturity tools is as one of many potential quality improvement and satisfying techniques that may be developed to optimise the trade-off between resource consumption and process completion (Goldenson et al., 2004; Ignacio et al., 2017). However, it is not as simple as allocating more or less resources, but the problem is to continuously optimise the use of resources against the value generated (Turner and Keegan, 2001; Wagner, 2006). In order to effectively achieve the optimisation, tactical tools such as capability maturity are required for measurement. In my role the challenge is to focus in on the business processes used to produce software, and the scope of resource consumption. The scope includes the success and failure of a resource allocation, the rates of consumption in relation to the deliverable, and measurables such as wastage, duplication, and so on. Hence, my concern is not simply to give the project managers and developers resources that they will use in current practices, but rather to establish statistical control of the processes for quality improvement. My motivation is to minimise human failure and to maximise the process deliverable against its specified objectives.

Because this research is to be positioned in industry and in daily work systems then all of my motivations may not be satisfied. There is a practical element to implementing the research as an agency of change, without adversely disrupting current practices (Wei and Pingyu, 2013). However, the managers in the software development company are highly

motivated to see if the implementation of these ideas will bring cost savings and also greater customer satisfaction. One of the managers' concerns is that software is produced in a timely fashion. The customer always expects the deliverable long before it is practically possible to make, test and deliver. Hence, business managers are motivated to see that every business process is running at its optimal capability. Ethical approval has not been sought for this study because no human subjects are involved. The focus and data types for the study are documents, observation of software systems data management (specifically the CRM data), and the documentation for the associated business processes and metrics. The agreement with the company is for nondisclosure of brand, location, or of any commercially sensitive information. All of these matters are to be complied.

## **1.2 THE RESEARCH CONTEXT**

The motivation for this research has positioned the data collection in industry. Many contexts can be considered theoretically in order to derive useful knowledge, but my primary concern is for the transfer of knowledge between theory and practice (Daneshgar et al., 2008). This has meant that the literature review has provided an in-depth scoping of capability maturity tools in relation to enterprise systems and their subsystems. This is sufficient theory in which to frame the context of study. However, the motivation and intention of this research is to transfer the theoretical knowledge into practice and to observe the changes that it may make. In order to shape a study that is feasible within the constraints of time and resources it is necessary to limit the extent of the data collection and to concentrate on one process in order to understand the contribution the utilisation of a capability maturity tool might make to the optimisation of the business process. Consequently, qualitative methods were selected in order to define the business processes, one process was selected for study, and then recommendations were made for changes for the optimisation of the selected process. In the following subsections the research problem, the research question, sub-questions, and hypotheses are outlined. Also, the research contribution is reported in order to provide a full overview of the research in chapter 1.

### **1.2.1 Research Problem**

The research problem arose from observation and critical reflection on practice. In practice some of the theoretical advantages a CRM system may give for the control, building and

delivery of software can be reduced by a multitude of factors, such as, data quality, human error, perception scope, availability, resource quality and quantity, and so on. Consequently, by simple observation in daily practice in the work system it was apparent that cost savings could be achieved (Saeed et al., 2017). However, a CRM in a large organisation is a complex situation with many different variables and motivations interacting to create the context. It was apparent that the scope of the problem is generic and not confined to this work situation. It is a work systems problem that arises when ideal theoretical systems are implemented in a real work situation. I had a strong belief that quality improvement processes and elements of statistical control would help structure the evaluation processes and better informed the feedback loops for process improvement.

Consequently, the problem is optimising the many business processes that function in concert with each other for the best business outcome. In the context and constraints of this research project it was not possible to adopt longitudinal or quantitative methods in order to investigate the problem. It was resolved that qualitative methods could quickly provide exploratory data that later could be developed into a more substantial and comprehensive study (Collins and Hussey, 2009; Yin, 2003). The problem however, could be addressed and adequately elaborated through these methods. The key deliverables would then be learning and a clear indication as to whether these ideas and motivations that I had would be valuable for the business.

### **1.2.2 Research Question**

The research problem has many relevant questions that can be helpful for finding solutions to the business problem. For example, questions that identify the many points of potential failure in the work system would all be helpful in identifying factors that may be susceptible to control and subsequent system productivity improvement. However, in order to focus the research onto an achievable outcome that is feasible within the work system context the research question has to take into account the concepts of optimisation and resource management (Kaur, 2014). In addition, my reading of the literature on quality management tools and systems suggested that the capability maturity tool is one of the most helpful in the business context when seeking to optimise process capability and customer satisfaction. Today the CMMI capability maturity tool has been optimised for business processes and business management utilisation. It has recently been updated (2016) from the former

Carnegie Mellon product and into a fully business-oriented tool for measurement and quality improvement (McKay, 2017).

Consequently, the research question is:

**What resource optimisation value  
has CMMI for IT services delivery?**

The relevant sub questions are:

How are IT services measured?

What are the critical system attributes for measurement?

What are the measurements used for?

How are defects disclosed by CMMI assessment?

The working hypothesis is:

CMMI gives quality improvement opportunities for IT services.

### **1.2.3 Research Approach**

Doing research is usually categorised into quantitative or qualitative approaches. More recently the concept of mixed methods has been popular where the two traditional approaches are used in different forms of partnership in order to give a comprehensive perspective of the research question. The choice of research approach selected is usually determined by the context and the problem (Halinen and Tornroos, 2005; Erickson and Kovalainen, 2008; Bailey, 2007). In a context where there are a large number of moderating variables such as in business and education contexts, then qualitative approaches are usually more effective. However, in contexts where variables may be easily categorised, and a clear demarcation made between the attributes of objects, then a quantitative approach may be more appropriate. Another determining factor on the selection of research approach is the feasibility of doing the study which may include assessments of difficulty, time resources, financial resources, and access to the required data.

The context of this proposed research has many moderating variables. Also, there are constraints on time and accessibility to all of the potential data. The amount of data available in a CRM in a large size software development company is enormous. In addition, there are many different data sources and data types available that could be used to enrich a study but not necessarily achieve the focus necessary for the useful construction of the intended knowledge. The motivation for this study is to transfer the theoretical knowledge of

capability maturity tools into the workplace and into practice. An approach that would best suit the situation and its constraints would be qualitative and, in an action, based framework (Kumaran et al., 2007; Yoynoussi and Roudies, 2016; Lal, 2017). The limitation in such a study would be the exploratory nature of the data collected for analysis and the ability to generalise to other contexts. However, gaining insight into the use of a capability maturity tool in practice and providing comment on its capability to provide process optimisation for resource consumption would be valuable. In addition, the generality of estimates and directions could be taken from such research will be moderated by managers who often only require exploratory data to trigger action for better practices.

Consequently, this research has resolved the choices of a qualitative approach and the data collection techniques associated with documentation, critical reflection, observation of processes, and the analysis of performance-based metric data. To make the research manageable a single process from the CRM was selected for study – change management. The CMMI guidelines were then applied for evaluation and data collection.

#### **1.2.4 Organisation information**

The research is undertaken in the company I am currently working at as QA engineer. It does data-warehouse and data-mining in a nutshell in finance service industry as background. The IT department provides software development around the data loading, maintenance, data mining, data consuming including data reporting, as well as part of the monitoring and operation and data quality services internally and externally. The head office is in Atlanta, US. and most of the direct decisions are from Australia office, where changes get approved and processes get evaluated. In this research we are not focusing on geo location but mainly on the process and tasks that is required to be carried out by NZ IT team for analysis and evaluation. The NZ IT service would involve around 500 employees from different business units across the Tasman mainly, with a small part from US.

#### **1.2.5 Research Contribution**

The ultimate goal of IT business is to continuously improve the service quality and productivity (Jakobsen and Sutherland, 2009; Kusakabe, 2015). Through the research, I expect to expose the issues existing in the current CRM development methodology and IT governance processes for resource management optimisation. The study will be focused on

the real work system as a case study, to show the impact of applying the theory in the daily software development practice, by starting with some tasks suitable for the scope of the research. These results can then be used later, on other processes in the system and monitored for their suitability.

The limitations of the CRM process will be examined and a valid theory solution of CMMI put to find out if the method will genuinely improve the ability of dynamic tracking, evaluating, analysing and assessing the process, and to improve the next iteration of projects (Looy et al., 2014). The research will also contribute to making the CMMI theory into an executable plan with cost and budget in mind, and to make it more adoptable in a generic work space.

With expected dynamic breakdown assessment from CMMI on a CRM platform, the managers will be more confident making executive resource planning, estimation, and daily decisions to avoid resource wastage and improve estimation flows. The provision of the CMMI assessment will also show the capacity and maturity of personal skills, so people have clear idea of what to upskill and to seek the relevant training. It is also expected that this research will provide the starting point for more discussion and evaluation for quality improvement of the CRM processes.

### **1.3 THESIS STRUCTURE**

The thesis adopts a standard report format with an introductory formality section that contains the title, the ownership, an abstract, a table of contents, and other lists of abbreviations, figures, and tables. Chapter 1 provides a complete overview of the motivation for the thesis and its findings. Chapter 2 is the literature review that identifies and analyses relevant publications on the topics of capability maturity, business processes quality improvement, and customer relationship management software for enterprise systems. Chapter 3 outlines the methodology used to collect, analyse and report the data in the research. Chapter 4 presents the research findings. Chapter 5 critically reflects upon the findings of chapter 4 in relationship to the research question, sub-questions, and hypotheses. Chapter 6 then concludes the thesis by reviewing the contribution, reporting my own critical reflection of learning during the processes, and making recommendations for further research. A reference section then follows of all the literature read to support this work.

# **Chapter 2**

## **Literature Review**

### **2.0 INTRODUCTION**

The purpose of chapter 2 is to provide a relevant literature review from a selection of journal and professional articles that are available in the AUT electronic library. In addition, google scholar was also used to identify literature in relation to the research topic. The searching was done by using keywords from the proposed research context, selecting higher ranked articles, and by prioritising articles that had a strong research basis. The result is that some articles have not been included and that many others that have fallen beyond the scope of the search are not included. However, the literature review is sufficient in order to provide the theoretical context and general background for a study on the use of capability maturity tools.

Chapter 2 is structured to first define capability maturity in relation to its history and current business models. In the second section business processes are defined for the relationship between business processes and their activities, resources, and metrics. In section 3 customer relationship management (CRM) software is defined in relation to the enterprise system and the quality management goal of customer satisfaction. The section also provides a scope for entering into practical fieldwork where CRM software forms the backbone for the industrial processes. Section 4 reviews the CMMI tool and its relationship to quality improvement. To conclude the chapter a review of the issues and problems related to the first four sections is made. This section is an evaluation and analysis of the literature review presented in order to justify a researchable context and problem.

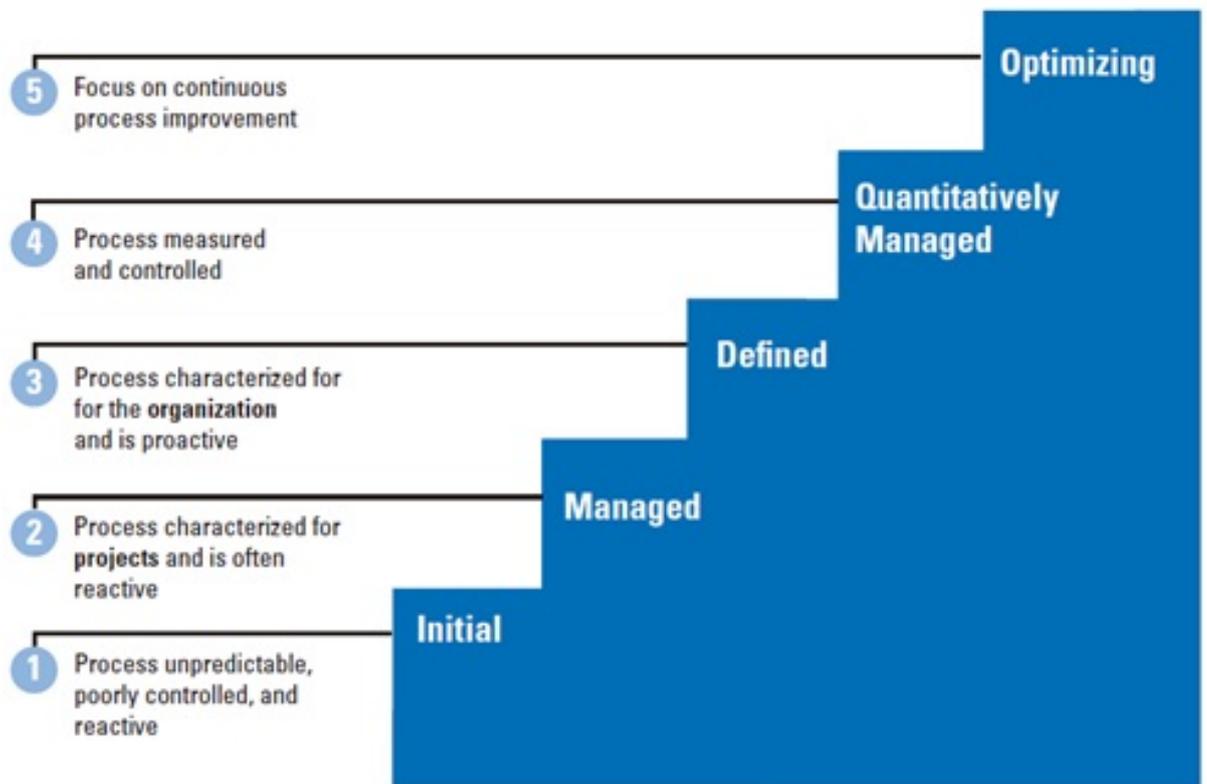
### **2.1 CAPABILITY MATURITY**

Capability maturity is a concept that was developed to link the processes that create business value to the expected value (Humphrey, 1988; Lacerda and Gresse, 2016). In the first instance the concept was applied to the production of software during the 1980s and was then formalised as the capability maturity (CMM) model in the 1990s. The intention behind the model was to rationalise complex processes into manageable units. Much of this knowledge

had come from IBM workers who had been involved with the industrial processes of producing software and had found life cycle and phased models to be advantageous in obtaining the business objectives for the software development (Kumaran et al., 2007). The argument was that if the business processes could be optimised against the expected deliverable then the system had reached its optimal potential. The challenge however, is the multiplicity of variables and determining factors that contribute to the outcome of a large software development project. The concept of capability maturity however, shifted the focus to the processes and the logical business steps that had to be achieved in order to deliver the outcome. The capability maturity model implementation (CMMI) addresses the concern of multiple and competing software development models, and has offered a unified approach to capability maturity optimisation (Luo et al., 2008). In the following subsections, literature is reviewed to document the different aspects that contribute to capability maturity.

### **2.1.1 History and Purpose**

CMM is the abbreviation of Capability Maturity Model, developed by SEI (Information System Audit and Control Association) in Carnegie Mellon University (CMU) to standardise the software development and services in an organisation (Humphrey, 1989; Goldenson et al., 2004; Pane and Sarno, 2015). The ability of an organisation to control, maintain and optimise processes is an ideal that aligns with optimal outputs. The concept of best practices is also strongly linked to achieving optimisation and the documentation of guidelines for best practice implementation. CMM describes five maturity levels that lead an organisation toward optimal performance through the management of the organisation toward a higher maturity level. Currently, most of the companies practice in level 1 and level 2, only, and very few companies can reach a level 5 maturity. The five levels are initial level, repeatable level, defined level, quantitatively managed level and optimising level (See Figure 2.1). The general CMM was originally developed for software development and delivery; and it is commonly used that way until a set of modified practices were defined in 2009 for IT service management. CMMI describes the integration of the CMM model into work systems, and has refined process areas within each maturity level. CMMI for IT service management is now widely adopted by IT services, which is usually referred to as ITS CMM or CMMI-SVC (Daneshgar, Ramarathinam, & Ray, 2008).

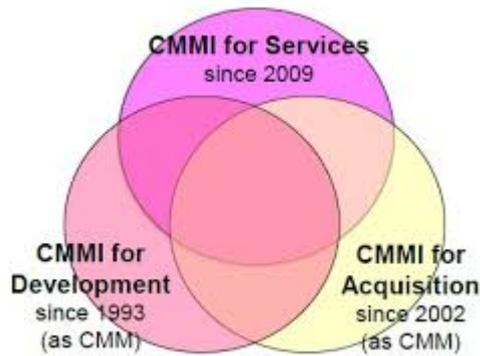


**Figure 2.1 CMMI-SVC maturity levels**

**(Reference: Daneshgar, Ramarathinam, & Ray, 2008, p.17)**

### 2.1.2 Structures

The structural features of the capacity maturity model are principally a process maturity continuum focusing on improvement for the practice from level one to the highest level 5 of capacity in the work system, cluster of related activities are defined as key process areas, goals, key practices, and common features, which contains five items, including engagement to perform, capacity to perform, activities performed, measurement and analysis, and implementation verification. The CMMI-SVC model was released in 2009 and formally named CMMI for services v1.2 model. CMMI-SVC inherited the CMMI maturity level categories in five maturity levels (See Figure 2.1). The definition of maturity is levelled as Initial, Managed, Defined, quantitatively managed, Optimising; and the process areas are Service Delivery (SD), Capacity and Availability Management (CAM), Incident Resolution and Prevention (IRP), Service Continuity (SCON), Service System Development (SSD), Service System Transition (SST) and Strategic Service Management (STSM) (Jakobsen and Sutherland, 2009).



**Figure 2.2 CMMI history and structures**

**(Reference: Kusakabe, 2015, p. 17)**

As CMMI-SVC is a derivative of CMMI with enhanced focus of IT Service Management, it gives the structure and content of the Essential Service Practices (ESP) in the seven categories elaborated below (Kusakabe, 2015).

### **Strategic Service Management (STSM)**

The Incident management system with service oriented architecture (SOA) has high dependency with the client requirement, market demands/standards, and analysis on business's current service capacity. Through the understanding of these factors, the operational support service portfolios and daily routine maintenance service portfolios can be established. Moreover, for each service portfolio, a series of standard services and correspondent Service Level Agreements (SLA) are established (Wei & Zhiqiang, 2011).

### **Service System Development (SSD)**

To maintain a service level, development management is considered with the characteristics of SOA, especially when there are other third-party systems consuming the service as well as the end users, through composite interfaces. Apart from composite software, the core service needs to have corresponding service operation monitoring software and inspection-related rules, regulations and procedures set up. For the required service operation monitoring system, a developing team is established, and CMMI-DEV implemented to management the development process (Torrecilla et al., 2016).

### **Service System Transition (SST)**

Upon completion of the development of the service operation system, the system will be formally reviewed and evaluated. Operating personnel need to inform impacted customers and systems, and deploy the service software into the production service system. The operational service engineers would have been recruited and trained to start performing within the defined standards and protocols. The emphasis on standards and protocol ensures the established services meeting the high level of standardisation required by SOA structure (Schaaf, 2007).

### **Service Delivery (SD)**

For a service level agreement, signed manually and digitally, periodic and temporary, service operational engineers monitor the client server data (local server or distributed cloud server, depending on the requirement of SOA) daily through the established monitoring service, perform on demand onsite inspection, and data analysis monthly with result of the analysis and summary of the field inspection for issues. With approval from client manager and other related personnel, temporary service jobs can be issued onsite or remotely, in accordance with the individual temporary service processes that are defined (Wei and Zhiqiang, 2011).

### **Capacity and Availability Management (CAM)**

For the operational incidents management services, the project team will focus the server capacity and availability on virtual or physical client server operation, and cloud service operation. Due to the nature of SOA, it is a proactive process, which requires the monitoring system to be running all the time, to ensure the availability and level of services (Lahtela et al., 2010).

### **Service Continuity (SCON)**

The nature the incidents management system requires the system to keep a data service stable and secure. Data server monitoring software and disaster hot swap backup environment, along with the trained staff for the disaster recovery are the key success factors. Constant testing on the recovery environment and the recovery procedures, is also compulsory in the guide for Service Continuity (Hochstein et al., 2005).

## **Incident Resolution and Prevention (IRP)**

A customer knowledgebase and a complaint handling system needs to be built to respond to the customer questions, e.g. fast response, quick analysis and taking appropriate measures and actions. An incident management system often has large volume of processes all the time, with requests from multiple distributed systems and customers; hence, there can be zero-tolerance to operational debts (Pongpanga, 2016).

### **2.1.3 Estimation Models and Measures**

The key benefit of using a capability maturity model is to have measures that are relevant to the business processes (Paultk et al., 1993; Sorensen, 2008; Young, 2006). In every measure there is an element of subjective estimation required in order to assess the status of the process. However, the systematic and structured processes within a capability maturity model are designed to deliver consistency in the estimations, error correction, and internal reliability. Benchmarking is also applied for validity checks and the contents of continuous quality improvement cycles minimises variation and potential for erroneous estimation. For example, assessing the maturity of CRM capabilities is based on three levels, corporate CRM capabilities, CRM product capabilities, CRM project capabilities. Each level includes different areas of business, which corresponds to different standards and assessment indicators. At each level, there are key indicators around the key activities. There are corresponding specific processes and activities. Capacity assessment is based on these key indicators and the status of the situation and state of the corresponding process of co-operation (Wagner, 2006; Wei et al., 2013).

In the CRM Capability Maturity Model, there is a detailed definition and description of the different levels of key indicators and standard processes and activities at each level, as well as a description of the insufficient measures. The assessment of capability maturity is mainly based on whether the current state of ability to meet the requirements set by the provisions of the division capacity, can or cannot meet the standards of lowest maturity, and vice versa. Therefore, a score evaluation on CRM competence maturity level can be made. There are detailed key indicators in each level of CRM competence maturity model, as well as detailed standard process and activity indicators. For each index's current capability status, it can be divided into five levels, to take 5 points. These are: no for 0, very few for 1, some for 2, and so on. 1-5 is used to assess the current capacity. According to the level of indicators

and the weight set by the critical level, and a total score is calculated (Crosby, 1979; Goldenson et al., 2004; Luo et al., 2008).

Finally, the total score of all the key indicators or the cumulative scores of all the standard indicators of the overall CRM capability maturity is rated. The score assessment results of the CRM Capability Maturity Model can be expressed in the form of radar charts. Each index is a radar branch line, which will indicate the current capability maturity assessment level. Also with the capability maturity standard chart and the planning Improved Capability Maturity Figure, visual guidance is given to improve the best practice maturity benchmarking chart, and the assessment of capacity to provide a complete and comprehensive assessment of a CRM Capability Maturity status report (Pane and Sarno, 2015).

The evaluation of CRM capability maturity is a useful example and is relevant to this research. Data is collected through surveys, monitoring, interviews and follow-up questionnaires. Detailed interview survey forms and evaluation systems based on the CRM competence maturity model core collection tools. For a specific evaluation project, the final CRM Capability Maturity Assessment will form a Capability Maturity Assessment report that includes a CRM Capability Maturity Diagram and a Text Report that provide a snapshot of current capability status, best practices, optimisation tips, prospects Planning and other circumscribed by the detailed description.

Fundamentally there are five checklist types for each maturity level. There is a policy type for each key process area; there are standards that describe the content of selected work products; there are process checklists that include: roles, entry criteria, inputs, activities, outputs, exit criteria, reviews and audits, work products managed and controlled, measurements, document procedures, training, and tools; there are procedures that describe recommended content to be documented; and, level overviews of an entire maturity level that is broken down into a checklist that includes: key process area purposes, goals, policies, standards, process descriptions, procedures, training, tools, reviews and audits, work products, and measurements (CMU, 2017).

#### **2.1.4 Quality Philosophy**

Quality is a way of thinking that has been developed for industrial control over the goods and services an industry delivers. It is inevitably customer centric and prioritises the customer

expectations over other determinants involved in the production of the goods and services. The way of thinking transfers into a corporate wide culture that emphasises the customer and continuous improvement to meet the customer expectation. It often includes employee empowerment, collaborative decision-making, and data driven or evidence driven models. The aim is to align the products and services of an industry with customer expectation at all phases of engagement. To achieve organisational aims the philosophy is process centric and consequently capability maturity is a significant element. The aim is to reduce variability so that the customer will experience consistency, and the industry will minimise the costs associated with satisfying the customer (Paulk et al., 1995; Lahtela et al., 2010; McKay, 2017).

From the business perspective there are many benefits in terms of optimising the expenditure of resources in order to satisfy customer expectations. Capability maturity tools enable an industry to measure progress towards customer satisfaction. It is done on a process by process basis and the metrics enable the reduction of variation when fed back into the continuous improvement cycles. Capability maturity measurements also provide a snapshot to the managers of where their ability to deliver it is up to and what is required to bring improvement. Quality philosophy is a way of thinking that supports a particular way of doing and controlling business practices. It provides a comprehensive explanation of how to achieve the business goals, affective controls, best practices, organisational guidelines, planning, how to use data, and so on (Schaaf, 2007).

## **2.2 BUSINESS PROCESSES**

An enterprise system is supported by many different subsystems that organise, manage and control a multitude of processes that contribute to the overall effect of the enterprise system (Weinberg, 1992; Davenport, 1993; Younoussi et al., 2016). Often it is said that business processes achieve the business goals. The intention of the statement is to provide a direct linkage between a business process and a planned business effect. In this sense business processes can be seen as a specific occurrence in chain of structured business activities. The chaining of occurrences is designed to generate outputs that are planned and are beneficial to the goals and objectives of the enterprise. There are many examples of business processes and some in the software development sector would be: testing, building, rework, surveys,

authorisation, budgeting, and so on. In the following subsections the terms process, activity, resource, and metrics are defined in the context of business process management.

### **2.2.1 Definitions**

Business processes are designed to add value to the customer. A Business process is generally defined as being a collection of related or structured activities and tasks that produce a specific service or product. Business processes are usually goal related and in particular, related to the satisfaction of customers. There are many types of business process that can be categorised into groups such as governance, management, and operations. There are also subcategories that group primary and secondary and tertiary processes in order to explain the overall networking and interaction in relation to the goal or objective to which the processes relate. A business process cannot exist independently from the overall organisational structure but rather it is embedded in relationship to many other elements of the enterprise system. A business process provides cross functionality and adds value through its actions. It must have a customer as the recipient and consists of a sequential order of activities. Principally a business process must be defined and have clearly specified inputs and outputs. Devonport (1993, p. 9) defined business process as: “a structured, measured set of activities designed to produce a specific output for a particular customer or market.... It is a specific ordering of work activities across time and space, with a beginning and an end, and clearly defined inputs and outputs. It is a structure for action. Processes are the structure by which an organisation does what it is necessary to produce value for its customers.”

### **2.2.2 Activities**

Business activities include any action that is involved with achieving the primary purposes of the organisation. An activity contributes to the achievement of business processes but is independent of the particular process and may contribute to many business processes simultaneously or independently. An example of an activity is accounting, procuring food, polishing a window, and many other similar actions. A business activity covers all actions which are undertaken in order to create value through the business processes. Clearly defined examples in terms of cash handling would be counting, storing, and securing. These activities differ from the processes that are related to cash handling and that these are things which are

done as steps towards achieving the business goals, but they are not the logical structures of the process.

Activities are small units of work that are planned for completion and the satisfaction of the business process. In some literature the word activity and task are used interchangeably. However, a task has clearly specified resources attached, for example time - start and stop. It also often has assignments and other precise details that are lacking from an activity definition. An activity is a more general open-ended description that outlines the things to be done and then later the resources can be associated. Both activities and task consume resources. The planning and allocation of resources for the satisfaction of both tasks and activities is a project manager and quantity surveyor estimation task. The activities are designed to accomplish work and productivity by converting the allocated resource inputs into the required outputs.

A task is one or more activities that need to be accomplished within a defined period of time or by a deadline to work towards work-related goals. A task can be broken down into assignments which should also have a defined start and end date or a deadline for completion.

### **2.2.3 Resources**

Resources are the input to tasks and activities. These inputs are wide ranging and can include time, finance, fuel, energy, people, facilities, and so on. Resources can be further categorised into their types, so that for example, work resources relate to the production requirements, material resources relate to the consumption requirements, and the cost resources relate to the financial and environmental requirements for the completion of tasks. Resources require planning, scheduling and management; and, consequently, trained personnel with support software that distributes and optimises the use of resources.

A Resource Plan is required for forecasting the level of resources required for satisfying process requirements. It will specify the quantities of each category of resource against the tasks and activities for a process. Such planning allows the optimal use of resources within a forecasting model so that the business deliverables are predictable and can harmonise within the life cycles of the many interacting systems. Resource scheduling is also a component of the plan that effectively and efficiently distributes resources based on time and requirement. This allows the work cycles of business to proceed smoothly when the resources are matched with the requirements for the optimal performance of the business

processes. Most businesses usually have a scarce supply of resources and consequently there are trade-offs in competition for the expenditure of these resources. The resource allocation plan is an important tool for the effective management of scarce resources and the optimisation of utilisation.

#### **2.2.4 Metrics**

Metrics are forms of measurement that are used in different contexts in order to report the variation between two attributes. The primary objective of a metric framework is to set up units so that one attribute may be compared with another. For example, it is impossible to measure the value of an entity without first identifying its attributes, and then establishing a system unitisation so that one attribute may be compared with another. In the simple situation of measuring the distance between the top and the bottom of a computer screen, a ruler with some form of unitisation such as centimetres, can be used, and then the result compared with the same measure on other computer screens. However, in the business situation there are many entities that have properties and characteristics which are not easily measured. For example, if the purchase price of a cup of coffee is compared between different shops or different locations then many properties such as size, type, and presentation of coffee has to be considered. In addition, coffee has many different characteristics such as origin, brand, and customer perception of value. In order to develop a metric system to compare two coffees requires considerable research if the comparison measurement is to be meaningful.

Metrics are a set of numbers that give information about a task or an activity. For example, key performance indicators (KPIs) are a metric that report the performance of processes in relation to their expected deliverable. Metrics are used to report the critical measures and any business. Without metrics and measurement, it is impossible for a business to know what they are achieving and the quantities and qualities of the goods and services. Consequently, metrics and metric frameworks are core to management activity, and the knowledge of what is being achieved by an enterprise system. The development of quality philosophy has shown that the measurement and the development of metrics that simply count outputs are not sufficient to satisfy customer expectations. Quality metrics also measure processes and process capability.

## **2.3 CUSTOMER RELATIONSHIP MANAGEMENT**

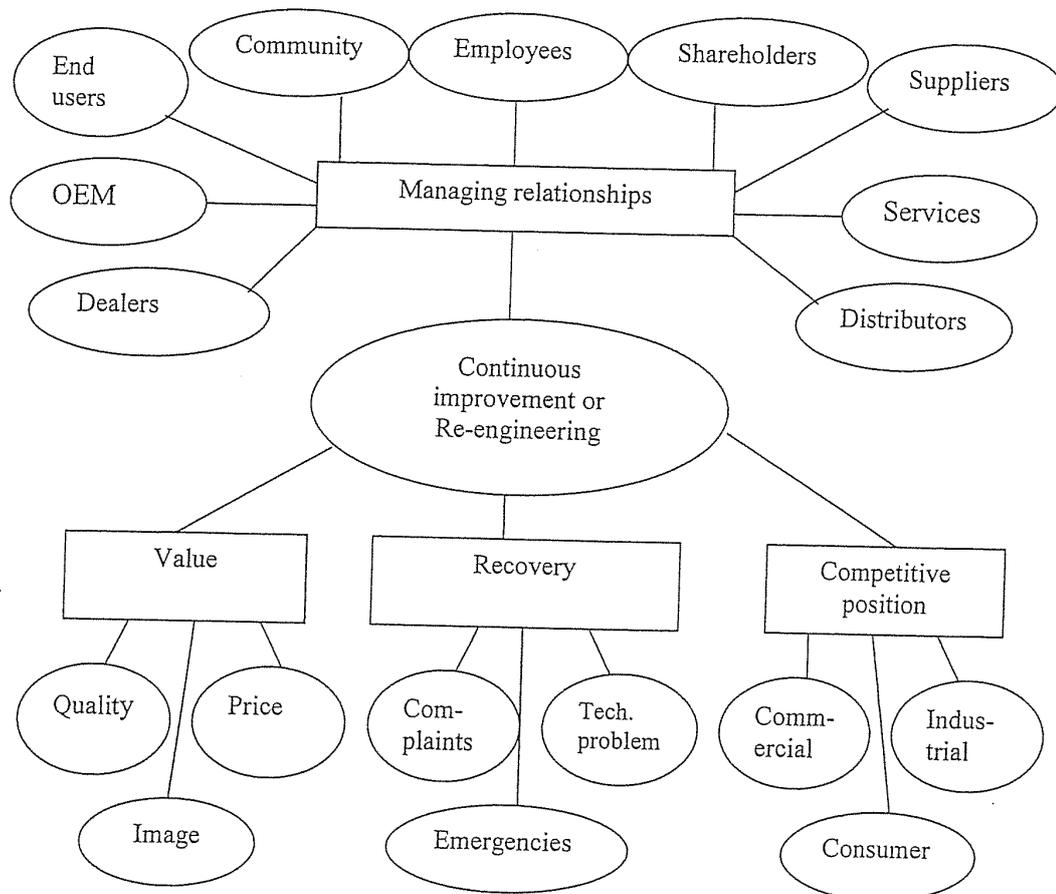
Customer relationship management (CRM) is a business centric concept that covers all aspects of customer management in relationship to the business. CRM is usually found as a software in the core of the business. The CRM software manages customer data and maximises the potential for the business to develop the customer relationship. CRM consists of people, processes, and technology that interact in order to deliver the goods and services to the participants. The CRM provides the forward connection with the customer into the backend of the supply chain that provides the customer services. Many information driven enterprises rely only on a CRM interface to manage information on behalf of suppliers. The following subsections review the CRM as a core enterprise system that mediates and generates value for a business.

### **2.3.1 History**

CRM software is an integral part of enterprise system design (Hochstein et al., 2005; Ignacio et al., 2017). The concept of organisations being enterprise systems was developed in the 1990s in response to widely available computing capabilities that any organisation could use for the management of information. The concept of enterprise system moved business organisations away from specific domains such as banking or forestry, and allowed more generic organisations that integrated information and provided new or amalgamated services that had previously been segregated into different domains of commerce. This meant that organisations were utilising the information that they were producing to leverage a greater range of products and services. It also meant that organisations became much more information centric and enterprise oriented. A whole organisation could run out of one database. Consequently, enterprise systems became generic information management organisations with enterprise resource planning systems at the back end (ERP) and customer relationship management (CRM) systems implemented for the front-end relationship control of the customers. Together the two software systems provided an enterprise with digital control over the entire supply chain from procurement (buy side), to storage, and through to the customer relationship (sell side).

Today these ideas are absorbed into core business practices for enterprise systems and are assumed to be a given (Kumaran et al., 2007). However, back in the 1990s the concept of an enterprise system was radically new and brought about significant changes to the way

businesses thought about their identity and how they practiced their commerce. The enterprise system has integrated all computing systems so that all phases for business operations can be internally coordinated and cooperation gained across the enterprise so that optimal performances may be gained from the available resources. The cross functional complexity of the situation is mediated by the software and its design. The implication is that software is the core of the enterprise system and it is often described as the digital backbone or nervous system of the enterprise. Many online electronic businesses have adopted CRM software exclusively as the core of their business and rely on other enterprises to supply any other required parts of the supply chain.



**Figure 2.3 Customer Relationship Management Structure (Anton, 1995, p.9)**

### 2.3.2 Structures

CRM software has been introduced to businesses since the early 1990s and has been a significant agency for change (Davenport, 1993; Wei et al., 2011). The structure of CRM and

structural arrangements are flexible, and they offered traditional business organisations the opportunity to change.

For example, Anton (1995) provided a three-part structural design for CRM implementation and application. He clustered the minimal elements for a CRM driven enterprise into those that relate to relationships for management, those that relate to continuous improvement or reengineering, and those that concerned value generation. The relationships to be managed were very similar to those which can be found in any traditional organisation, but the structural proposition was different. He grouped elements that were previously segregated in silos, together, and provided them as objects for management attention.

### **2.3.3 Processes**

The introduction of CRM into businesses change them from firms to enterprises. Enterprises are process centric rather than product centric and the processes are oriented toward customer satisfaction. In the historical day back in the 1980s and 1990s these concepts were radical and brought about the structural transition of business systems into new formats and with a new emphasis (Lahtela et al., 2010). A process centric organisation is concerned with the management of the production of value rather than the production of any particular product or service. Value in this sense is not the number of widgets that are going out the door or the number of customers that are coming in the door, but rather the customer perception and the esteem that they hold for the widgets and services which are available through the enterprise system (Schaaf, 2007). Consequently, CRM allowed an enterprise to concentrate upon their customers to build and enrich the relationship that they had and could have with the enterprise. All of the processes within the organisation are oriented toward customer satisfaction, and all the phases of the system life cycles are oriented toward customer satisfaction and customer retention.

These radical changes towards process centric customer management demanded that the business get to know their customers and their requirements rather than focusing on simplistic transaction numbers. The customer became an ongoing relationship that needed to be managed and cultivate to maximise the benefit to the business. In this way the customer became inclusive rather than exclusive from the business processes. CRM in this sense can be seen as a business strategy. Strategically the customer is required for profitability, for

reputation, and for business continuity. Consequently, CRM software is a system that provides consistency within the enterprise system, a backbone for structure, an infrastructure design, and the repository of many processes that support the business goals. In this sense the CRM is an indispensable element in the enterprise system that has replaced many of the formal structural elements (Turner et al., 2001).

However, the business as an enterprise system became much more complex, data centric, less stable, and in a constant state of transition (Wagner, 2006). The management of a CRM centric enterprise requires different skills and aptitude than a traditional business system. CRM is a business strategy to manage, select, and know customers, and for the extraction of long-term value from the customer relationship. It is strategic and a strategy, and connects the three elements of people, technology and processes. From the data perspective, a CRM has a multiple of processes to manage customer contacts and customer information. Retention of this information is critical for knowing the customer, and the processes for managing information- that include matching, cross-referencing, profiling and so on.

#### **2.3.4 Resource Management**

Resources are generally seen as the input to processes and have a significant cost to the enterprise system (Wagner, 2006; Young, 2006; Saeed et al., 2017). The procurement of resources is a critical aspect of the supply chain and it has been discussed in section 2.2.3. The two aspects of procurement and distribution or allocation of resources are shown to be critical for the success of the enterprise system. One aspect of the CRM is to mediate the effective and efficient expenditure and distribution of resources within the enterprise system. The allocation of resources is an economic activity where supply and demand are managed in relation to the satisfaction of value. Some of the control features include the trade-off between participant parties, the balancing and the equilibrium is of competitors, the utilisation of cooperative games, and the strategic design of bartering and trading systems within the enterprise. In this way efficiencies can be gained in the utilisation of resources. One resource management technique is resource levelling. It aims at smoothing the stock of resources on hand, by reducing both excess inventories and shortages.

Resource management systems require particular elements for effective management. First, Data is required on demand for the different resources, and second, forecasting models

built to project as far as possible into the future of predictable demand. The goal of resource management is to achieve 100% utilisation and hence maximise the potential productivity from the infrastructure and its processes. However, this is not always possible, and it resolves itself into a quality management problem. In order to maintain 100% utilisation, the cost is too high and hence a reasonable variation must be accepted by tolerance around the target perhaps 95% or any other target around which quality improvement may be made. The aim of achieving 100% utilisation of resources is mediated by quality management theory and the ambition to constantly reduce the wastage (or variation from the target) until the whole system is moved towards its optimal performance. An enterprise system may invest in resources in order to maintain continuity but also to optimise the system capability. The retention of skill groups and the capability for up skilling is a critical aspect of an efficient and effective resource management system.

## **2.4 CMMI AND QUALITY IMPROVEMENT**

The capability maturity implementation framework (CMMI) evolved from decades of practice in the software industry (MaKay, 2017). It is gone through a number of iterations to arrive at its current form and content, and it is promoted as a management tool for increasing the efficiency and productivity of business processes. The framework provides structure and measurement capability over diverse and complex processes in order to establish and promote direction toward optimal performance and customer satisfaction. In the following subsections CMMI details are itemised so that the required information will be available for implementation during the research.

### **2.4.1 Definition**

CMMI stages the representation of five maturity levels for business processes, and for process improvement. Because CMMI is concerned with implementation it also has a number of schedules to assist putting the tool into practice. The following paragraphs provide a description of each stage (CMU, 2017):

- Level I: Processes are unpredictable, poorly controlled, and reactive. These are performed processes and not their theoretical constructs. The process performance may vary. Also, it may not be compliant with all the QA tests, cost budget and time

allowance according to the original specification, but majority work does get done. The human behaviours have low effectiveness and frustration levels are high.

- Level II: Maturity Level 2 deals with managed processes where the process is managed. That means the strategic plan is executed, skilled and trained personnel are involved, enough resource is available, products and service is controlled, the stakeholders are kept informed, and the process is audited and evaluate with according specification and requirement. All processes are planned, documented, performed, monitored, and controlled at each level, but they also have a reactive element. The managed process comes closer to achieving the defined objectives, such as quality control, cost budget, and time allowed. The human behaviour has an overreliance on experience.
- Level III: Maturity Level 3 deals with defined processes where the process is defined, that: Is clearly specified, understood, deployed and executed across the entire organisation. The processes are proactive. Processes, standards, procedures, best practices and so on, are defined at the organisational level. Project or local tailoring is allowed, however it must be based on the organisation's standardised processes and defined per the organisation's best practice guidelines. All of the organisation must comply and cannot "opt out." The human behaviour has people understanding, following, and supporting the processes.
- Level IV: Processes are controlled with statistical and quantitative methods. The human behaviour has developed a greater sense of teamwork and interdependency.
- Level V: Process performance is optimised through continually improvement in incremental and innovative technological revision cycles. The human behaviours expect improvement and are motivated to work towards it.

Implementation schedules are also available for each of the following process areas (CMU, 2017):

- Causal Analysis and Resolution (CAR)
- Configuration Management (CM)
- Decision Analysis and Resolution (DAR)
- Integrated Project Management +IPPD (IPM+IPPD)
- Measurement and Analysis (MA)
- Organisational Innovation and Deployment (OID)

- Organisational Process Definition +IPPD (OPD+IPPD)
- Organisational Process Focus (OPF)
- Organisational Process Performance (OPP)
- Organisational Training (OT)
- Product Integration (PI)
- Project Monitoring and Control (PMC)
- Project Planning (PP)
- Process and Product Quality Assurance (PPQA)
- Quantitative Project Management (QPM)
- Requirements Development (RD)
- Requirements Management (REQM)
- Risk Management (RSKM)
- Supplier Agreement Management (SAM)
- Technical Solution (TS)
- Validation (VAL)
- Verification (VER)

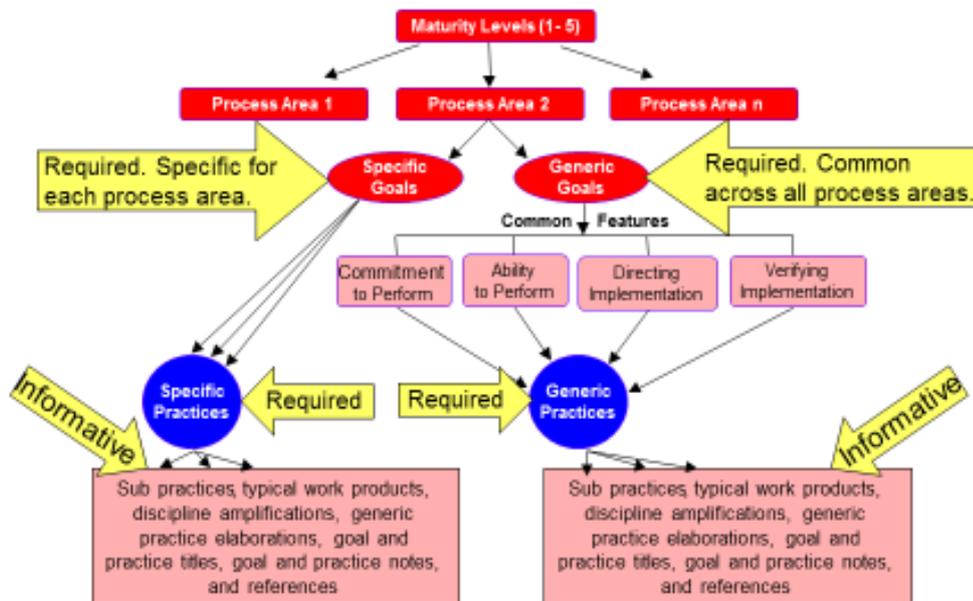
#### **2.4.2 Structures and Processes**

Within each of the 5 Maturity Levels, there are basic functions that need to be performed – these are called Process Areas (PAs) (CMU, 2017). For Maturity Level 2 there are 7 Process Areas that must be completely satisfied. For Maturity Level 3 there are 11 Process Areas that must be completely satisfied. Given the interactions and overlap, it becomes more efficient to work the Maturity Level 2 and 3 issues concurrently. Within each PA there are Goals to be achieved and within each Goal there are Practices, work products, etc. to be followed that will support each of the Goals.

#### **2.4.3 Organisation and Metrics**

Figure 2.4 shows the interrelationship of the different elements of the CMMI framework. Under the five maturity levels there are three process areas defined. Under each of the process areas specific goals and generic goals are defined to respectively cover each process area, and give commonality across all process areas.

# CMMI Terminology & Structure



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**Figure 2.4 CMMI Architecture**

**(Reference: CMU, 2017, Slide Set # 13)**

Each of the goals has a direct linkage to specific and generic practices. The generic goals have common features that distribute fairly across all goals. For example, the commitment to perform and the ability to perform. In this fashion the CMMI framework encapsulates from the highest to the lowest levels of detail under the umbrella of each maturity level. Consequently, there is a huge amount of information available for each maturity level in order to achieve; first, its assessment, secondly the assessment against the definition, and then adoption of steps to improve the processes (CMU, 2017).

Metrics are specified in relation to the goals that are set for each process area. So that for example the process area, measurement and analysis (MA), has two specific goals and five generic goals, as follows ( ):

- Specific Goal 1 (SG 1) Align Measurement and Analysis Activities: SP 1.1 Establish Measurement Objectives; SP 1.2 Specify Measures; SP 1.3 Specify Data Collection and Storage Procedures; SP 1.4 Specify Analysis Procedures.

- Specific Goal 2 (SG 2) Provide Measurement Results: SP 2.1 Collect Measurement Data; SP 2.2 Analyse Measurement Data; SP 2.3 Store Data and Results; SP 2.4 Communicate Results.
- Generic Goals and Practices: Generic Goal 1 (GG 1): Achieve Specific Goals, Generic Practices; GP 1.1 Perform Specific Practices.
- Generic Goal 2 (GG 2) Institutionalise a Managed Process, Generic Practices (GP): GP 2.1 Establish an Organisational Policy; GP 2.2 Plan the Process; GP 2.3 Provide Resources; GP 2.4 Assign Responsibility; GP 2.5 Train People; GP 2.6 Manage Configurations; GP 2.7 Identify and Involve Relevant Stakeholders; GP 2.8 Monitor and Control the Process; GP 2.9 Objectively Evaluate Adherence; GP 2.10 Review Status with Higher Level Management.
- Generic Goal 3 (GG 3) Institutionalise a Defined Process, Generic Practices (GP): GP 3.1 Establish a Defined Process; GP 3.2 Collect Improvement Information.
- Generic Goal 4 (GG 4) Institutionalise a Quantitatively Managed Process, Generic Practices (GP 4); GP 4.1 Establish Quantitative Objectives for the Process; GP 4.2 Stabilise Sub-Process Performance.
- Generic Goal 5 (GG 5) Institutionalise an Optimising Process, Generic Practices (GP 5): GP 5.1 Ensure Continuous Process Improvement; GP 5.2 Correct Root Causes of Problems.

Each process area also has specific statements of purpose, description, and metrics to assess the measurement of capability at each level. For example, for MA the following purposes descriptions and linkages to related process areas are itemised ( ):

**Purpose:** The purpose of Measurement and Analysis (MA) is to develop for supporting a measurement capability in providing enhanced information to management.

**Description:** The process area of Measurement and Analysis includes:

- Specifying the target goals of measurement and analysis with requirement of identified information and expectation
- Specifying the measures, analysis methods, and data collection mechanism, storage, reporting methods, and continuous feedback system
- Implementing the data collection, storage, analysis, and reporting methods
- Providing goals achieving status that provides information for decision making, and taking according adjustment and amendment actions

The process integration of measurement and analysis activities of the project provides:

- goals planning and estimating
- Performance tracking based on plans and goals
- Identifying and resolving issues found in process
- Providing a baseline for implementing the same measurement into possible further processes

The staff responsible for implementation of a measurement capability can be either employed in a separate organisation-wide program or from internal talent acquisition. Measurement capability can be combined into separate projects or even other organisational functions, such as QA or BA. The initialisation for all measurement activities is from the project view. Additionally, a measurement capability is useful for identifying information that is organisation wide and enterprise wide required. In supporting the capability, the measurement activities provide required information at varied organisation levels including the business level, organisational level, and project level to avoid redo the work as the organisation gets mature. Project-specific data and outcome would be chosen to be stored in a project-related working repository. When data is required to be shared across projects organisation wide, the data may be transferred, migrated or cross referenced to the organisation's main measurement repository. CRM supplier can provide measurement and analysis of the components, which is critical for effective management of the quality control, cost budget and time allowance originally set out in the project plan. The valuable insight is provided with enhanced management of supplier agreements, into the date that can be used for its performance analysis.

**Related Process Areas:** The project attributes estimation and other project planning related information is defined in the Project Planning process area. The project performance monitoring and tracking related information is defined in the Project Monitoring and Control process area. The work products and service management related information are defined in the Configuration Management process area. The customer requirements fulfilment related information is defined in the Requirements Development process area. The requirement traceability maintenance related information is defined in the Requirements Management process area. The organisation's measurement repository establishment related information is defined in the Organisational Process Definition process area. The variation verification

and the appropriate utilisation of statistical analysis methods related information is defined in the Quantitative Project Management process area.

In addition to all of the above information regarding measurement and analysis, specific practices by goal is also provided. These are very detailed statements about, for example in SP 1.1, establishing measurement of objectives, and so on. Consequently, the structures and metrics for CMMI are clearly specified from the highest level to the lowest level within an organisation. These descriptions are also divided into each of the five levels, the process levels, the specific and general goals, and the specific and general practices, with precise detail.

#### **2.4.4 Quality Improvement**

The CMMI model in its earlier versions was often used with ISO 9001 for quality improvement. However, the latest version of CMMI has incorporated many of the ISO 9001 best practices and the newer ISO 20000 best practices. The CMMI framework adopts Deming's plan- do- check- act (PDCA) life cycle of quality improvement as the core engine for driving progress. The PDCA life cycle is strong on checking and then acting on the evaluation of the check data. The check data influences the next planning round in the life-cycle. A trained and skilled workforce are part of the capability CMMI provides. CMMI identifies sets of processes that when performed correctly will improve the achievement of business goals, and also ways of measuring progress towards these goals. The whole focus is on process improvement rather than the product or service build, and consequently the customer is the beneficiary of a better product or service. Not only are customers happier but the processes are repeatable once the enterprise gets beyond a level 2 satisfaction. When the enterprise system is optimised then there may be a range of capability maturity levels for different processes within the system, but the overall effect is to maximise the customer satisfaction, minimise the cost, and sustain repeatable continuity.

The definition of process areas also allows specific targeting for quality improvement. This means that if the variation in specific areas is to be reduced then it is possible to select the relevant processes that relate to the area of concern and to begin a quality improvement strategy using the CMMI framework. The goals and best practices definitions also forward confidence to the implementers that they are not only on track, but they are also fulfilling the requirements of quality improvement. For example, if the goals of the particular process area

are fulfilled then that implies that the intent of the process has been achieved. This level of confidence is motivating for users of the framework who have the specified required goals, and also, the expected practices. In many respects the CMMI framework becomes self-reinforcing once the levels of capability improve beyond a critical tipping point and the PDCA life-cycle becomes the silent hand behind all the business processes.

One criticism of CMMI is that it has so much documentation it becomes cumbersome to implement and to manage. This is a common criticism of all quality management frameworks and each must be treated as a long-term investment for the enterprise system. The time and resources committed to implementing CMMI can be managed through a CMMI framework in order to optimise and consolidate the relevant capability maturities. Communication of the requirements and best practices can be a major hurdle for people who are not familiar with quality philosophy. Consequently, the implementation of CMMI has to be calculated and planned in advance, and designed to fit quality management requirements for change management. When an implementation is done effectively the benefits are greater than the costs for the enterprise, and it represents a long-term investment that may be capitalised.

## **2.5 ISSUES AND PROBLEMS**

The literature reviewed in chapter 2 outlines key organisational concerns that are found in enterprise systems. In the first instance the transition between traditional business organisations and enterprise systems has been documented. The key differences between the two is the focus on business processes in enterprise systems. Enterprise systems also have characteristics such as instability, consistent progression, and complexity that is not found in traditional business systems. Consequently, many issues and problems arise when enterprise architecture is implemented and software such as CRM is adopted for the core consistency within the business.

Capability maturity is a process oriented measurement methodology that contributes valuable knowledge for the management of enterprise systems. A manager needs to know how capable the systems are at meeting customer expectations. In order to get a clear picture, measurement tools such as the CMMI can be utilised to position the current status of individual processes, clusters of processes, and the overall system. This means that any point in time a manager knows how well the system is working and how it is progressing towards

an optimised state. The problem then arises that if a manager knows the overall system is operating with a particular capability, and individual processes within the system arranging anywhere between two and four on the CMMI scale, what can be done to improve the system. The manager is faced with many possibilities and guidelines for best practice. However, it still remains a complex problem, when so many processes have influence on other processes.

Business processes require resources to enable the tasks and the activities. A significant challenge faced by everyone (including automated purchasing and negotiating bots) is the optimal use of resources for the attainment of the business goals. How, where, and why resources are distributed is a debatable and contentious problem. As with most business processes estimation that is both based on quantitative and qualitative evidences is used to produce a best guess at delivering resources. Underlying problem-solving strategies for resource distribution include game theory, experience, economic modelling, and other estimation frameworks. However, no strategy is perfect and will produce optimal solutions in every situation. This leads wide open the question of best gameplay and optimised resource distribution strategy.

Many enterprise systems have adopted CRM software to resolve problems in the management of enterprise systems. The CRM software acts as a touch point of stability for all the end-users and as a tool for negotiating resource distribution and overall progress towards the business goals. CRM has many processes within its influence and research questions may be developed around the ability of users to diagnose problems, improve quality, and optimise the functionality. Hence, the literature review completed in chapter 2 identifies and locates many researchable problems and gives rise to related questions to investigate solutions and to probe assumptions around optimisation.

## **2.6 CONCLUSION**

Chapter 2 has reviewed substantial literature around the topic of interest. Capability maturity, business processes, CRM software, and CMMI has been elaborated in detail to identify researchable problems around the topic of interest. In chapter 3 a research problem has to be identified a research question, sub- questions, and hypotheses defined. The selection of each of these elements that will guide the research towards answers has to be done on a feasibility basis. There are many problems, issues, and related questions that would be very interesting to follow, but many are too difficult, too time-consuming, and too complex to be completed

within the allowable resource requirements for this thesis. Consequently, chapter 3 will evaluate the issues and problems raised and identified in this chapter 2, and then defined a research methodology that can be followed in order to make a useful contribution to knowledge.

# **Chapter 3**

## **Methodology**

### **2.0 INTRODUCTION**

Chapter 2 has reviewed a set of relevant literature selected from the electronic databases. This literature review was focused around the topic of capability maturity and business systems, to define a context for study. The aim of this thesis is to investigate the usefulness or otherwise of the capability maturity tool CMMI in a work systems situation. Chapter 2 has left a set of issues and problems that are relevant to research. In chapter 3 one problem must be selected and then operationalised to collect data. Consequently, in this chapter a research question is derived, and a research methodology is defined so that answers may be found to the research question, and also a better understanding of the research problem developed.

Chapter 3 is structured to first review three relevant studies that will assist in defining a workable methodology for this research. In section 2 the guidance taken from the review of similar studies is used to select the researchable problem, a relevant research approach, and make a forecast of what the result can be for doing research in this way. In section 3 the research design is elaborated by specifying the research question, the research sub-questions, a working hypothesis, and a research plan. The research plan also includes a data map that maps the research question onto its sub question and data collection plan. In section 4 the data requirements for this research are specified. Section 5 discusses the limitations of adopting a qualitative research approach and concerns that may be raised about transferring these results elsewhere. The hope is that the learning from this research can be transferred from the context of study and industry experiments. The case study qualitative approach will allow others to read this work, something similar to a novel or an interesting story, and then they can think about their own context and bring about innovation and quality improvement using the CMMI assessment tool.

### **3.1 SIMILAR STUDY REVIEWS**

The purpose of reviewing research publications that are similar in nature to the proposed area of study is to learn from previous research how to do the work. The focus of reviewing the

following three papers is to look at the research methodology and to identify approaches, techniques, decisions that the researchers made, and the sorts of results that they found. From this analysis I will then be able to critically reflect and decide upon the approach and strategy to use in order to achieve my objective of evaluating CMMI in a work situation.

### **3.1.1 Luo, Wang, Zhou (2008)**

This paper provides a foundational overview of the CMMI approach to quality improvement and also how to improve project processes by applying the tool. It provides guidance on the complexity of setting up the implementation of the tool in organisations. The reader is alerted to the requirement of five process performance models: the lifecycle model, the quality model, the resource model, the measurement model, and the control model. These models are required in order to estimate, predict, monitor and control a work system, and consequently move the capability improvement toward an optimised state. Importantly, the authors describe in detail the resource model. One of my key concerns on undertaking this research is to understand optimisation of resources in the work system. My hope is that the CMMI tool will provide the ability to optimise resources. They elaborate the cost model in relation to the resource model and emphasise the necessity to estimate, analyse, and predictable process performances in relation to assessing the potential return on investment for each of the process activities. The resources model can assist in improving the consumption and better distributing resources for each activity. They also state that the effectiveness of any resource model is heavily dependent upon the quality of data.

The paper is largely a theoretical work that not only defines and clarifies terminology, but also contributes algorithms and step-by-step guides as to how to implement each of the aspects of CMMI. For each of the five life cycles the implementation algorithms are provided, and guidance is given on generating system test use cases. This information can be useful to me when setting up a proposal to improve the capability of decision-making processes, and resource allocation processes for the CRM at the core of the work system to be studied. It is also helpful to be able divide the CMMI application into the various life cycles. These lifecycles not only interact but each provides a unique contribution to for example, resource management. The continued emphasis on the relationship among them are described for the efficiency and accuracy of collecting data, and the consistency of information and data. These matters concerning the importance of data quality and hence, in an experimental work,

attention is to be paid to how the data is to be collected and which processing techniques are selected to deliver the required information.

### **3.1.2 Lal (2017) Control Framework Implementation**

Lal (2017) researched the implementation of COBIT 5 into a business environment that had already adopted ITIL as the control framework for the retail company. The research question concerned what Value COBIT 5 could add to ITIL business practices. The relevance of this study to the proposed research is that the element of COBIT 5 that Lal (2017) chose to study was the COBIT 5 capability maturity tool five-point scale. ISACA now owns CMMI and the two capability maturity concepts, and tool usages are to converge in the near future. The study was also industry based where the researcher was attempting to transfer the theoretical knowledge into practice. Hence this study can contribute learning towards understanding the ways of doing this type of research in business situations.

Lal (2017) focused his attention onto three IT processes that were performed by people every day in the retail sector. The aim was to understand each process for the logical steps, interview the people doing it, show them the capability maturity tool, let them self-assess on their IT business process, and then let them make recommendations as to how the capability of their daily practice could be improved. This is similar in terms of what I intend to do but I do not intend to interview people but rather observe the work system documentation and records of business practice, and then apply the CMMI tool for error correction. In my case the ideal would be to document and analyse three processes but in terms of feasibility these processes may be excessively resource consuming, and the number may have to be reduced.

Lal (2017) chose a qualitative case study approach because the phenomenon of interest cannot be studied outside of its natural setting. This meant that the actions of the IT services operators were unique in characteristic and required particular attention to understand the complexities of situation that have a bearing on the performance of the business process steps. Secondly, the main study focus was on real-time events and involved studying a contemporary phenomenon in the organisation and in real time. Thirdly, an overarching determining factor was that it is extremely difficult to control variables in such a circumstance. All businesses have many moderating variables making it challenging to set up effective variable control. The observing of human behaviour around a business practice

is a complex task in a complex setting, indicating that there may be too many variables for a singular study to deliver useful process improvement information. Consequently, Lal (2017) convincingly argued for adopting qualitative measures and a qualitative approach to doing such research.

The implications of the study are far-reaching for what I propose. Although Lal (2017) is considering the human factors associated with three IT services processes, the context and setting for what I propose to do was similar. The focus of my intended research is a CRM work system software and the related work processes. My motivation is similar to that of Lal (2017) who was equally concerned about improving business processes so that the productivity of the work system would be greater. The angle he took was to accept that capability improvement equates to more acceptable work system outcomes. He was also interested in transferring learning into the workplace that would be valuable for the workplace.

### **3.1.3 Pane and Sarno (2015)**

This paper illustrates an application of the CMMI tool for the quality improvement of object-oriented analysis and design. The purpose of CMMI is to improve processes that create a product or service within an organisation and therefore improve the customer experience. The study started by constructing checklist criteria in relation to process areas as defined by the CMMI. Each criterion was given a score and then the scores were summarised into a total that represented the completion of the UML diagrams. Object-oriented design requires compliance with the three steps of analysis (identify, illustrate, specify) and then three steps of design (arrange, build, proceed). The CMMI framework may be applied for development, acquisition, or services, and each has different content that targets improvements in the specific areas. In this case they selected the development application that outlines the ways to improve processes in order to develop the products and services. The starting point has been summarised in section 2.4.3 where the specific goals, and generic goals are specified in relation to the area for improvement.

For my research the way these people have gone about their methodology is important. In the first instance the industrial area of software development is broken down into its domains and then a decision is made regarding development, acquisition, and services; in terms of utilising the CMMI goals as metrics to measure the capability levels and also

progress towards improvement. They have also broken the work system down into its logical and required object oriented life cycles. In the situation I intend to look at the CRM software also has predetermined work cycles that come with the software and are also customised by the end-users. These researchers developed a scoring system based on intervals from 1 to 10, where the least score indicates nonfulfillment of the criteria on the checklist and the highest score fulfilment of the criteria on the checklist. They then go on to develop more complex metric system which will optimise performance and the process area and also reduce the cost of failure by not passing defects to the next stage in the software development process.

## **3.2 RESEARCH GUIDANCE**

The review of previous studies shows that attention has to be paid the nature of the CMMI tool, the selection of processes, qualitative methods, the use of checklists and other provided guidelines in order to make the tool work and quality process improvement proceed. In this section the learning from other researchers is used to shape an appropriate methodology for the proposed action type research. In addition, the problems and issues identified in chapter 2 are brought forward in order to select one problem that can be adequately research within the time and resources constraints.

### **3.2.1 Research Problem**

In chapter 2 a number of problems and issues were identified in section 2.5. Some of those problems have been identified from the bigger contexts of organisations in transition to enterprise systems. The related problems included managerial control, information systems and processes, managerial concerns regarding optimisation, the excessive number of guidelines for best practice, resource management, strategies, CRM systems and related quality improvement problems. Many of these problems are relevant to the context of the proposed study but are either too large or too difficult to be effectively investigated with the resources and time available for this study. However, some of the underlying concerns regarding optimal use of scarce resources and measuring costs associated with business processes, present feasible targets for research.

In entering a business context there are many different variables that may be measured but some of them require less conditioning or less structuring before the value can be gained. For example, measuring Information Systems is a very complex task that has been well

documented in many studies and published literature. Whereas measuring costs is a simple metric framework and the data is usually more accessible. Consequently, in order to focus a study that will achieve the objectives of this research it is proposed that the resources that are concerned by different business processes are targeted, and a cost framework developed for measuring the resource consumption of processes. Further refinement will also be required that may include reducing the number of processes studied to a manageable amount. Thus, the problem that is feasible for study, from those presented in chapter 2.5, is resource management.

### **3.2.2 Analysis of Studies**

The three studies presented in section 2.1 were selected for the teaching points they make, they can be helpful for implementing a research methodology. Lou et al. (2008), has valuable information regarding the setup details for data collection. They also identified five underlying lifecycles with process steps and the model for each. In particular the resource model and the related cost model provide a valuable structural information for knowing what to look for, and how to apply the CMMI tool to particular processes. They also demonstrate system test cases and how to control data quality while using the CMMI tool. Lal (2017) reports research that is very close to the context that I wish to be involved. He applies the CMMI tool in an industry context with the express purpose of bringing about quality improvement. The way he went about doing this research is important. The first instance he chose a qualitative case study approach in order to manage the variables within the business situation and also to create the type of knowledge he wanted. Principally the research was aimed at transferring abstract theoretical knowledge about the CMMI framework into practice. To do this he narrowed his research field onto three IT service processes. He then worked with the human factors to first understand the process, then define it in their terms, and gave guidance for them to use the CMMI tool for quality improvement on the particular process. The context and the description of how the research processes were achieved is helpful to what I propose to do.

The third research paper reviewed by Pane and Sarno (2015) itemised in great detail the application of the CMMI tool in the software development context. It was a very detailed and highly structured report of OO software development and process improvement. The useful learning from this study was first of all the utilisation of checklists to assure that each

metric for each classification within the CMMI tool was recorded and then put through for data analysis. Also, the researchers divided the work system into parts so that they could focus effectively on specific elements within the work system and the related processes. In this way the CMMI tool was able to be used effectively on singular processes and then on to groups of processes. The outcome of the research showed that the CMMI tool was able to systematically bring quality improvement to the processes and software development.

### **3.2.3 Research Approach**

In the research reports reviewed in section 2.1, each chose to use a qualitative case study approach to the implementation and use of the CMMI tool. The approach was considered to be more advantageous because the effect of what was intended could be achieved. The complexity of a multitude of variables and interaction within a work place was considered to be too much for a quantitative study. Consequently, the full scope of the CMMI framework was utilised to achieve sufficient focus that useful data could be found and used for quality improvement (see figure 2.4 for the overall architecture).

Quantitative studies usually start from an abstract framework of concepts, theories and assumptions, and then abstract back into this framework to rationalise the data and to report the findings (Collins and Hussey, 2009). The aim of my study is to transfer the theoretical guidelines provided by the CMMI framework into a work system and practice. A quantitative study could be used for this purpose, but it would require a very large number of cases to be sampled in order to make the results useful (Halinen, 2005; Erickson et al., 2008). Also, a significant resource would be required to translate the quantitative results into useful guidance for practice. A significant risk would also be taken with quantitative results that the information provided for action may be too selective or too abstract to bring about the intended effects. The type of change, the type of influence, and implications for practice require full assessment in relation to the research approach selected, and the type of knowledge the preferred approach will deliver.

A qualitative approach that has been used by others to implement the CMMI framework and to use the CMMI tool in action is the best way for this research to proceed. In the first instance the three studies reviewed provide guidance in the different areas of risk that are involved with doing an action based research project in a real work system (DeMarco and Lister, 1997; Erichson et al., 2008). Case studies are widely used in Information Systems

research because they can provide an example of a very complex instance of action that is useful for the understanding of the information system and the related processes. Case studies are generally exploratory in nature and they give a snapshot of action in relation to the multitude of variables that are involved in the information system. Learning may be gained for the making and the maintenance of better Information Systems from this type of case study work (Yin, 2003; Simones, 2009; Hancock and Algozzine, 2006). The insights provided into specific instances, events and situations are critical in understanding the bigger picture of the impact of the software or software system. The implementation of a CMMI framework in the utilisation of the tool to enhance decision-making processes is an Information Systems study.

One of the biggest problems in a case study approach is the amount of data that a researcher needs to collect and process (Halinen and Tornroos, 2005). It is critical that a researcher focus in on a specific instance and limits the context to a manageable dataset for reporting. In this way case study is selective and the quality of description will limit the ability to transfer the learning to other contexts. The practical situation intended for this research is a very large software development enterprise that has a large number of systems in place to manage information, and people. The researcher must make clear judgements as to the specific instances that will provide information regarding the usefulness or otherwise of the CMMI process improvement implementation.

#### **3.2.4 Expected Outcome**

The expected outcome from this research is the transfer of knowledge from theory into practice. In addition, all of the processes of the research will be documented so that other people can follow the processes and also learn by reading a case study. My hope is that these things may provide motivation for other people to take the CMMI tool and experiment with it, and use it in practice with the intention of improving capability (Saeed et al., 2017).

Because this is an industry based project is expected that the theoretical learning taken from the CMMI literature will progressively move through phases for the implementation. Each of these phases can be recorded and reported so that others may learn from this study and have a guiding map for investigation (Bailey, 2007). Also, it is expected that when the system process is changed to improve its capability then the overall work system will have an improved productivity. The target company has a very large CRM system as its backbone.

Consequently, doing research on a limited number of processes in detail should provide the workplace with information for quality improvement of other CRM processes.

### **3.3 RESEARCH DESIGN**

The previous two sections have provided contexts and structure in which to guide this research. There is now sufficient focus from which research questions can be derived and a research plan developed. In the following subsections the research question, the research sub-questions, the research hypothesis and a research plan are given.

#### **3.3.1 The Research Question**

The research problem that was selected by feasibility analysis in section 2.2.1 suggested that the resources consumed by different business processes are a target for quality improvement, and that the related cost issues in relation to process resource consumption are a significant problem worthy of solutions. Consequently, the relevant research question is:

What resource optimisation value has CMMI for IT services delivery?

#### **3.3.2 Sub-questions and Hypothesis**

With every research question there are also relevant sub questions that will help to investigate the context and relationships more closely. The relevant sub questions are:

How are IT services measured?

What are the critical system attributes for measurement?

What are the measurements used for?

How are defects disclosed by CMMI assessment?

The working hypothesis is:

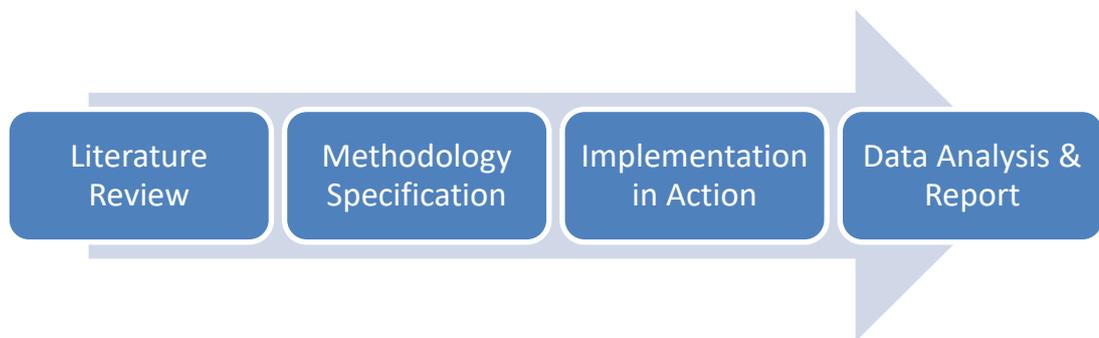
CMMI gives quality improvement opportunities for IT services.

### 3.3.3 Research environment

The main data source will be sampled from the framework we used, which is called SERVICENOW®. It is the IT process and CRM management system used in my company. We use it for incident tracking, process monitoring and change management. It is set up according to our ITIL regulations. We are mainly analysing the data from its incident tracking system module, change management module and resource management module. Of the reports we are gathering. The process time, the resource used, and business unit involved will all be our valuable data source as the baseline of our research analysis.

### 3.3.3 Research Plan

The sequential model for the research plan is to take the CMMI tool as it is defined in the literature and then to implement it in an industry situation. The research sequence is defined in figure 3.1. The emphasis of the plan is largely upon the action. In order to identify a clear target for the action, then considerable analysis of the literature and critical reflection upon the practical work systems situation has to be made prior. The research plan allows for these steps and also accounts for both the researcher prior knowledge and the intended outcomes of the research project.



**Figure 3.1 Research Plan**

### 3.3.4 Reliability Measures

In qualitative studies triangulation is usually used as the benchmark for validity (Collins and Hussey, 2009; Pane and Sarno, 2015). Internal consistency is established by compliance with the data collection methods for reliability. Also, techniques are used within the data such as repetition to assure that the reported facts have strong evidential grounding for reliability claims. Triangulation is, where more than one methods are used to collect data, and then the data is mapped against the other types for reliability purposes (Kaur, 2014). Depending on

the type of study, consistency can be looked for across the data types or in other studies differences have to be established for reliability purposes (Erickson and Kovalainen, 2008; Bailey, 2007). In this proposed study three different methods for data collection are to be used in order to gain different data types. Triangulation and repetition will be the principal reliability measures.

### **3.4 DATA REQUIREMENTS**

The data requirements for case study can be widely varied (Yin, 2003). In the proposed research context, a number of data sources will have to be overlooked because of the cost and complexity of accessing. For example, the CRM is the backbone of the information system. It includes a multiplicity of Information Systems data sources and potential ways for data collection (Halinen and Tornroos, 2005). However, the focus of this study is to be on the resource consumption of the process or processes and not upon other elements that are within the CRM information system. Consequently, there is no need to interview or involve people when the data on costs and resource consumption can be gained from documents. In the following subsections the specifications for data collection, data processing, and data analysis are presented.

#### **3.4.1 Data Collection**

The agreement with the industry workplace is that no specific details will be disclosed of the workplace or indicators given of how to identify the workplace. As a general description this is a very large franchise chain that operates globally and has one location in New Zealand with approximately 95 employees. It generally deals in information services that are made available across a multiple of industry sectors and can be described as a modern-day enterprise system. The backbone of this enterprise system is a very large CRM implementation. The implementation spans the entire business so that customer requirements are the input and customer deliverables are the output. The intermediary processes that produce value for the customer are principally information driven and are dependent upon the software developers in the business to produce timely, efficient, and effective software to satisfy the customer requirements.

Three principal data sources will be available for collection. These are Observation of the CRM system processes, Documents of the CRM system processes, and Critical

reflection by the researcher as the research proceeds. The observations that may be made will be of exceptions and problems that the system itself throws up. For example, rework may be required on account of poor communication of requirements, the alteration of customer expectations, or a number of other causal factors. Data may be collected on these by the documentary records that are kept of all exceptions. The researcher has to read the documentation and to transfer into diary form relevant examples and incidences that reflect a description of the CRM and daily work actions.

The largest source of data collect will be the documentary evidence that is archived on the CRM, its systems and processes, the implementation, the architecture and design, and other matters that are relevant to the specific workplace. This data is to be collected in the form of documents but because of the anticipated large volume of data, then documents will be selected only in relation to the overview of the system and of the specific process or processes that are to be studied in detail. Important images and data sets will be anonymised and then imported into the data collected for analysis.

Because the researcher is an employee in the enterprise system and immersed in the software development teams, the researcher becomes part of the research (Bailey, 2007). Consequently, the researcher thinking about the processes being observed and documented becomes an important element of the data collected. The type of thinking being employed will be reflective, comparative, and deductive. In this way the research is not neutral but is acting as a learning agency within the research framework. The researcher will therefore maintain a diary in which critical reflections will be recorded as the research progresses. This will be a valuable repository of information that can be later triangulated with data from the other data methods and will act as an integrating component for the internal consistency of the data. Inevitably critical reflection introduces bias into the research that is declared. Such a bias can be a positive or negative impact on the descriptions provided from the case studies. However, in this case the researcher's intimate knowledge of the systems and the functionality of the CRM allows a greater depth of exploration of the data and the later analysis of data in far greater depth.

### **3.4.2 Data Processing**

The data is to be collected in different formats. The observation data is to be recorded in an electronic notebook so that it can be searched later by keyword. The documents are to be

collected by photographing them with an iPhone and archiving them so that they can be searched and sorted and imported into Nvivo as required. The images are to be dated and named in accordance with the accessed date and the type of image being stored. These two keys will allow search access by the electronic search engine for retrieval, grouping and comparisons. The type of documents will be at systems level for systems architecture, and process level to understand each of the relevant processes in the CRM system.

In terms of critical reflection, the thinking is to be captured into an electronic diary that is divided into columns of date, idea, and action. In this way the diary will track a continuous time-based flow of thought and its implications for action. The data is to be keyed by problem, solution, application, and affect; so that it may be rapidly searched by the electronic search engine. In this way data processing can be automated and controlled by the researcher. The important and critical information can be brought back under topics, keys, and in relation to the research questions being asked. CMMI evaluation of the processes will also be recorded in the three types of documentation.

### **3.4.3 Data Analysis**

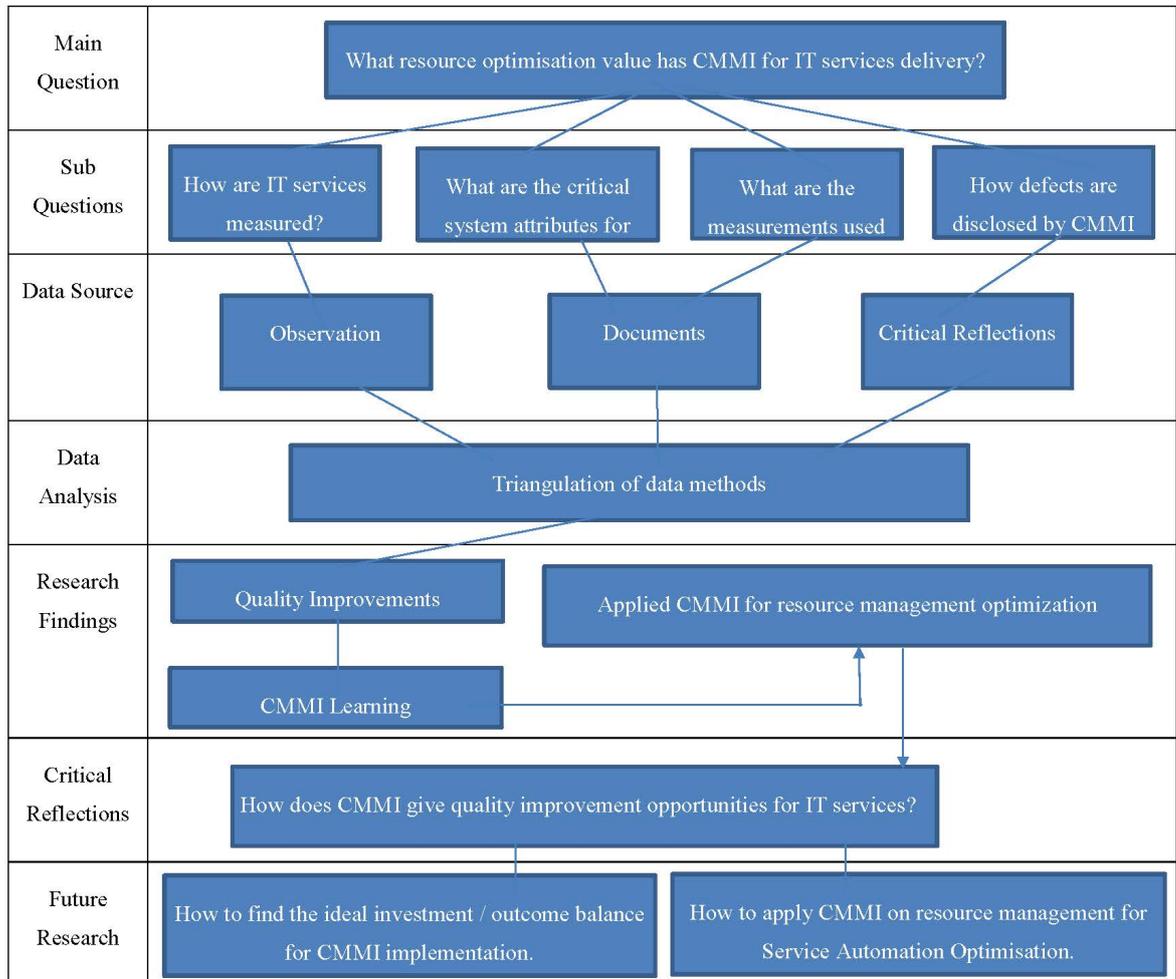
The data analysis will be undertaken by triangulating the different data types and using the template guidelines provided by the CMMI process guides to report the potential process improvement. The CMMI process guides consider the measurement of the specific (SG) and the general (GG) goals, and each of the specific practices by goal. In this way the current, the changed, and the improved practices may be reported (Luo et al., 2008; CTU, 2017; Ignaacio et al., 2017). In some instances, the higher architectural level documentation will simply be reported by description, but the descriptions will include relational analysis with regard to the operational units. In addition, incident reporting for example will be treated as exceptional analysis that will give insight on the functionality of the CRM system and potential process improvements that may be made.

Doing analysis in this fashion looks for patterns in the data (Yin, 2003). These patterns are similar to what a software tester looks for when doing software testing work. The system functionality is the result of many processes interacting. The specific target process for this research will be change management (Lahtela et al., 2010; Pane and Sarno, 2015). Change management is an overarching process that impacts many sub processes. The study of the change management process will hence provide results regarding process improvement

that may be generalised to other sub processes, and possibly other higher-level processes. The data analysis on one process is consequently related to others.

### 3.4.4 Data Map

The data map in figure 3.2 draws together all the data requirements elaborated in this section 2.



**Figure 3.2 Data Map**

### 3.5 LIMITATIONS

The choice of a qualitative approach necessarily limits the extent to which these results may be transferred to other contexts. In the immediate context the findings from the two processes are proposed to be observed, documented, and subjected to critical reflection, should be transferable to other processes in the CRM information system. The assumption here is that

there is sufficient similarity between the resource requirements of one process and another. This may not hold true for all processes but there is a commonality provided by the CRM backbone within this industrial setting. The triangulation of different data methods within the CRM contexts should provide sufficient reliability that the findings between one process and the other can be transferable.

The other issue is the validity of these results when they are transferred into different contexts and beyond the immediate CRM and industry site of study. The best match would be between a similar CRM system, that has had a similar implementation. However, it could be expected that there will be variations on account of choices made in the implementation and also the context of work. Hence, the case study approach places limitations upon the transfer of these results into other contexts. The hope is that people will read these findings and it will stimulate their imagination when they think about their own system and their own practices. In this way some of the limitations will be overcome in terms of the transfer of knowledge but it cannot be assumed that the results in the study will easily transfer elsewhere.

### **3.6 CONCLUSION**

Chapter 3 has taken the research problems and issues defined in chapter 2 and selected by feasibility a researchable problem and then derived a relevant question and sub questions for research. A full methodology has then been elaborated that may be applied within the proposed work situation to achieve the aims of the research. The aim of the research is to transfer the theoretical knowledge of the CMMI quality improvement tool into the workplace. Consequently, a qualitative research methodology has been chosen and specified. In chapter 4 the results of implementing this methodology will be reported.

# Chapter 4

## Research Findings

### 4.0 INTRODUCTION

In a software engineering environment, there are so many projects and roles that demand management involvement, so that different projects and roles can be taken care of, and people from different teams can iterate freely and effectively, to keep the business running and the productivity evolving. The research is based on a CRM software development framework in my working environment. We use a CRM system called “ServiceNow®”, with an ITIL management framework applied. The CRM is pre-defined and customised accordingly to cope our development life cycle and IT service delivery needs. The main purpose involves relationship management, project management, incident tracking, service management, support management, service operations and change management. In chapter 3 the research methodology was defined. In chapter 4 the research work has been done and it is reported. For simplicity the company is going to be called a fictitious name, EFX. Otherwise the results are reported as specified in chapter 3 in terms of variations, documentation, observation of CRM processes, and critical reflection.

This chapter will explain how the framework works, which roles are involved, which relationships are managed in the framework, where are processes and activities being composed, what resources do we have and need to manage to improve productivities, how to measure the IT service delivery, what are the measures used for, and how are process management defects disclosed by CMMI assessment. In section 4.1 the system documentation is reviewed and reported. In section 4.2 the actual CRM is documented to reflect the customised implementation. In section 4.3 the processes are observed, and in section 4.4 the activities are observed and reported. Importantly in section 4.5 the resource management issues are reported. In section 4.6 I then critically reflect on the problems and issues and experiences encountered in the research. In section 4.7 the templates are extracted from the CMMI method, then applied to the CRM change management process and optimisation calculations made.

## **4.1 ABOUT SERVICENOW®**

ServiceNow® is a CRM framework that many IT companies choose to adopt in facing the challenges of managing a complex business. There are 2 main modules which are customised and maintained in EFX to help the tracking of software development and the IT service delivery management. To handle the challenges from the common issues in the IT industry, ServiceNow® helps us to track, monitor, and report on the status of EFX's projects of software developing and IT service delivery. The CRM framework allows management control of the processes and activities that are required for software development.

ServiceNow® has many modules that can be plugged in freely. Its incident management, change management and resource management module are main modules that EFX has adopted. It is used to control the processes, as well as to monitor the resource allocation. The following subsections review the different critical elements in the system.

### **4.1.1 The EFX's Challenges**

Modern IT companies suffer frequently from service interruption, resource misallocation, project pressure, and many other issues in software development and service delivery. These negative issues always lead to income loss, reputation damage and unsatisfied customers. All of these negative things are critical points of failure and EFX has to deal with effectively, on a daily basis. To reduce and avoid the negative impacts from the IT service issues, EFX has strategy that works on staffing, processes, the technology and information system, and a fault recovery strategy to help restore the order to the usual operational levels as soon as it can when problems occur.

EFX cannot function in such an environment with tribal knowledge and informal systems. They require stability of the business operations and accurate service information. The information must provide certainty of an incident impact, who is handling the issue, where is it at on a fixed time base, what is the cause of it, how to implement a sensible plan to resolve the problem, how to apply correction to the program, self-service support provisions, evaluate capability, and feedback of the outcome for further learning. The IT service processing approach in EFX is proactive and user's business enablers rather than reactive ad-hoc style to eliminate the impact from the incidents to the business operation. IT has access to consolidated information about the service in one unified system with records to better leverage workflow and automation to speed resolution. This is a case based system

where organisational knowledge of incidences is built up over periods of time. Also, human resource configuration is the biggest part of EFX's IT project budgeted cost, which gets more focus and effort than IT infrastructure management. The Management team does not get enough accurate real-time vision of capacity, making it hard to manage the resource within their capacity. Lack of visibility leads to poor allocation of resource, inaccurate budgeting and resource underutilisation.

Inside of the general core IT infrastructure, the reliability and connected usability of the information is required for reliable resource management. It is shown that traditional manual processing and Excel spreadsheet reports is not sufficient for real time monitoring and quick effortless turnarounds. EFX's resource management demands has accurate and updated resource usability reports based on continuous consolidation. The ServiceNow® provides the overall CRM services that have been customised. As the workload becomes bigger and bigger and issues occur more frequently, in varied areas, including operations (incident, problem, challenge, which are managed in Incident Management Module) and planning (project planning, feature enhancements, bug fixes); then the usefulness of the system has been proven.

#### **4.1.2 Design – The ServiceNow® Customisation**

In EFX, ServiceNow® Incident Management module is used to simplify the process of restoring flawed or unplanned disrupted IT services. It allows the IT department to capture and categorise incidents through self-service channels, e.g. chat systems, email systems, phone logs and uplink events. Event based prioritisation ensures the same standard of IT service delivery levels, and passes on to the IT solution teams compulsory information fulfilment reports. A feature of On-call Scheduling can escalate the incident to the specialist 'support teams' and 'assignment groups' with triggers automation and bidirectional notifications, so the assignment will be acknowledged, and customer is updated. A chatting feature can be used where there are needs of collaboration, which will also be logged automatically.

ServiceNow® IT service automation suite (EFX, 2017) contains many tools that are used by EFX for investigation, triage and incident resolving. Self-service can also help the user and technician to search and fix the known issues in the knowledgebase, feedback to the work tracking tickets and make contribute to the existing or new work articles. For further

incident management, ServiceNow® Configuration Management Database has a feature of business service management mapping, which provides graphical views of complex IT infrastructure and service relationships to help technicians see the business impact of the incidents, problems, service requests and change requests. ServiceNow® Orchestration is in general used to resolve the visibility of an incident in resolution, and to provide more efficiency for service restoration. Continuous improvement, so called re-engineering of IT service delivery. ServiceNow® incident management module tracks, monitors and real time reports each status of the incident lifecycle with the feedback recorded. The management board has the full visibility, through the built-in indicators, report and odometers to monitor the individual requirements. ServiceNow® performance analysis also provides in-depth intelligence for decision-making and control.

Resource management and project management control in ServiceNow®, is for managers who directly configure the resource to create resource utilisation schema. Also for requesting project member's configuration and assignment of particular tasks to the human resource it plans for. The application also provides an accurate real time IT resource capacity view. Integrated with ServiceNow® the service automation suite, provides the ability to unify the human resources, assign the tasks to all the possible work force that has the capacity, and to optimise resource distribution based on subjective judgements. This includes applications that used for operation and project tasks as well as construct customised application on top of the ServiceNow® service automation suite.

#### **4.1.3 Architecture – The Fitting**

The overarching management framework for the CRM is ITIL. The most critical key success factor is to track the status of the current processes. ServiceNow® is there to help with the visualised status monitoring where changes are frequent in EFX's development environment. The ITIL framework provides continuous improvement through its developmental cycles and also a customer centric focus. ServiceNow® is used for delivering the service and to identify the impact of the affected services and potential causes with pre-defined service management maps, and solutions in the knowledge base templates. When there are problems then the Orchestration feature is used to automate common resolutions.

For baseline statistics about the status of the incidents, human resources, processes, ServiceNow® is used to create operational insight and provide informed decision-making

basics with detailed metrics and survey feedback presented through configurable reports and dashboards. In EFX the views of resource availability are used to report from ServiceNow the resource requests so that managers get the accurate picture of availability from the available information across all resources necessary to accomplish any tasks being managed. This usually enables more accurate resource allocation and solution of resource requests, in most of the cases. But many of the decisions are made on subjective criteria and the logging and reporting functions reflect this. Due to the limitation of the size of EFX development team, the resource control is in several locations and needs to be in one single resource management system for all IT work. ServiceNow® tends to provide such a resource management system to handle all the resource management reports and allocations. It is expected that ServiceNow® provides consistent resource management to every operational and project-related IT task and all relevant applications, for integration of resource management and task-related information views and actions. The actual implementation and observation of daily functionality indicates that these key points require consolidation so that there is greater resource control.

EFX relies on ServiceNow® for resource matching with requirements. Precise alignment of resources with requests via calendars, schedules, and flexible allocation options, tends to avoid repeated over-allocation of resources for operational tasks to maintain a level of capacity. Consequently, the capability to provide adequate resource monitoring and control is available, but the actual implementation on a daily basis requires process quality improvement.

#### **4.1.4 Structure – Inside ServiceNow®**

The structure of the ServiceNow® framework, that I am going to take for a use case, relies upon a change ticket procedure. I will elaborate from observations how this is formed and how the process flow works inside its lifecycle. Figure 4.1 shows the screenshot of a change ticket that provides the input to the CRM for the workflow management processes to act on. This input initiates a whole chain of decision-making, information generation, and distribution of work to teams who when authorised will act upon it.

Change Request - CHG57237

Save to Draft Submit for Approval

Draft Change Management Assessment Pending Initial Approval Pending Business Approval Pending CAB Approval Scheduled for Implem

Change Number: CHG57237 Status: Draft

\* Assignment Group: [ ] \* Type: Normal

\* Lead Implementer: [ ]

Requested by: [ ]

Location: [ ]

If you wish to discuss the available Impacted Services, please contact Nicholas Fletcher or Change Management.

\* Category: -- None --

\* Sub-Category: -- None --

\* Reason: -- None --

\* Will this change break DRP?: -- None --

Watch list: [ ] [ ]

Vendor Reference #: [ ]

\* Impacted Services: [ ]

\* Outage: -- None --

DC Access Reqd?: [ ]

Configuration item: [ ]

\* Short description: [ ]

\* Description: [ ]

\* Impact Statement: [ ]

Change Resubmitted: [ ]

Risk and Impact Assessment\* SOX Impact\* Schedule\* Implementation\* Testing\* Work Notes

Risk Assessment

\* Ease of Implementation: -- None --

\* Level of Complexity: -- None --

\* Difficulty of Rollback: -- None --

\* Risk: -- None --

Impact Assessment

\* Number of Products/Services Impacted: -- None --

\* Customers Impacted: -- None --

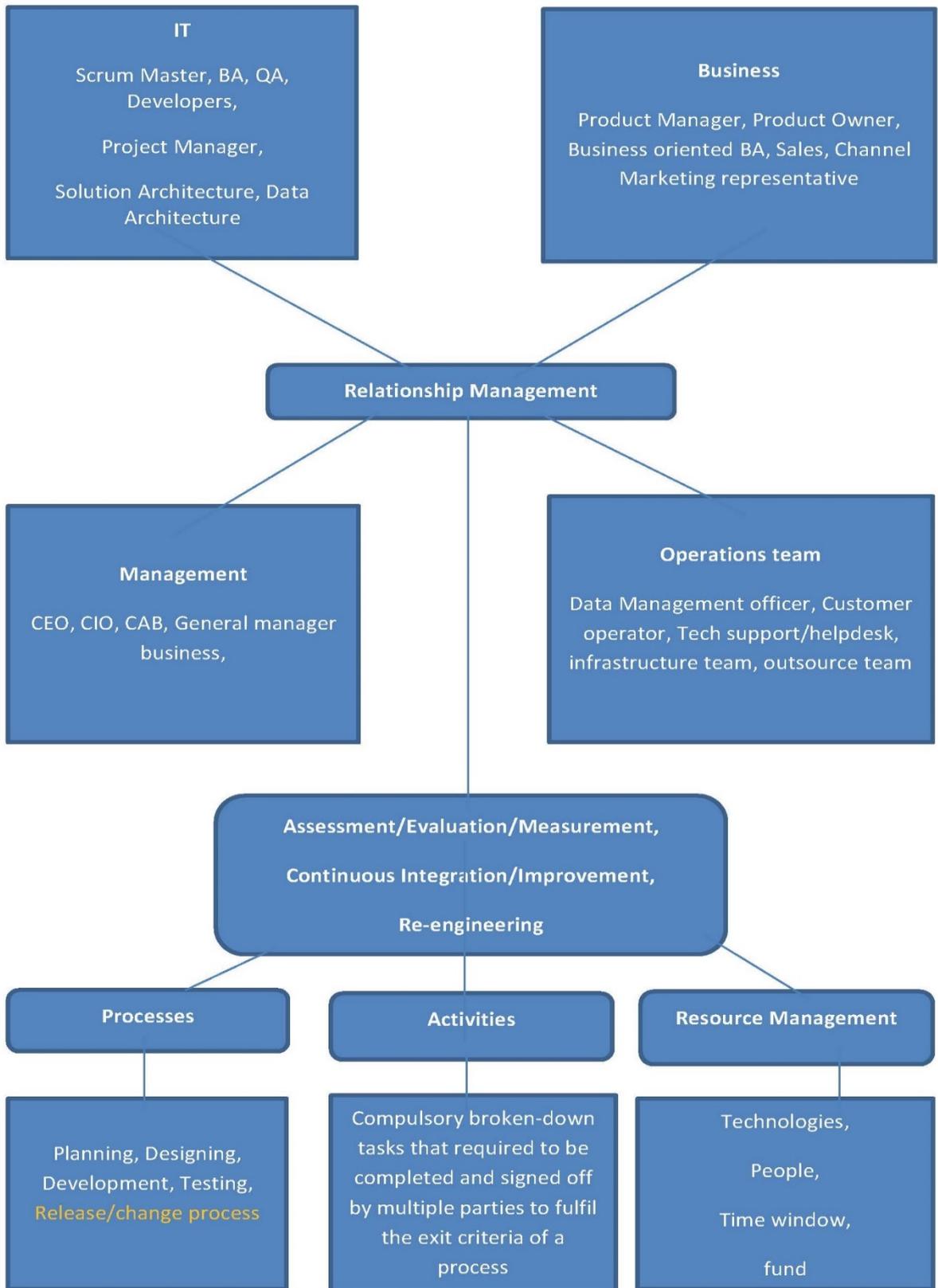
\* Outage Duration: -- None --

\* Impact: -- None --

Save to Draft Submit for Approval

**Figure 4.1 Captured EFX ServiceNow® change management interface**

As is shown in Figure 4.1 (Captured EFX ServiceNow® change management interface), a change ticket contains many components, including change number, assignment group, lead implementer, requested by, location, outage, DC access required, configuration item, status, type, category, sub-category, reason, will this change break DRP, watch list, vender reference number, short description, description, impact statement, change resubmitted, risk and impact assessment, SOX impact, schedule, implementation, work notes, approvers, affected CIs, change tasks, service requests, incident (related), incidents produced, problems (related), change requests, firewall rules and outages. All these are required for the definition of the particular change, and trace of the processes.



**Figure 4.2 Observed IT service framework at EFX**

The statuses include draft, change management assessment, pending initial approval, pending CAB approval, scheduled for implementation, post verification testing, rollback, PIR and closed. This describes the status of the change, where the change is at and what the next steps are. Any actions taken and completed are expected to be logged into the tickets, so the members of management and sometimes clients will have the vision of the change and knowing the nature of the change, the impact it will bring, what the prerequisites are for it to happen, who are the members of the change action, and whether the change is implemented into the production system. These concerns match the resource management requirements which are integrated in the same suite as another application.

## **4.2 SERVICENOW® IN EFX**

Figure 4.2 shows the actual layout of the CRM architecture in EFX. The following section will now discuss each of these elements. In EFX, most of the projects and incidents are handled by a CRM system called ServiceNow®. The ServiceNow® system integrates and manages the relationship between parties internally and externally. In addition, it also manages the steps of each project, the processes and tasks. It coordinates them through a series of designed processes and approvals until they flow to their final target, which is being released. The following subsections summarise the documentation and observations of the CRM.

### **4.2.1 The EFX IT Service Framework**

EFX has four physically isolated systems. They are Dev, QA, CTA, and Prod, all of which are identical in configuration and software system. The only variations are with the data set being different. The first three systems have mock data, which is different from the Prod system, which has customer live data. All the developing work is done on Dev servers with extraction of Prod as baselines and then promoted to QA servers for testing purpose. After compulsory tests are done, the modification will be synchronised to CTA servers for beta testing by the external and internal clients. While or after clients are being satisfied with the result, the modification is then released to Prod system, under the audible work flows of the change management with tracks and logs.

In the work system some change request criteria have, an incident raised and worked on towards the end of the developing work, completed the testing works in QA environment,

and in CTA environment with no obvious flaws found. A representable change with all the change details is listed in section 4.1.4, would have been raised as a change ticket with linkage to an original incident, a service request, a task, a problem, or sometimes a knowledgebase template, alongside the full description of the configuration. ServiceNow® provides the workspace through the whole process of the change, where multiple roles can work, log, approve, sign off their work, and know the exact status of the change with the possible impacts and issues. The ServiceNow® change management will also keep multiple roles from different team updated with comments notification, pre-configured email recipient groups, watch lists, and other features from service automation suites for change members to collaborate on moving the change along the work flows.

## **4.2.2 Relationship Management**

The relationship between different departments are critical to be managed throughout the development life cycle on each individual project and processes underneath. There are four departments of personnel who interact with each other during each process. They are IT team, the business team, the management team and the operations team.

### **4.2.2.1 IT team**

The team delivering the core developing function is the IT team. Our IT team briefly includes back-end and front-end developers, Project managers, Scrum masters, Business analysts, Quality Assurance engineers, Data architectures and solution architectures. Scrum masters own, monitor and facilitate the back logs while they go through each of the process. They often do their job by adjusting and re-organising the priorities of the processes and activities from the queue for each of the other functional team members, based on business strategy and resource allocation. Project managers liaise and leverage in the larger picture to ensure the balance of the projects and processes whether they are suitable for the deadlines of the planned or unplanned release. Since EFX is a financial information provider, the business is built on a massive dynamic data bureau. Therefore, another important key role in IT team is the data architect, who is responsible for data mapping, structure design and data mining. Last is the solution design, whose job is to fit business logic into software technical design in a macro way, evaluate the system design and estimate the impact and risks to our current system.

The roles in the team that are involved in the change management briefly include the following,

- Scrum Master, who is responsible to manage the scrum and backlogs.
- BA, is our business analysts, sometimes covers certain tasks off product owners.
- QA, is the testers who perform quality control and conduct testings and make reporting and signoff.
- Developers, are our coders who are responsible for code contributions and technical analysis plus triage.
- Project Manager, is who owns the projects.
- Solution Architecture, design the architecture of the system and programs.
- Data Architecture, designs the data warehouse structure including data mining.

#### **4.2.2.2 Business team**

The business team usually involves Product managers, product owners, business BA, sales and channel representatives. Product managers take overall responsibilities for all the products, in the aspects of orientation, requirements, functions and even style. The Product owner is to liaison between the business analyst (BA) and product managers to get the details of the business requirement confirmed and later to sign off the functions and tasks. The Business BA is mainly investigating and translate business strategy and business purposes into business requirements. The Sales and channel representative will perform promotions and presentations including demonstration and business consultation for the existing and potential customers. They keep the business revenue coming and they are highly reliant on the support from other teams, especially the IT team, for their tasks such as technical demonstration, presentation and of resolving customer's technical issues, and negotiating on the delivery of technical customisation.

The roles in the team that are involved in the change management briefly include the following:

- Product Manager, is who controls the products and has an oversight.
- Product Owner, is who owns one or more products and liaises with clients and makes user feature suggestions.

- Business oriented BA, is responsible to analyse and evaluate the features and functions from the business point of view and make according outcome.
- Sales, is the selling personnel, who sells the products or concept features to the clients, based on an agreed service level agreement.
- Channel Marketing representative, is the personnel who is responsible to supervise the channel or board of clients, determine the common needs and make feedback on both directions.

#### **4.2.2.3 Management team**

EFX is an international enterprise, with the local New Zealand division having its own management team, under joint management from NZ-AU pacific management board. I will be mainly discussing our local management team in New Zealand, which includes a CEO, a CIO, general business managers and the CAB (change advisory board). Local CEO in New Zealand acts as directing manager who will be responsible for all the business directions, including the market position and high-level products design. The CIO leads different IT teams and align the IT works with other business units. The General business manager will be responsible to provide the CEO the general business updates, and assign and execute the general business directions for all business units for alignment and improvements. The CAB is a board of senior managers, who evaluate and sign off the coming changes for releases, based on their impact, risks, black out period, blockage and other factors, such as emergency releases and change freezes. The roles in the team that are involved in the change management briefly include the following:

- CEO, The EFX's NZ local directing manager.
- CIO, local, regional and global managing director of IT.
- CAB, is the change advisory board, which delivers support to a change management team by approving requested changes and assisting in the assessment and prioritisation of changes.
- General Manager Business, is the directing manager who is responsible for the overall strategy of the product marketing, where feature requests often come from.

#### **4.2.2.4 Operations team**

A large amount of hardware and software framework maintenance and monitoring jobs of EFX operations is through an external outsourced company. They are responsible to provide infrastructure and support, dev-ops functions, change operations, system monitoring and DR configuration services, and so on. Apart from the outsource vendors, there are other technical operation roles, like our technical support, helpdesk, infrastructure team and customer support team. Technical support is our internal maintenance operators, who is responsible for daily maintenance and some other infrastructure tasks. Our internal helpdesk is located in Australia, who is responsible for our IT work environment incidents. They will respond to incidents and requests raised mainly by internal employees. Another important part of the team is the customer support and DMO (Data Management Officers) they are customer facing with tier one support. They are also the resource to find end user issues and requirements, then make feed back to the system as part of the iteration process. The roles in the team that are involved in the change management briefly include the following:

- Data Management officer, so called DMO is responsible for special data operations, as well as health monitoring the data by analysing the outputs.
- Customer operator, is our call centre, which take care of customer care for external customers and response to the customer requests.
- Tech support/helpdesk, is our internal support for general IT administration issues, very rarely dealing with external customer.
- Infrastructure team, is out IT hardware, OS and network experts.
- Outsource team is third-party vendor operators who are responsible for server maintenance, configuration, monitoring installations and implementations.

#### **4.2.2.5 The EFX relationship management**

The interaction in the change process between the roles can be complicated in EFX in practice, although a well-defined baseline relationship is rather clear and easy to follow. A perfect scenario example is started with the developer receiving go-green comments in the incident ticket by the QA, and the developer raises a change request from a link in the incident ticket page. Then the IT team together comment and fulfil the detail described in the previous sections in this chapter. It then gets the change management assessment, where CAB will

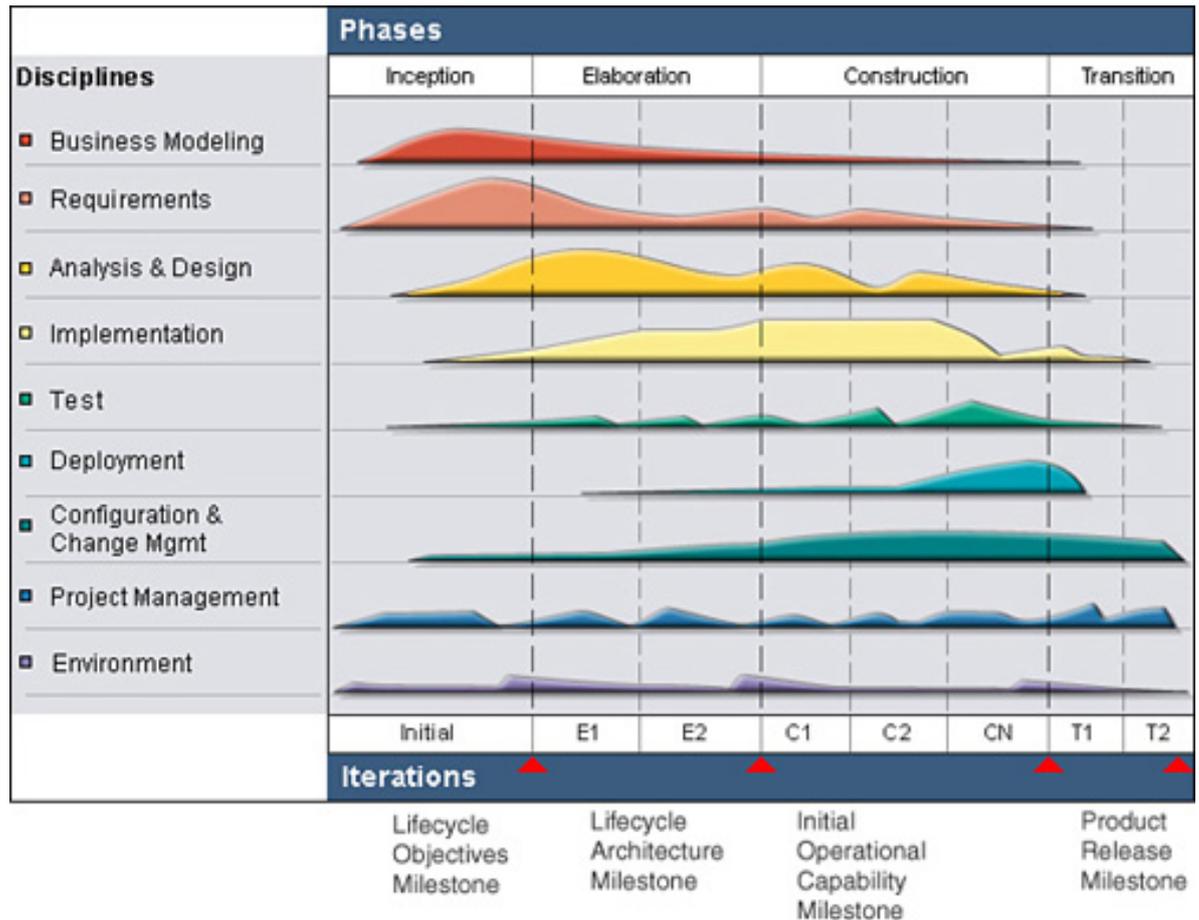
comment and fill the detail of their analysis, including impacts and estimations. Upon completion of the change management assessment. It is now submitted for initial approval by CAB, local change manager and the QA. The next step is for a business unit to approve the change, based on the technical and non-technical information about the modification. The whole business team may be required for signing off, sometimes including an invitation to external clients' business teams or IT teams. After all the approvals and sign-offs from the previous workflows, CAB should have sufficient information on making a decision to approve for the actual change to be booked for the operations team to do the actual implementation in the Prod environment. In EFX, this part of the operation team is outsourced to a third-party company, who is responsible for the operations, such as implementations and monitoring. They will confirm the schedule of implementation and prepare for the action on the designated day and time. After the operations team made the implementation, QA will visit the Prod environment for a function and sometimes a regression test. If it fails to meet the designed behaviour standard, the operations team will be informed to perform a roll back, which will restore the Prod environment back to the exact status before the implementation according to the implementation plan instruction that developers created. The QA comes back to check with a rollback Post Verification Testing. If the Post Verification testing passes, there will be a PIR meeting with all four teams, IT, business, management and operation, to wrap up the accident following a formal PIR procedure and leave a record for auditing purposes. At this point the implementation is successful, Operation and QA will approve it to close the change ticket.

#### **4.2.3 Measurement, Continuous Improvement, Re-engineering**

In such a complex framework with many processes and roles involved in the activities, there will always be a requirement for improvement, as all systems have flaws and points of failure. To continuously improve and evolve, it takes measurements, and analysis, ending with actions to improve. Repeating the cycle, it will keep the effectiveness of the system, which leads to a high productivity, and all the improvement is built into the software Development Lifecycle. In the life-cycle design, there are concepts for clarification that are required to identify the layer CMMI can be applied to have positive feedback in the framework.

### 4.2.3.1 SDLC in EFX

Software development is a complex activity and it is varied based on the many factors that depending on the nature of each individual customer requirement. I will briefly introduce and explain the concept of our workflow and will discuss the detail under the coming headings. There are a few different approaches EFX takes for software development. Part of the EFX projects follow RUP develop methodology, as shown in figure 4.3 (Observed development lifecycle at EFX).



**Figure 4.3 Observed development lifecycle at EFX**

(Reference: <http://www.informit.com/articles/article.aspx?p=1155863&seqNum=2>)

As commonly known, classic RUP software development lifecycle defines for phases in it: Inception, Elaboration, Construction and Transition. Each of the phases ends with their Major Milestones, meaning each phase is actually the period between the two Major Milestones. All the targets being fulfilled, is the validation for the phase to end, and projects to enter the next phase. Inception targets establish project boundaries of the system and establish a business case. To get the precise outcome, all the entities that interact with the system have

to be identified in the high-level interaction. The critical path also lies in the focus of the ongoing business and requirement risks along the whole project. There also comes the first important Major Milestone, *Lifecycle Objective*, which defines the very existence of the project itself. In our system, this phase is usually happening in a short time period, as most of our projects are based on a certain level of existing system.

The Elaboration phase is to analyse the problem areas and to establish the system architectural structure base, compose robust project plans, and eliminate high level risks. To achieve this, based on the understanding of the whole system, decisions are required to be made, including scope, primary functions and other non-functional requirements, such as the desired performance. At the same time the supporting environment is expected to be completed, including use case, templates, policies and other tools.

The second Major Milestone is, *Lifecycle Architecture*. Construction is the major phase. All the parts and applications are developed and integrated into a form of product, that is then tested at different levels. Being a tester myself, this is the phase I mainly work in. I know the construction phase is the main step in manufacturing, where the focus is on the resource management, process control, cost refinement, progress making and quality control.

The third Major Milestone here is *Initial Operational*, which confirms if a product can be implemented in the test environment as Beta. The Transition phase means to transfer the software and functions into an end-user usable product. It can include multiple iterations such as PVT, roll backs, or minor adjustment. It can have issues on some functional adjustment, non-functional adjustment, configuration, implementation and usability checks, but not major structural issues, as they are meant to be resolved in the early phases. The end of the phase is the fourth but not the last Major Milestone, *Product Release*. This is because business can now choose if the requirement is fulfilled or they need to start a new lifecycle immediately, as sometimes the last Major Milestone can coincide with the first major Milestone of the next lifecycle.

#### **4.2.3.2 Processes**

Similar to the Software Development Lifecycle phase concept, there are nine core workflows in the Software development framework, in which, six of them are Core Process Workflows and three are Core Support Workflows. These core works flows defines the processes of our development works. The workflows are visited over and over again in a lifecycle, being

different from traditional waterfall development method. The nine workflows are used in turn in the project, with different emphasis and intensity on each iteration. Our processes are designed out of the core workflows, which will be discussed more in section 4.3 Processes. I will only list the definition of the workflows here and talk about the change management processes more (in “ ” below), as I will analyse it as my detailed use case later.

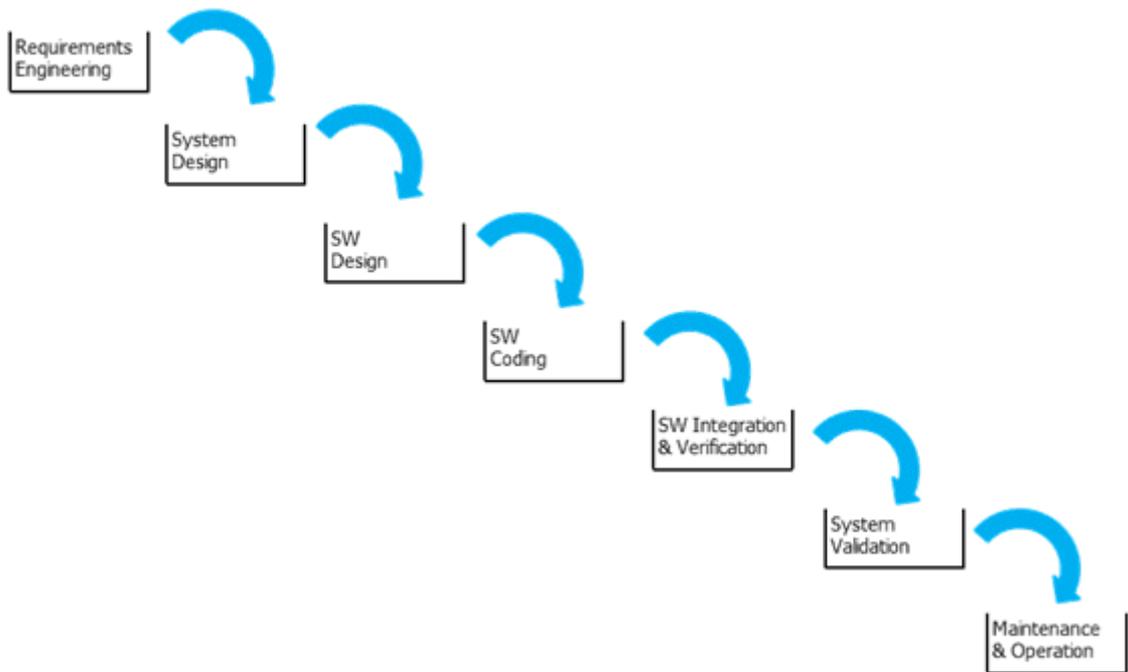
- Business Modelling
- Requirements
- Analysis & Design
- Implementation
- Test
- Deployment
- Configuration & Change Management

“The configuration and change management describes a scenario where a group of personnel from different teams work together to accomplish multiple tasks to get to one goal. The process has certain defined rules, flow policies, signing offs and exit criteria. The evolving system can have multiple environment, multiple instances, multiple versions and multiple status. It may also involve parallel development, distributed development systems and build automation as well as the auditing on product modification root cause, time and roles involved.”

- Project Management
- Environment

Some EFX projects also use other development methods, such as water fall in Figure 4.4 (Classic waterfall process flow chart). It is adapted to be: Requirement Engineering -> System Design -> Software Design -> Software Coding -> Software Integration and Verification ->System Validation -> Maintenance and Operations, as shown in figure 4.5 (EFX water fall processes).

In the last three processes, they involve the change management process as well, which is an important and complex process, for continuity reasons. The process gets the product to be published to the end user. Multiple activities are required to be done or signed off by people from different teams. This will be discussed further in section 4.2.3.4, Resources.



**Figure 4.4 Classic waterfall process flow chart**

(Reference: [http://www.the-software-experts.com/e\\_dta-sw-process-model-waterfall.php](http://www.the-software-experts.com/e_dta-sw-process-model-waterfall.php))



**Figure 4.5 EFX water fall processes**

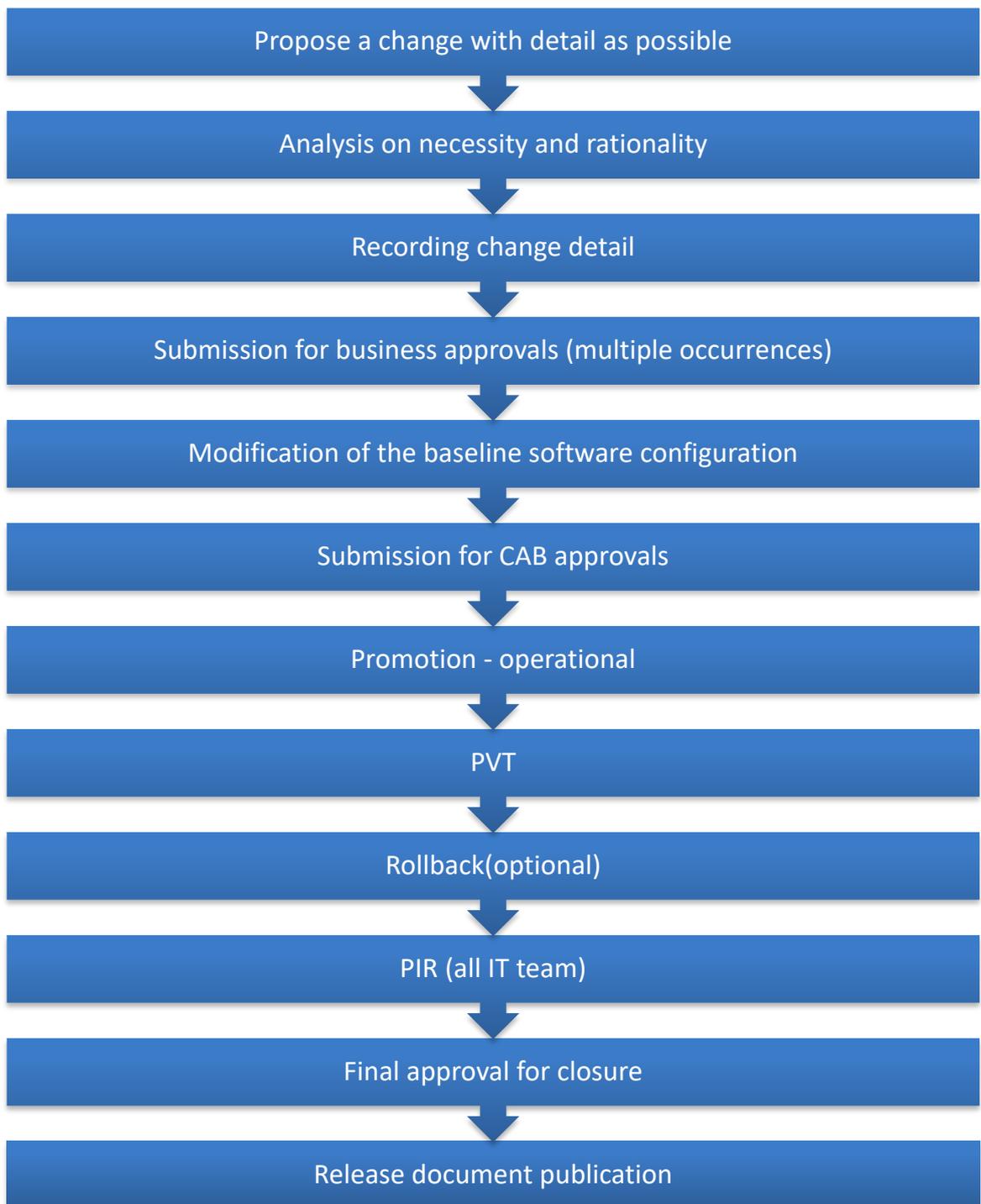
### 4.2.3.3 Activities

The activities are defined by the individual tasks that are required to be completed before moving to the next, and until all are completed to end a process. It involves multiple roles individually or together to get tasks completed and signed off. I take activities under the change process within EFX as a sample use case to discuss the activities inside of one process. The Change process is under MOC (Management of change). The whole purpose of software development is to make change to the system. Since there is a requirement to change, there has to be management, to control and manage the change to be effective. The common activities in the change process in EFX are shown in Figure 4.6. The possible activities within the change process are:

- Propose a change with detail as possible
- Analysis on necessity and rationality
- Recording change detail
- Submission for business approvals (multiple occurrences)
- Modification of the baseline software configuration
- Submission for CAB approvals
- Promotion - operational
- PVT
- Rollback(optional)
- PIR (all IT team)
- Final approval for closure
- Release document publication

In EFX the change is strictly controlled and managed, the change detail is updated to pass the accurate and clear information to the next development process. The change processes include establishing the control points and setting up reporting and auditing policy. In the CRM framework, ServiceNow® is used to control the whole process. Since the beginning of a project, the change is continuous. There might be adjustment of the requirement of the planning or the design, the possible design change after the QA finds issues in it, and even personnel change that affected the resource allocated. All these situations need to be dynamically managed during the development lifecycle that will affect the status of a change. Bug tracking, requirement management and risk control will all be reflected in the change

process. The change process keeps the project in a controllable manner in the dynamic environment, and makes it responsive to trace back or rollback to a certain status in the past.



**Figure 4.6 Possible activities within change process**

In related to the nature of the change process, all the activities mentioned that EFX has our compulsory and recursive. During one change ticket in ServiceNow®, most activities are sequential, but in the actual work, many activities are optional, and others are repeated.

#### **4.2.3.4 Resource**

Resource is the most important part of the IT service development. It is an enabler and an issue unless suitable strategic management is established for resource control. The objects in IT service delivery resource management are: technology, people resource, system time window, and funds. These are exactly what is important in EFX as well. EFX has weekly board resource meetings to monitor and adjust resource allocation to ensure that the projects get minimal impact on resource management issues. Among the four main objects, human resource is that hardest one, because it is hard to predict, to measure and to manage. The human resource management ability is a core success factor, which would have to continuously improve through process management to achieve the milestones and eventually lead to successful projects.

The roles involved in change management are varied, and they are from different teams with different field expertise, levels of authority, levels of knowledge and many more differences, which makes it harder to estimate, measure, plan and manage. In EFX, the change process involves all four teams mentioned previously with most of the roles in the chart, and every role is responsible to complete their unique activities towards the completion of the change process. This will be discussed further in section 4.5 Activities.

### **4.3 PROCESSES IN EFX**

The implementation of the CMMI tool had to be managed with the current CRM processes. The implementation of an external evaluation tool had to be adapted to the output of current processes and then applied to improve and resolve issues. The focus was on the processes and activities in the software development management domain. In the following subsections, the processes and activities are reviewed.

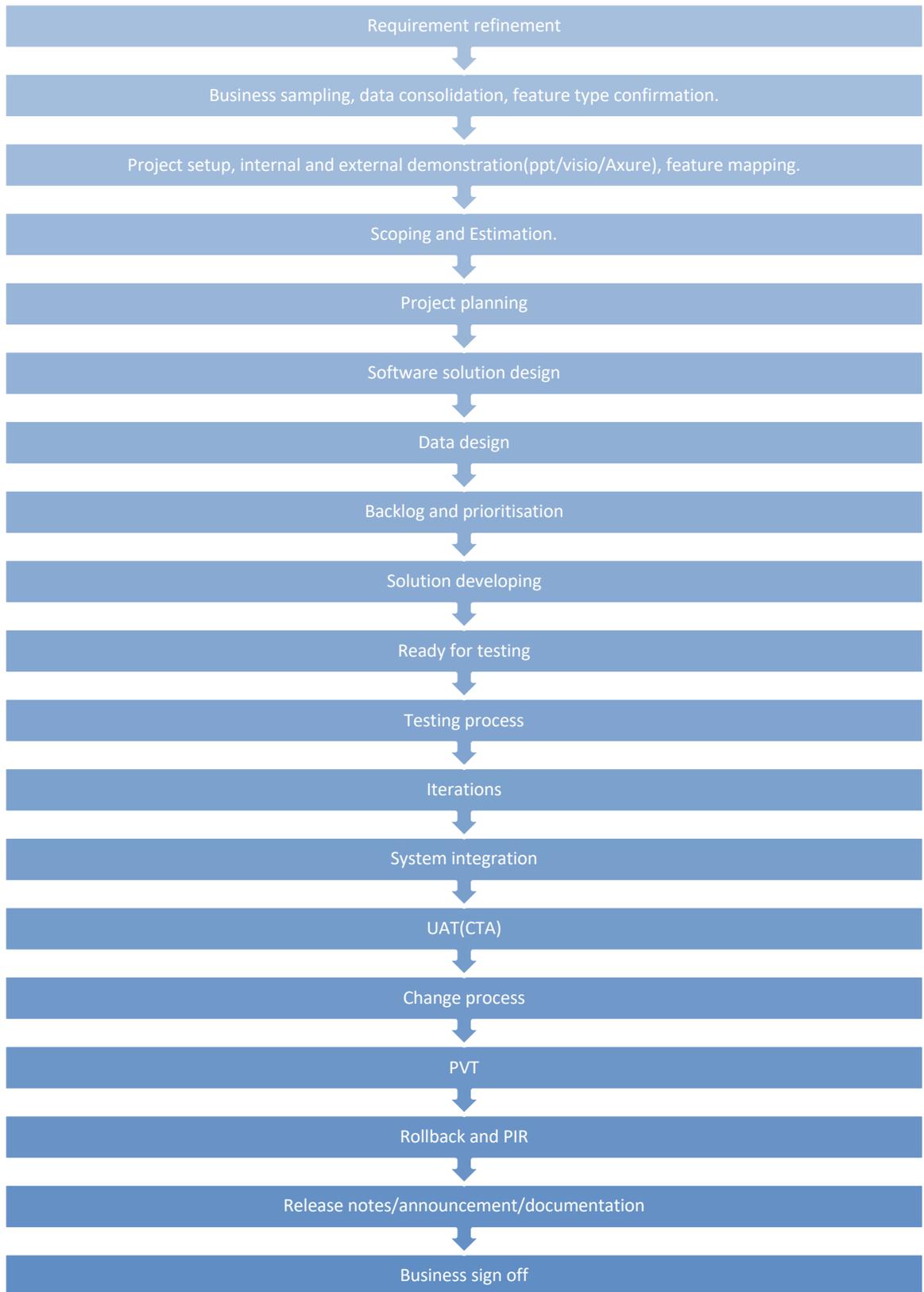
#### **4.3.1 Main Processes**

EFX conceptual process flow is shown in Figure 4.7.

- Requirement refinement

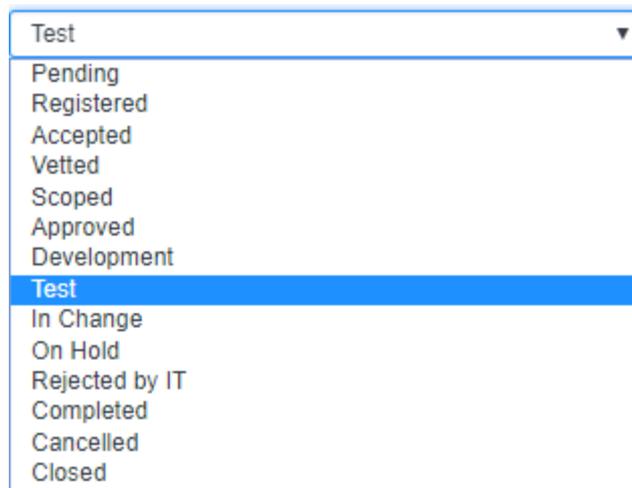
- Business sampling, data consolidation, feature type confirmation.
- Project setup, internal and external demonstration(ppt/visio/Axure), feature mapping.
- Scoping and Estimation.
- Project planning
- Software solution design
- Data design
- Backlog and prioritisation
- Solution developing
- Ready for testing
- Testing process
- Iterations
- System integration
- UAT(CTA)
- Change process
- PVT
- Rollback and PIR
- Release notes/announcement/documentation
- Business sign off
- Retrospective

The CRM system has optimised and consolidated the processes into more manageable template, which is exposed in the life of a typical incident. The life of an incident is exposed in the defined status of an incident from ServiceNow® designed template as the snapshot.



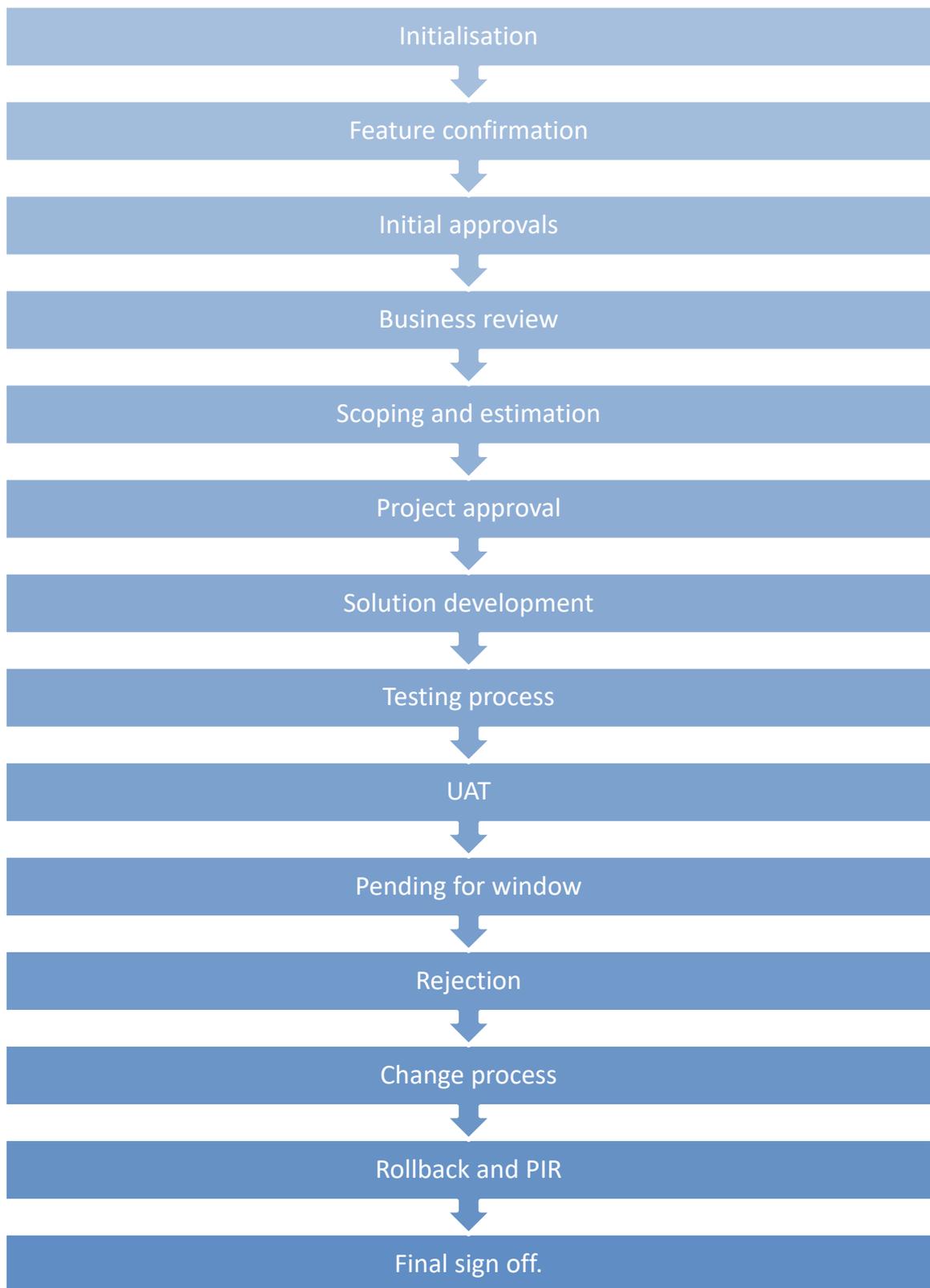
**Figure 4.7 Main EFX processes**

Processes showing in Figure 4.8 (Captured EFX ServiceNow® change flow chart) are representing the following, which can be extracted into refined process flow in Figure 4.9 (Extracted process flow chart).



**Figure 4.8 Captured EFX ServiceNow® process flow chart**

- Initialisation
- Feature confirmation
- Initial approvals
- Business review
- Scoping and estimation
- Project approval
- Solution development
- Testing process
- UAT
- Pending for window
- Rejection
- Change process
- Rollback and PIR
- Final sign off.



**Figure 4.9** Extracted process flow chart

### **4.3.2 The Importance of Change Management**

Among all process conducted, the most important and complex to manage is the change process. In the actual work environment of EFX, users continue to submit the need to modify the project schedule, without any guarantee of time delay; the system due to changes in demand results in the original and originally stable state changing and errors and anomalies occurring. These are the emergence of demand management flaws. The importance of demand management reflects the seriousness and enforceability of the project plan to ensure the realisation of the project objectives. By introducing requirements change management, the software requirements document becomes a shared commitment and serves as a reference document that requires the document to be fully communicated and shared between design, development and test roles. In addition, through demand management efforts, everyone is made aware of the impact of changes on the project and changes in costs, which in turn contribute to the quality of demand.

Requirements for change management includes change requests, EFX CAB committees conduct analysis to identify changes in requirements, and responsible person design and development confirm that changes in requirements can affect modules and code, developers modify and change test specific changes, and changes in another person's needs. Changes to adapt to the situation are made in order to verify. Analysis of the impact of changes in development is by the project team responsible for the large-scale projects. They establish demand management, demand tracking analysis, and according to the actual needs of the impact analysis.

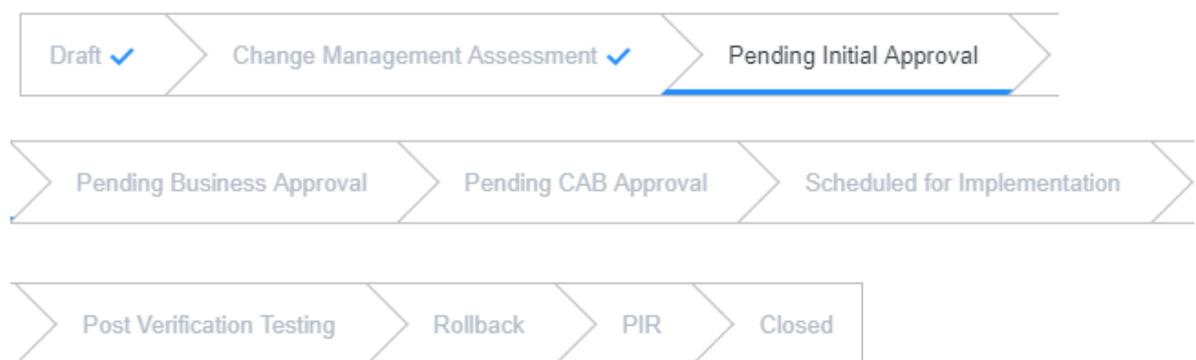
Looking at any individual change process, they can be rather simple, but having the actions of composing, reviewing, and amending. But in EFX, the change management is not simply for records and audit. The change process in EFX is for monitoring the change, ensuring the project is controlled, but also keeping track of change weighing and velocity analysis to provide an indication of the development improvement possibilities.

### **4.3.3 Use Case**

As described in the previous subsection, the change process has all four teams plus external clients with their members involved in the process of change management. But in actual practice, there are varied scenarios. As such, some changes are the system updates that requires project sized testing in PVT rather than a sanity check for some small changes. In

this case it will require the scheduled time table to be approved by QA lead that the management team and the business team will need to be informed with highlighted impact notification. This includes more details on the consequences, and projections if the implementation fails. Another possible scenario is if the change requires network team (from internal operations infrastructure team) to be standby through the change. Or rather some cosmetic change or notification publishment that does not really need the care of management team, such as Christmas shut down notice, that is periodic, regular and consistent. But regardless of the varied scenario, current process in ServiceNow® requires all the process work flows to be fulfilled right through to the end of the life of a change ticket, which might be an overkill sometimes to get those many roles involved to complete some tasks that are redundant.

#### 4.4 ACTIVITIES IN EFX CHANGE MANAGEMENT



**Figure 4.10 Captured EFX ServiceNow® change tasks flow chart**

The tasks in the change management are the compulsory workflows defined and requested in the change management system in the ServiceNow® framework that each role is involved and requested to complete to achieve the milestone to end the whole change process.

It can be commonly categorised in to the following actions, as resource allocation, business steps, technical resource, test planning, feedback loops, consequence handling, signoffs and alterations. Each task has its own mini life cycle through the change process, and some of them may and would have to overlap each other. The tasks of change process in EFX are being discussed in the following paragraphs. And due to the scope of this thesis topic, I will pick up only change processes and break them down with activities involved. Figure 4.10 (Captured EFX ServiceNow® change tasks flow chart) shows the life of a typical change,

from draft, change management assessment, pending business approval, pending CAB approval, scheduled for implementation, post verification testing, optional roll back, optional PIT to Closure.

In this section some of the main activities are identified to discuss and find out what is the requirement for fulfilment.

#### **4.4.1 Business Steps**

Although the change process is part of the technical and developing approach, the business team will still have many tasks to finish and to approve. In EFX practice, the most critical tasks in change management for business team to complete are described in the following paragraphs.

The Product manager is to confirm and evaluate the business requirement being fulfilled by the change and to assess the impact and the risk that the change is going to bring to the current Prod environment in a high-level perspective. The baseline for them to approve the change is the business analysis from the feature confirmation from product owner and business impact report from business oriented BA. The sales team sometimes needs to be consulted to assure future features they agreed with external client are not compromised or disturbed with the current change. And at last the channel manager will need to verify the purpose to their long-term plan with their marketing strategy. Occasionally, they would validate with surveys and research to ensure the precise effects to EFX's market position and market plans.

#### **4.4.2 Proposal**

In EFX ServiceNow®, Proposal is to compose a change ticket, and record the details of the change, related incident, development detail, risks and impact; which is equivalent to a note or comments. The information recorded may vary depending on the department and the nature of the incident and change. The point is that change proponent can record concise and informative information, such as the environment configuration status at the time of the defect, the function being changed, and so on.

ServiceNow® as a Change management tool in this situation is not only to facilitate the recording of information, but also to give some tips and reminders in the record to help the proponent record changes more accurately and with a better coverage.

### **4.4.3 Test Plans**

Being a senior QA engineer myself, I know exactly how the testing part is important to the change management. The tests do not end when a code change is validated. The job is not actually done after the change is physically in its place with the Prod environment. Test planning will happen after the developer raises the change ticket. The QA will be providing a series of reports with technical details, information lists, the technical test cases being executed, entry and exit criteria of the tests, a test coverage report, QA estimation of impact and risk analysis, Post Verification Testing (PVT) plan, disaster recovery test plan, rollback test plan, regression test plan, and so on.

All the test plans will be provided to the change team members to consider, logged for future reference, and executed with a recorded result during and after the implementation. As the physical implementation is performed by a third-party vendor, there will be many interactions and collaboration between them. As such, the Data Management Officer and most of the internal technical support team will be working together in this function as well, for example, to help the QA gather more coverage of the test plans.

### **4.4.4 Change Review**

The EFX Review activity defined in ServiceNow® has several visions and goals. The first priority for the reviewers, which usually is the CAB committee, is to confirm and make sure the change has its sensible purpose, and determine whether it needs modification and alteration. Secondly, the reviewer confirms the possible impact of the change, based on the impact analysis, to decide whether the content of the change needs to be altered, and whether other aspects of the project require changes to be made simultaneously. The last requirement is to assign project members for implementation.

The point here is that the reviewer needs to have a clear idea of the relative impact of the change. This does not mean that the change has to be modified, but rather to know whether it is possible to modify the change and whether it is worth modifying. Obviously, this information is not given by the proponent at the time of recording, but should be made as a judgement by the reviewer, who is assisted by other systems or tools.

#### **4.4.5 Query and Analysis**

The project manager needs to know the current status of each change in the project, make various management decisions according to the change status, analyse and estimate change data, understand the project quality status, periodically reprise the inventory, find the source of changes, and even perform institutional according strategic policy improvements.

The key here is to determine what data to analyse and how it is analysed.

#### **4.4.6 Implementation**

Implementation is to make modifications according to the change requirements. This is done by outsource operators (SAS) according to the schedule made between EFX and SAS, based on the system time window, e.g. time outside system up hour, system backup, service maintenance, data maintenance and system restarts.

The priority is to ensure that the implementation of changes is completed thoroughly by following the plan. For example, a requirement document is updated with the functional change, but without user manual changes or public notices. Under the situation of division of SAS operations and EFX internal IT team, a critical issue is how to coordinate and synchronise the change operation with multiple groups to ensure the consistency of work products. An initial goal of change management is to track back in the project, which means that amendments made to the changes should also be recorded and associated with the changes to achieve a two-way tracking.

#### **4.4.7 Acknowledgement (PVT)**

Acknowledgement is called PVT in EFX, where the lead tester confirms and validates that the change was indeed implemented, and the rest of the system is not affected at all (or the reason for rejecting the change was reasonable).

PVT is the main technical task in the change process, as most of the code change is completed and tested in other environments, and Prod environment configuration is analysed and validated. The most typical PVT contains two parts: one is to ensure the code change works the same as tested in QA environment, and, the second part is to ensure the affected area does not have a negative change on the overall system. Although both parts of the PVT testing will be performed according to the prepared test plan, there will always be issues during as the PVT task is carried out. The implementation window usually happens at 4

o'clock in the morning, where most clients are at rest for their server requests and servers are completed with their daily routines, backups and service restarts. The developer of the code change is requested to stand by while operations team carries out the implementation and QA does the PVT.

Also, it is to be noticed that, since it happens in a tight time window at middle of the night, all the PVT tasks will only have some communication recorded. As the nature of the task, some technical details may be missed or not logged.

#### **4.4.8 Rollback**

In reality, it does not matter how precise the testing can be, there will always be the case when the change fails the PVT testing. In fact, it happens rather often, mostly due to the implementation issues and configuration issues. Apart from the roles mention in section 4.2.9, one member from the change management team and the lead developer will also be on call. When a PVT failure occurs, the QA will consult the operations team for implementation detail and passes this on to the standby developer with the testing details. The developer will attempt to diagnose the issue and find a hot fix solution and the QA will repeat the PVT procedure. But due to the tight time window of about 1 to 2 hours, the attempts will be with much effort. The change will usually fall into a rollback routine and the QA will inform the on-call change management member, who will then approve for a roll back. The operations team will then perform a full rollback according to the prepared technical rollback plan to restore the affected system change back to pre-implementation status.

Once the rollback is completed, the QA will log in to the Prod environment to perform the testing according to the rollback test plan and regression test plan, to ensure the system is restored and fully functional as a pre-implementation status. A signal will be sent by QA to the rest of the roles for completion.

#### **4.4.9 Feedback Loop / PIR**

The feedback loop is an important part once the implementation fails and as the change falls into the rollback routine. This normally starts with a Post Incident Report (PIR) meeting in the next day of the scheduled change. It will have the change management team, the developer, the QA, and the operations and optional business team members. The meeting is to discuss and point out some key event logs, find the root cause and analyse the possible

further testing changes or requirements, fixing potential, and, solution and improvement probability.

After the meeting, a PIR report will be generated with a detailed solution plan for further treatment of the incident and plan for how the current incident is going back to the backlog for re-engineering. This will be forwarded to broader management team and business team for awareness, and they will contribute suggestions for consideration in re-design. An actual PIR template form is attached below in figure 4.11 showing the contents of an incident number, report date and time, recovered date and time, blackout duration, system and application affected, incident summary, corrective action taken, and event timeline. There will be signoffs on the same form with all the meeting attendees.

<h2 style="color: red; margin: 0;">Post Incident Report</h2>	
<p style="color: gray; margin: 0;">Incident Title</p>	
<b>Incident Number:</b>	
<b>Reported date &amp; time:</b>	<b>Dd mmm yyyy hh:mm</b>
<b>Recovered date &amp; time:</b>	<b>Dd mmm yyyy hh:mm</b>
<b>Duration:</b>	
<b>System / Application Affected:</b>	
<p style="color: red; margin: 0;"><b>Incident Summary:</b></p> <p style="margin: 0;">Text ...</p> <p style="color: red; margin: 10px 0 0 0;"><b>Corrective Action Taken:</b></p> <p style="margin: 0;">Text ...</p> <p style="color: red; margin: 10px 0 0 0;"><b>Timeline:</b></p>	

**Figure 4.11 PIR template**

#### **4.4.10 Consequences**

Consequences of the change process is the aftermath on the process that all team members together determine and evaluate the results, sometimes with project retrospective sessions. An informal meeting will usually be held by the QA or BA as a briefing or demonstration, in wrapping up the change and the project for the business team to represent to the clients and customers. This should include some technical information, but mostly non-technical details of functions, features or behaviours level. Any known issues are demonstrated as well at this time to refresh the team.

Sometimes a retrospective session will be held for some larger projects to summarise and determine the processes from all aspects for all the roles and contribution to as input to the next project.

If any issues may have occurred, technical issues will be logged into knowledgebase, and new incidents, and process issue will go to Scrum Masters and Project Managers to evaluate and add input into future project to change. All the information from the meetings and tracks will be logged into the relevant tickets from the multiple applications of ServiceNow® for future reference.

#### **4.4.11 Signoffs**

In EFX, there are multiple signoffs that occur during and at the end of the change process. As this is the last process in a project, most of the roles involved will have their final tasks signed off to form and contribute to the final achievement.

- IT team
  - ✓ the Developer, solution architecture, data architecture and BA need to sign off the code change and potential affected area at the beginning of the change process.
  - ✓ The QA will need to sign off twice, first is to approve the change is ready for promotion and implementation to the Prod system. The second time is to sign off the successfulness of the PVT. This action will trigger to close off the whole change ticket, ending with achieving the completion mile stone of the whole change process.
  - ✓ The Scrum master and project manager need to sign off the project and close the backlog, incident, change ticket and all related tickets in the ServiceNow® framework.

- Business team
  - ✓ Business oriented BA and product owner will approve the function alteration at the beginning of the change process, right after the developer has completed the full technical specification of the change, then signs off again at the end of the process confirming the PVT result has fulfilled the User Acceptance (UAT) criteria.
  - ✓ The sales and channel marketing representatives will sign off on behalf of the requesting client at the end of the change process.
  - ✓ Product manager will do the final sign off based on the rest of the business team's input to approve the change. This meets the high-level business requirement.
- Management team
  - ✓ Change Advisory Board (CAB) will sign off the change for a change closure to create the mile stone for the whole change process.
  - ✓ General Manager (business) will review the change at the very end of the project and sign off.
  - ✓ The CEO and CIO does not have to sign off on the change process.
- Operations team
  - ✓ Data Management Officer (DMO) is optional to sign off if there are any data grooming script needed to be run as part of the configuration before the change happens, and signing off again after PVT report is validated with the data part.
  - ✓ Customer operator and Tech support/helpdesk does not have signoff tasks in the change process. Only if they have raised the original service request, they will need to review and close it off.
  - ✓ The Infrastructure team is only required to sign off, if there are any infrastructure configuration change within the change process.
  - ✓ The outsourcing team needs to sign off to confirm the validation of the scheduled implementation time, and sign off again after the implementation for the QA to wrap up and finalise the whole change ticket.

#### **4.2.12 Closure**

Although it does not sound like an action or a task at all, the closure tasks are equally important as the implementation operation itself. As the formal finalising stage of a task or a project, in EFX it usually includes many tasks. Consequently, there are more tasks than the retrospectives and demonstrations. The closure means more, like external customer satisfactions (live UAT), technical debts tracking, extra documentations (such as user manual modification or user access templates), archiving (repository or documents), business reengineering, measurements of system robustness, measurements of the project performance, and sometimes for large projects, a change grouping workflow may also occur. In most cases, the sales or a member from business team will follow up the change for a little longer while after the change to verify if the UAT results from customer for their data and operations in the live system is rather fluent or the issues found being intended design or minor enough without needing a hot fix. Otherwise they will feed back to the IT team if any critical flaws come from customer feedback.

Any IT services with changes will cause technical debts. At this closure stage of the change process, they need to be addressed, documented and ready for a later prioritisation. And this may not limit to technical problems but also some compromised business requirements found in BA. Further documentation may be required to support internal and external users for the insight of the change, such as user manual modification or user access templates. A repository version tidy might be required as well as document versions archiving.

A business review may occur for the functions and feature the change have brought. Extra system tests or performance tests may be required at this stage for some certain project if it has not been scoped in the developing stage. Or it can be estimated and analysed for future actions. Scrum masters or project managers may want to do a project performance evaluation as addition of the process. Also, when the incidents are clustered, or simply the code change are overlapped from version control, or business requirements are merged into each other, in EFX, a change grouping will occur, to clarify and to trace for the project scope and repository branching history.

Sometimes the closure tasks can get very complicated and make the members in the process frustrated. One example that happens frequently is that some changes take a longer time to close if there needs time to approve the rolled-out features. Many examples can be

seen in the actual working environment. A quick one, without breaching the business confidentiality is, when a function is tested in the QA environment with a time machine, who roll back and forward the system time, it makes to the change process once it is practiced in the CTA environment by the clients, but the PVT in Prod environment will have to leave the timed testing outside the scope, as altering the timing of the live system is obviously not an option, which will cause the crash of many systems. The closure of this would be to test the result again, or monitor the system for the time being, and get the change closure done with a postponed proof.

## **4.5 RESOURCE MANAGEMENT ISSUES**

All software development processes highly depend on resource availability. A Company as EFX is no exception. The resource meeting is always a highly contested zone, where resource is discussed at project, and process level across teams. The main types of the resource focus on the technical resource and human resource. The following subsections discuss these issues and give examples of how the matters are planned and resolved.

### **4.5.1 Technical Resource**

In section 4.2.5 the technical resources have been introduced and are a primary requirement for productivity that relies upon optimisation. It is a fundamental ingredient the change process, since the actual change will be happening on technical level. In EFX, the internal technical resource is defined with clear levels, which are intellectual properties, software and OS licences, code base, core system, infrastructure, networking, bandwidth, utility framework, and some part of the Human technical abilities. There are also external technical resources EFX adopts. Most of the IBM servers are running on a third-party server farm, with their operations team managing, configuring and monitoring the operation of each environment, listed above. Also in some scenarios, EFX outsources development and the QA tasks as well to an outsourced vendor.

They will be part of the change process as well if some parts of their tasks are in the criteria of the change. These will be discussed before the change could happen, tasks will be justified and assigned to the exact people capable of implementing the change. In ServiceNow®, these third-party information requirements are visible for the internal teams, when they seek them.

#### 4.5.2 Human Resources

Among all resources required to complete the tasks through to a process closure in EFX, the human resource is the most difficult to manage. It is because there are so many factors that could affect the planned schedule. The following paragraphs highlight some of the factors:

**Accidental loss** of human resource obviously cannot be predicted, such as un-planned leave. There always can be good contingency plans and quick response of resource changing to keep the impact minimal.

**Emergency assignment** is also an impact on the resource management, where there are emergency spikes that need work done other than items from the prioritised backlog.

**Misaligned schedule** between teams happens often in EFX, where scheduling of projects overlaps the different vision and prioritisation schedules can cause mismatches. Frequently, the IT team tends to take smaller or bigger issues when they have similar priority, but in the Business team, they have clear deadlines for them from their business strategy, that is not seen by other teams.

**Inaccurate estimation** from resource meetings happens too in EFX, where under-estimation or over-estimation occurs, due to the job being assigned to people have less or more knowledge and experience about the task. This can vary severely in measure and influenced deliverable times.

**Subtle prioritisation** is another issue. Although the resource and priority are defined in the weekly resource meeting, there are still items being missed, as some process like change process has many roles and activities involved. Some projects have very complicated requirements that request many extra tasks to be done by different members from different teams, and the tasks also have their own dependency.

#### 4.5.3 Resource Allocation

Since the change process is more complex and a critical process prioritised other processes during the software development lifecycle, the proper resource allocation is more complicated and harder to realise. In EFX, the resource requested may be technologies, human resource, implementation time window and budget. The technologies, implementation time and budget are the easier ones to manage, as being physical property and easy to expand. The hardest resource allocation to deal with are the human resources.

In the change process, most of the teams and roles are involved and responsible to complete tasks for the change process to complete. EFX commonly deal with multiple projects at the same time, and in a 2 weeks iteration, usually about 20 incidents make it to the change process plus releases from larger projects. This means members from different teams will be working on different projects, and moreover, most members work on multiple projects at the same time. The reality is complex and most of the members focus on different projects at the same time. If one change is pending on a member who is working on another project, the change process has to be pending. If more projects' change processes become pending, the member or members on the next change process task will be idle, regardless if the next task is more critical, a larger task or time consuming. A congestion and sometimes a dead lock are generated, which in these parallel projects situation, will cause multiple projects to fail. This will cause not just performance of the IT to be compromised, but also the permanent damage to the business through delivery failure.

#### **4.6 CRITICAL REFLECTIONS**

Through the observation, documentation and discussion, there are many issues that can be seen in the change process and can be reflected upon in terms of a perfect scenario. In practice and in an action, things are not as pure and perfect as theory. However, all of the documentation and observations are suggesting that the resource management is pivotal to project success, and where there can be improvement by way of measurement, analysis and process enhancement.

As mentioned in the literature review, the resource allocation is the economic activity in satisfying supply and demand. This means that improvement of resource allocation will be an effective way of improving productivity. In reality, it will mean that EFX can get more things done, in a given time, or complete one thing in a better time frame. In the previous sections the CMMI framework has been evaluated and discussed as a potential application in resource management. The suggestion is that CMMI can assist the decision-making for the input of the processes. The CMMI measurement and analysis (MA) is critical in this scenario, where CMMI can be adopted to improve the awareness and visibility of the resource utilisation status ratio.

The practical observation and document data reported in this chapter suggests that the visibility of the resource capacity is not clear. The activities that require resources are

discussed and logged into the CRM as the result of meetings. There are no regulated indicators that are showing the allocation status and utilisation rate in the exposure. The ServiceNow® system alone cannot make the resource management function on its own that is effective unless it has quality input. The best utilisation rate can be reported but in negotiating the resource distribution there is still room for improvement. Subjective judgements are acceptable and open to continuous adjustment, but the suggestion is the implementation of the CMMI tool as is reported in this chapter has a valuable impact on the quality of input data.

#### **4.6.1 Optimisation Required**

Among the demanded tasks in EFX's change process, the activities are logged in ServiceNow® with details of work done, time consumed, and outcomes. All of which show the progress, status, and roles visible to the management board, but it does not have a measurement or analysis to show the velocity and capacity of the roles within teams for adjustment during the process.

Once the process starts, it is almost linear approach. Even with multiple projects or incidents in the scenario. Most of the activities get resources on a first in first serve basis. This is mostly because the resource planning board does not have the quantified information on each process and activities for a detailed resource planning. And without the proper resource planning, it unleashes the teams into the fields where they can only see the directions but not know the pace they should be going at. They are all pointing to the lack of planning in resource management in a process level. But from resource management board point of view, the paradox is that there is not enough information supporting them in resource planning in this level apart from the work logs and status reports.

When the tasks are small, the problem is not so obvious, since team members can always slide small pieces of tasks in, when they have window. And this does not cause any issues in the short term. But the situation gets intensive and struggling when tasks require a big portion of the available resource to finish. That is when a bad situation appears as multiple roles are idle pending on one particular task to be done by one role. Worse than this is multiple changes are waiting on the same tasks to be done and there is nothing that can be done to prioritise it.

The strong suggestion from this field research is that the tasks within the processes need to be measured, analysed and planned better; and have continuous feedback loops that update current status information in real time.

#### **4.6.2 Productivity**

When a deadlock situation described in section 4.6.1 happens, there is no effective productivity by all the teams at that moment. Resource wise is helpful, but no further tasks can begin to move until the bottlenecks are treated. The issue sometimes is subtle, and builds up under the cover of work routines. When it is disclosed that a few roles are busy with some tasks that are holding the whole work system back from full productivity, better real-time planning and intervention are required. The roles stuck in the process get the blame and the whole team is frustrated.

The current processes are managed for the resource to be distributed for each of the projects, but none of the processes and tasks along with the activities within, are well planned based on the inadequate measurement and analysis. The strategy and approach in the large scale in EFX planning is considered adequate, the CRM tool is in place and well defined and executed, but it is open to improvement. The resource management measurements can be more accurate than the current estimates and based on quality improvement strategy to lift the capacity. This can be done without further investment and use the current resources available. The CMMI framework will have to be incorporated within the management framework but this can be done with minimal training and no extra resources.

The current observation of the EFX approach with the change management process shows the severity of the issue impacting the current team capacity and productivity. With the improvement of the resource allocation realised by adopting CMMI measurement and analysis the management board will be able to make better resource plans that will ease off the deadlock situation, and free up more resources for getting more tasks done. As long as CMMI tools can be properly deployed, utilised and evaluated, then the resource management board will have a much comprehensive base line for the resource planning, and ultimately there will be a major productivity elevation.

## **4.7 OPTIMISATION OF EFX CHANGE MANAGEMENT PROCESS**

The Software development life cycle relies on continuous optimisation of process management based on controlled measurement and analysis of the contents of importance. Improving the change management process, which is the critical part in the approach, would make great different in the whole development lifecycle. The aim is that by using the change management process knowledge gained, and applying CMMI measurement to each of the tasks, and productivity gains may be made. Analysis of the outcomes to provide baseline information for making more specific resource planning decisions, has potential to reduce the idle status of roles and the lift the productivity.

### **4.7.1 Activities**

Taking the activities in change management process in EFX described in section 4.4, they are the tasks to be measured and analysed with CMMI tools. As there is no existing template for this, a custom measurement tool is composed for each of the following activities. By evaluating them with the customised CMMI tools and goals, there is potential to improve by optimising the whole process. The list of activities concerned are as follows:

- Business steps
- Proposal
- Test plans
- Change review
- Query and analysis
- Implementation
- Acknowledgement (PVT)
- Rollback
- PIR
- Consequences
- Signoffs
- Closure

## **4.7.2 Apply CMMI**

For each of the activities, goals are setup for measurement. Despite the minor difference, the baseline practice by goals is demonstrated in the following subsections.

### **4.7.2.1 Specific practices by goal**

A set of specific practices by goals is designed according to the work system.

#### **SG 1 Establish Baselines**

Identified tasks' Baselines are established. Most of the baseline tasks and activities has been configured in the ServiceNow® framework, which has been refined again according to the CMMI structure. Boundary and limits are also set and outlined in ServiceNow®, so they are visible and ratable. It is then maintained by managed and tracked change specific goals, which are documented and audited through and on top of ServiceNow® platform.

Capacity maturity action is to establish valid, reasonable, and desirable baselines for the change activities to compare and evaluate the actual progress.

The implication of resource management is to have a preset baseline to compare the result for adjustment to be made in resource planning.

#### **SP 1.1 Identify Change Activities**

Based on the existing ServiceNow® configuration of the change process, the change activities, components, and related work are identified and used to adjust the running tasks and activities under change management. After this being done, we have made a baseline of the scalable change activities as well as the previously defined simple steps in ServiceNow®.

Capacity maturity action to take is list all the possible change activities to perform a complete assessment to avoid blind spots.

The implication of resource management is to make the assessment complete without hidden areas.

#### **SP 1.2 Evaluate Change Management System**

Specified change management in ServiceNow® is established and maintained with all activities required within the process. The indicator and input touchpoints are inserted into

ServiceNow®, so that the change management decisions and amendments are assessed and viewable as well.

Capacity maturity action to take is to integrate the CMMI measurement adding into ServiceNow® to provide a fully integrated view taken all activities is also well defined in ServiceNow®.

The implication of resource management is to provide comprehensive reports in each of the stages in the change within one integrated reporting and viewing system.

### **SP 1.3 Create and Release Baselines**

For internal resource management use, the baseline setup in the ServiceNow® are created and released along the actions on the activities required in the change process. This has enabled the ServiceNow® CRM system to has the enhanced ability to monitor and control the standards of the activities alongside the change process to be compliant and measurable.

Capacity maturity action to take is to set up creation and release policies and to automate the CMMI assessment baselines reports to according members on a regular basis for maintenance updates.

The implication of resource management is to keep the resource management board informed with the latest working baselines updated for adjusting the resource planning according to the current teams' capacity maturity level, on their tasks.

### **SG 2 Track and Manage Changes**

Change process with all the its activities promoting software changes into production environment under ServiceNow® change management are now tracked and managed with refined CMMI standards. The activities are logged with its status, dependencies and other elements defined in CMMI logging embedded in ServiceNow® along the line of the change process. They are also feed back to the CAB, and being adjusted actively. This is second special practice goal to accomplish.

Capacity maturity action to take is keep the changes tracked and managed with CMMI integrated in ServiceNow®.

The implication of resource management is to be aware of the status of the parallel changes for more accurate resource allocation.

### **SP 2.1 Track Tasks Requests**

Change tasks requested by the change process is defined to be actively track in ServiceNow®. This actively reduced the redundant requests and made the current procedure more efficient. Up-level this special practice has obvious effect on optimisation of the change process.

Capacity maturity action to take is to keep records of the tasks requests occurred in each change process.

The implication of resource management is keep track of the tasks requests, to extract a pattern of the resource requirement for certain type of the changes.

### **SP 2.2 Control Change activities**

The activities predefined and occurred in the change process are made under control. This feature shows that the activities are following the planning and within the time and resource allocated. Another one feature here has provided critical information to the CAB and is greatly improving the transparency of how the tasks in the change process being completed, and not just when and what has been done before the CMMI measurement is imported to ServiceNow®.

Capacity maturity action to take is to keep the change tasks under control to reduce the resource wastage, while the requests are still fulfilled.

The implication of resource management is to trim the change tasks to avoid resource wastage on the unnecessary tasks.

### **SG 3 Establish Integrity**

The last special practice goal is establishing and maintaining the integrity of the baselines set out in SG1, making sure the CMMI measurements setup inside the ServiceNow® CRM system is stable, well established and reviewed to be up to date with all the movements and adjustment happened and made to the change process. The reminder and notifications of the amendments are also set up to be sent to stakeholders and watchers in ServiceNow®.

Capacity maturity action to take is to establish and maintain a serial of policy to keep the decency of the baselines.

The implication of resource management is to have a stable, established and maintained CMMI assessment framework that can always be trusted and replied on.

### **SP 3.1 Establish Change Management Records**

The records of change management activities are set up in ServiceNow® to be established and maintained in a formal manner, with multiple elements set up in the change management ticket for each change activities as description and measurements.

Capacity maturity action to take is to keep change management recorded in a formal manner that is visible and easily accessed.

The implication of resource management is to have access to real time change management status and history of the actions and decisions taken.

### **SP 3.2 Perform Change Activity Audits**

Another special practice goal to ensure and maintain the integrity of the baselines is implemented by perform change activity audits in ServiceNow®, as the change activity audits are critical in tracking, measuring, controlling and reviewing each change activity from ServiceNow® CRM platform.

Capacity maturity action to take is to maintain the integrity of the baselines by keeping the change activity audits, which will provide the trace of the actions being taken.

The implication of resource management is to have full access to the change activity audits to track the actions done on the baselines for assessment.

#### **4.7.2.2 Generic practices by goal**

A set of generic practices by goals is also designed and implemented in ServiceNow® for to the work system of the change management use case specified.

### **GG 1 Achieve Specific Goals**

Achievement of the previously implemented specific practice goals of the change activities is supported and enabled by inputting into resource management established in ServiceNow® CRM platform to produce desirable expected outcome.

Capacity maturity action to take is to take special goals practice.

The implication of resource management is keep the special goals practice into achievement for a complete integrity.

### **GP 1.1 Perform Specific Practices**

The specific goals of the change activities defined previously is achieved by executing and performing the previously implemented specific practice goals of the change management activities.

Capacity maturity action to take is to evaluate the completeness of the specific practices.

The implication of resource management is to ensure that the special practices are completed for a full assessment.

### **GG 2 Institutionalise a Managed task**

The activities occurred in the change process and tracked in ServiceNow® are managed in an institutionalised manner, so that the integrity and standards set is kept and maintained, trackable in ServiceNow®.

Capacity maturity action to take is to keep managed change tasks institutionalised to the standards.

The implication of resource management is knowing the managed tasks are according to the standards set.

### **GP 2.1 Review the Organisational Policy**

An organisational policy is established and maintained as an addition of the change activities in ServiceNow® CRM platform in planning and performing each change task. The organisational policy is maintained and followed to ensure the activities are carried out in one unified standard of EFX's change process management.

Capacity maturity action to take is to establish and maintain a strategy for planning and performing in an organisational level.

The implication of resource management is to keep the planning and performing policy unified at an organisational level, so that the resource is planned according to baselines based on one single policy and standards underneath it.

## **GP 2.2 Plan the activity**

A detailed plan is established and maintained in ServiceNow® when performing at the change activities level. This made sure the change activities have a well-defined plan to follow and proven to be effective avoiding spontaneous ad-hoc work flow.

Capacity maturity action to take is ensure there is plan established and maintained for each change task.

The implication of resource management is knowing the change tasks has a maintained plan for execution that is visible to avoid spontaneous actions with resource consumption.

## **GP 2.3 Resources Distribution**

Only according resource is provided for performing the change activity, in orientation of contributing towards the milestone of the change management process. With the provision from CMMI measurements provided by other goals and recorded in ServiceNow®, the resource distribution is refined in a level of further optimisation.

Capacity maturity action to take is to provide managed resource distribution according to the resource available and tasks requested, for prioritised projects.

The implication of resource management is keep optimised and managed resource distribution based on the baselines and status of the current resource allocation, in balance of the requests and plans.

## **GP 2.4 Assign Responsibility**

Based on the CMMI measurements and analysis recorded in ServiceNow®, refined responsibility and limited authority is assigned for better performing the change task in well controlled approach. The assignment depends on its contribution towards the milestone of the change management process to filter out the redundant. Up-level this goal restrained the resource allocation in a reasonable and managed range.

Capacity maturity action to take is to assign ownership responsibility and authority for teams' members to fulfil the change task requests.

The implication of resource management is to ensure that the assignee for the task has proper level of responsibility and authority for performing the change task, not less or excess, in order to maintain a managed level of resource allocation.

### **GP 2.5 Skill Set of People**

As ServiceNow® has CMMI measurement embedded, the shortage of the skill set of people is revealed. By knowing that focused training is clearly proposed for the people performing or supporting the change activities, on demand in varied ways.

Capacity maturity action to take is keep the people trained and have the according skill set for the task.

The implication of resource management is to ensure the capacity maturity by having skilled people for the tasks, so that a flexible planning can be an option for resource management.

### **GP 2.6 Manage Task**

The goal ensures the designated activities in the change process are placed under appropriate level of control. The measurement of this goal tracked in ServiceNow®, will disclose the level of control through carrying out the activity, to adjust if the level of control is under or over the pre-defined boundaries.

Capacity maturity action to take is to plan and keep appropriate levels of control on the change tasks.

The implication of resource management is to ensure the change task is under planned control at all time, so that there will be no extra cost of resource.

### **GP 2.7 Identify and Involve Relevant Stakeholders**

This goal is set up in ServiceNow® to identify and keep the relevant stakeholders involved in the change task informed and provide reference in the future planning. The refined involvement of stakeholders has dramatically improved the efficiency of the current EFX's change process management.

Capacity maturity action to take is to determine the relevant stakeholders and involve them in the progress of the change task according to the premade plans.

The implication of resource management is to keep all relevant stakeholders in the loop, so there will be no unplanned tasks requests during performing the task.

### **GP 2.8 Monitor and Manage the Task**

The ServiceNow® with CMMI better monitors the change task planned for performing and managing the change activities and taking appropriate adjustment action, with obvious positive result. To keep the monitoring and managing level to each task is a critical action to achieving the optimised process.

Capacity maturity action to take is to keep the task progress under monitor and provide continuous adjustment based on the alterations from baselines.

The implication of resource management is to have continuous adjustment in place to ensure the resource allocation being optimised at all times.

### **GP 2.9 Objectively Evaluate Adherence**

Another goal described in CMMI template is to objectively evaluate adherence. And by tracking and maintaining the consistency of change activity in ServiceNow® for performing the change task according to its specification, standards, and procedures, and identify the flaws, it is rest assured the continuous improvement moving forward.

Capacity maturity action to take is to objectively evaluate adherence of the members following the plan in detail for the change task.

The implication of resource management is to ensure the plan is being followed and if there is alterations or flaw, they are being reported and evaluated.

### **GP 2.10 Review Status by Higher Level Management**

Ultimately the status, the activities and the enhanced outcome of the change activities stated through ServiceNow® are reviewed by higher level management board for the issues to be resolved at business strategic level.

Capacity maturity action to take is to take the review of the task performance aligned with high level management and issues to be resolved.

The implication of resource management is to ensure the high-level management board is aware of performance and issues occurred in the review, to provide baselines update to adjust resource allocation.

### **GG 3 Institutionalise a Defined task**

The task is defined as being institutionalised now by a set of rules established in ServiceNow®. The level of this goal depends on the measurement of the refinement of the institutionalisation of the rules being setup to the standard for the activities.

Capacity maturity action to take is to have the task defined institutionalised.

The implication of resource management is to ensure the defined task is in a standardised manner, being valid to evaluate.

#### **GP 3.1 Establish a Defined task**

The description of a defined change task in ServiceNow® CRM platform is established and maintained during the task being executed and project plan being modified. Keeping the description of the task on track helps EFX to ensure the change process under close control.

Capacity maturity action to take is to ensure the defined task is established according to its descriptions.

The implication of resource management is to have a stabilised progress on establishment of a defined task to plan the resource accordingly.

#### **GP 3.2 Collect Improvement Information**

The goal here is to collect appropriate measures, measurement assessment, and feedback information derived from preparing and performing the change tasks. By collecting, recording and analysing those information through ServiceNow®, the future improvement opportunities are enabled. The enhance reports is also automated to provide the possibilities of optimisation decisions to CAB of EFX's.

Capacity maturity action to take is to collect detailed measures, results and improvement information during the life of the task from planning to completion.

The implication of resource management is to use the collected information to feed back to get better resource management.

### **GG 4 Institutionalise a Quantitatively Managed Task**

The task is quantitatively managed as being institutionalised now by a set of quantitative measurements established in ServiceNow®. The level of this goal depends on how accurate

the quantitative measurements of the refinement are institutionalised, and being aligned with other change activities for the same unified standard, so the measurement is valid in comparison and assessment.

Capacity maturity action to take is to have the quantitatively managed task institutionalised.

The implication of resource management is to ensure the defined task is in a quantitative managed manner, being valid to evaluate.

#### **GP 4.1 Establish Quantitative Objectives for the Task**

The description of quantitative objectives for the change task in ServiceNow® CRM platform is established and maintained during the task being executed and project plan being modified. Keeping the description of quantitative objectives for the change task on track helps EFX to ensure the quality and performance is addressed with unified quantitative standards.

Capacity maturity action to take is to ensure the quantitatively managed task is established according to its descriptions.

The implication of resource management is to have a quantitatively controlled progress on establishment of a quantitatively managed task to plan the resource accordingly.

#### **GP 4.2 Stabilise Sub-Task Performance**

The performance of one or more sub-task is tracked and evaluated in ServiceNow® to testify the stabilisation and to identify the ability of completing the change task to achieve the designed quantitative quality and performance target goals. In the refined assessment level, the control over the change activities becomes possible in ServiceNow®.

Capacity maturity action to take is to stabilise the sub-tasks to a consistent performance of completing the change task.

The implication of resource management is to have consistent performance to enable the quantitative performance evaluation.

#### **GG 5 Institutionalise an Optimising Task**

The task is optimised as being institutionalised now by a set of optimisation targets established in ServiceNow®. The level of this goal depends on how the optimisation targets

are institutionalised, and being aligned with other change activities for the same unified optimisation goals, so the goals are valid in comparison and assessment.

Capacity maturity action to take is to have the optimising task institutionalised.

The implication of resource management is to ensure the defined task is in an optimising manner, being valid to evaluate.

### **GP 5.1 Ensure Continuous Activity Improvement**

The goal is to maintain a continuous improvement of the change activity, according to the tasks requests. ServiceNow® has provide a platform to accommodate the tracking of continuous improvement, constant review and analysis has made sure the improvement progress has continuous effects to the change process.

Capacity maturity action to take is to continuously improve the change task.

The implication of resource management is to have positive feedback on continuous improvement of the tasks and achieve the overall optimisation of the change process and resource allocation.

### **GP 5.2 Correct Root Causes of Problems**

Once the root causes of defects and other issues are identified, they will be corrected in the change task and logged into ServiceNow® CRM platform. The goal is critical as being the execution that provides the physical correction and adjustment to the work system to realise continuous up-lift of the performance.

Capacity maturity action to take is to identify root causes, the issues occurred during performing the task and reduce them by resolving the problems.

The implication of resource management is to keep the issues at a minimal level and eliminate the effect from the problems in order to make more accurate resource management plans.

### **4.7.3 Visible Optimisation with CMMI in Resource Management Process**

Before the optimisation, the management board has no other way but to prioritise tasks and projects base on the estimation off limited data sets. Resource allocation has always been inaccurate, causing peak and off-peak performance for the people responsible for the tasks.

After the CMMI measurements are set, there is more visibility of the velocity and capacity. This will provide valuable baselines for the teams and roles to focus on the weak spots and to prioritise, manage and adjust the tasks in order to create a productivity elevation.

#### **4.8 CONCLUSION**

The CRM Capability Maturity Model can be used to assess the CRM process maturity of enterprise users, to assess the maturity of the vendor's CRM system (rather than simply good and bad) to assess the maturity of the CRM project (rather than simple successes and failures). The utilisation and improvement will continue to promote the orderly progress of the CRM industry.

Rating the maturity of an enterprise's CRM process, configuration and implementation can effectively be useful for planning, organising, leading, controlling and managing. It can improve the progress of the project, and can promote and assess the work of CRM utilisation improvement. Collection of CRM online capabilities data and maturity assessment can include taking surveys, monitoring, interviewing, tracking results and data from other methods. Based on a CRM capacity maturity assessment model, detailed interview questionnaires, data collection, and an evaluation system will be the main tools. For a specific evaluation project, the final CRM Capability Maturity Assessment will form a Competency Maturity Assessment report that includes a CRM Capability Maturity Graph and a Text Report that will provide an overview of current competency status, best practices, optimisations, and prospects. It is particularly important that the report is not fixed, but dynamic, will continue to track the assessment.

In summary, rating the capacity and maturity of an organisation's CRM implementation can effectively plan, organise, lead, and control the progress of the project, for which productivity elevation is possible with much less cost and effort than further investment into the current team.

# **Chapter 5**

## **Discussion of Findings**

### **5.0 INTRODUCTION**

In the previous Chapter 4, the ServiceNow® functions and working environment of EFX are reported focusing on tasks, roles and resource management of one single process (Change Management Process) in the development life cycle. CMMI has also been introduced to experiment for an outcome of quality improvement of resource management in the change tasks. All the practice has been applied according to Chapter 3 methodology with minor adjustment. The research findings enable the researcher to see that the theory of CRM and CMMI can be utilised collaboratively for resource management within a complex software development environment to assist project management, process management and resource management for an optimised productivity elevation.

Based on the research findings from Chapter 4, a comprehensive review is going to be made in this chapter 5 to find the answers to research the questions, the hypothesis, and the extent to which critical reflections may go. Chapter 5 contains 5 sections, Section 5.1 is to cover the minor alterations of the research methodology that were made in practice. Sections 5.2, 5.3 and 5.4 are the comprehensive discussion and complete answers to the research question, sub-questions and hypothesis summarised in Chapter 1. These will be done according to the facts and outcome in the research practice with analysis with the associated theory support from Chapter 4. The chapter will then be wrapped up in Section 5.5 as a conclusion, being a justified summary of all the answers.

### **5.1 ALTERATION TO RESEARCH METHODOLOGY IN RESEARCH PRACTICE**

After the actual research practice being started, there are a few alterations that has been made to amend on the original research plan. These alterations were necessary in order to make the research work in practice. The changes were mainly refinement of the questions and focus on a particular part of the work system to suit the scope of the research. Also, the most critical, singular, and most effective use case is sampled for the best result. The following subsections summarise these changes:

### **5.1.1 Resource Allocation Focused**

At the beginning of the research, process management is thought to be the first priority when optimisation and quality improvement are to be made. However, as the research proceeded through document analysis and observation it was clear that a subset of process management was fundamental to determining the biggest gains and quality improvement. Resource management issues were to the fore and these were seen to causal factors that influenced many of the other processes. In particular the availability or lack of availability of resources could cause bottlenecks and disrupt the intended workflow. Hence, it seemed relevant to focus in on resource management, the distribution, and the allocation of resources is a significant factor in quality improvement for project management. It is natural and research that acid progresses things become more focused and it is easier to concentrate on key factors that will give the outcome and satisfy the aim of the original research proposal.

### **5.1.2 Not Sampling the Whole Processes/Workflows**

The original plan is to take a use case of a whole processes along the SDLC, but while examining the processes of EFX, it was found that according to the scope, the EFX processes are far too complex and will take much more than this thesis could contain. So, it has been changed to only sample one process and apply the experiments in much more contained and controlled scenarios to show the effective results without the involving other side factors and complications from the EFX working environment.

### **5.1.3 Focusing on Change Process, Already an Effective Result**

To support the decision of Section 5.1.2, that I only take change process as the use case, then change process has been proven to be a complex process involving many tasks, resource management cases and roles with relationship management issues. The tasks can be experimented with applied CMMI designed measurements to demonstrate the hypothesis and provide enough evidence for summary and answers to the research questions. Also, being the final process of the SDLC, the change process is most critical and important process that will benefit most in the software development house of EFX. Hence, the change process was selected as the only process to be studied.

## 5.2 ANSWERS TO SUB-QUESTION

This section, starts with bring summaries and answers to the research questions from the collected evidence and results presented in Chapter 4. The answers to each sub-question are provided in tabulated format so that the evidence may be summarised and presented from chapter 4. In order to give a valid answer to the main research question, the four sub-questions summarised in Chapter 1 will be presented, answered and analysed.

**Table 5.1 Sub-Questions with Answers**

Sub-question 1	How are IT services measured?
Summary	<p>In section 4.1.2, a key point is made that the IT service delivery level with event based prioritisation is the main goal of the IT services. And in section 4.2.3, the detailed approach of the Software Development Life Cycle contributing to the ultimate goal of IT service delivery is revealed in multiple depths of IT service processes, activities and resource management. Those being the exact score points that rank an IT services goal for delivery.</p> <p>In section 4.3, processes are examined and presented with one particular example that is measured currently in ServiceNow® CRM system, for technical details and status details, which has a limited resource planning application for decision making based static reports.</p> <p>In Section 4.4, Activities in change process in particular are discussed to show the teams work towards the mile stone of the process, contribution of each activities to the process, and the collaboration of the teams and roles, leading to the resource discussion in section 4.5.</p> <p>In section 4.5, resources are discussed in the use case background to show the critical impact and potential of improvements. Human resources are the most difficult to measure and manage, but will have the most effective result upon optimisations.</p>
Answer	IT services are measured by process, activities and in resource management approaches, ultimately for its quality delivery. And Resource allocation has the most effect on the productivity improvement.

Sub-question 2	What are the critical system attributes for measurement?
Summary	<p>In Section 4.6 it was discussed that apart from the static reports from CRM logging, the visibility of the capacity is required to be measured to enable the resource management board to have a more detailed resource planning opportunity.</p> <p>The attributes are described in section 4.6.1, where the criticalness is discussed with and without the proper measurement and analysis. Flaws are also exposed when resource planning only relies on CRM statistics. A brief negative consequence is also explained in the same section.</p> <p>A plan should include measurement of the dynamic measurement and analysis with CMMI that described in section 4.7.2, where a series of Special practice goal and general practice goal are designed to measure the tasks to provide dynamic measurement and analysis upon the capacity of each role performance on the tasks. This will provide more useful information for the resource management board to prioritise rather than only using CRM static reports.</p>
Answer	Apart from CRM static reports from activities logging, CMMI designed measurements are critical for the resource management board to make a more detailed and dynamic resource management plan, ultimately leading to process optimisation.
Sub-question 3	What are the measurements used for?
Summary	<p>In section 4.2.3.4, it has been explained how the measurement is fed back to the system for measurement, continuous improvement and re-engineering of the processes with four teams involved as resource input to the projects.</p> <p>In section 4.6.2, the productivity improvement is discussed as the ultimate result of utilising the measurements in the resource management planning, stating that, ‘As long as CMMI tools can be properly deployed, utilised and evaluated, the resource management board will have a much comprehensive base line for the resource planning, ultimately there will be a major productivity elevation. ‘</p>

Answer	The measurements are used to loop back to the system continuous improvement and re-engineering, through improving the resource planning based on the measurements and analysis.
Sub-question 4	How are defects disclosed by CMMI assessment?
Summary	With designed CMMI measurements as defined in Section 4.7, effective measurement and analysis as possible. In the use case, the designed CMMI assessment included three special practices by goal and five generic practices by goal to assess. Each of the goals has been defined with measurements, the analysis of all the measurements is summarised with a descriptive score that shows the true capacity and performance of the task. Comparing each score of the tasks will show the particular tasks with flaw and the root cause of the problems, which is marked in GP5 for institutionalisation of an optimising the task. The CMMI tool is also exposing a lot of other dynamic information to form the baseline information for the resource management planning and continuous improvement.
Answer	The defects are disclosed by applying CMMI assessment through measurement and analysis to each task and comparing the score and scale for decision making.

### 5.3 HYPOTHESIS TEST

In Chapter 4.7 conclusions have been drawn to justify result of using CMMI tools in the measure and analyse tasks for process optimisation in order to provide quality improvement opportunities for IT services. Table 5.2 Hypothesis Testing will extract the points from chapter 4 to evaluate the hypothesis presented in chapter 1.

**Table 5.2 Hypothesis Testing**

Hypothesis	CMMI gives quality improvement opportunities for IT services.	
Variations	For	Against
Summary	For each task in the process, the CMMI tool application practice	On top of the normal CRM tracking and reporting, adding CMMI

	<p>gives dynamic descriptive provision for the resource planning, which enables them to make comprehensive resource allocation, on top of the prioritisation made upon CRM static reports.</p> <p>CMMI tool gives parallel comparison for each task to be measured and analysed.</p> <p>Although the cost of fund and effort of the establishment if large, the establishment is on-off, and the return is great and obvious.</p> <p>Selective use to begin the adoption will ease the cost burden, and providing a practice space in which to perfect the techniques.</p> <p>Making careful analysis and planning for implementing the CMMI assessment will avoid the extra cost for adjustments.</p>	<p>assessment is an extra investment, which will require additional funding for the system to be setup.</p> <p>As the CMMI assessment is comprehensive approach, the cost is depending on the complexity of the working framework. Establish the CMMI tools into some complicated process or working environment will be of a large cost.</p> <p>Also applying the CMMI tool will be quite an effort for the team members as well for the extra work of auditing their work and retrospectives. And this will be a continuous job.</p> <p>Continuous adjustment of the CMMI assessment plan is the key of maintaining of getting the comprehensive effective outcome.</p>
Determination	Beginning within the reasonable scale of use and with carefully planned implementation, CMMI does give quality improvement opportunities for IT services.	

#### 5.4 ANSWERS TO MAIN RESEARCH QUESTION

The following Table 5.3 answers the Main Research Question presented in Chapter 1, based on the results evaluated above and the sub question answers.

**Table 5.3 Main Research Questions with Answer**

Research Question	What resource optimisation value has CMMI for IT services delivery?
Summary	<p>As concluded in chapter 4.8, CMMI can assess the processes and tasks within the CRM framework. It provides provisions of the capacity and maturity of the processes, activities and resource allocation, which enables a more comprehensive resource planning. It contributes to the ultimate outcome of resource optimisation for IT services delivery.</p> <p>And further thinking of the usage and the future of the practice can be utilised in the whole industry for more generic application, ‘such as: CRM vendors, business users, consulting organisations, consultants, the Ministry of Information Industry and relevant ministries, relevant practitioners, etc.’</p> <p>And ‘In summary, rating the capacity and maturity on top of an organisation's CRM implementation can effectively plan, organise, lead, and control the progress of the project, with which a great productivity elevation is rewarded with much less cost and effort than further investment into the current team.’</p>
Answer	Utilising CMMI for IT services delivery will have many positive outcomes on resource optimisation by its ability to use measured and analysed assessments.

**5.5 DISCUSSION**

Being the core element of the research, the Capacity Maturity Model Integration is defined in relation to current business models, followed by presentation of relationship of business processes and their activities resources and metrics. CRM software is also defined, and a scope is provided with practical field work with CRM as backbone system for industrial process management. A review of issues and problems has also been concluded with evaluation and analysis in justifying a researchable context and problem. This is found to be the foundation of the EFX work system that utilises the ServiceNow® CRM for its work system. The observations and definitions have been explained in section 4.2 and the relevance to the research justified.

In detail, the nature of the general business process was discussed from the definition of the business processes, to activities within, until resources required as input, ending with how the metric measurement method is setup and influences work. The business process is described as a chain of occurrences with inputs of resources specified to draw to a milestone for achievement. It is to add value to the customer with a collection of related or structured activities or tasks that produce service or products. It is also goal related and in specified environment for the goal of customer satisfaction. They can be categorised as governance, management, and operations in function; and subcategorised as primary and secondary and tertiary in networking and interaction. A process is embedded in relationship to many other elements and systems. Devonport (1993, p. 9) defined business process as: “a structured, measured set of activities designed to produce a specific output for a particular customer or market.... It is a specific ordering of work activities across time and space, with a beginning and an end, and clearly defined inputs and outputs. It is a structure for action. Processes are the structure by which an organisation does what it is necessary to produce value for its customers.”

Inside a business process, there are a series of planned small units of work that contribute to the completion and satisfaction of a process. Activities can be described as tasks that are the attributes of business requests. Usually, tasks are the fulfillers of the processes, which needs to be finished in a timely and orderly manner, and one may depend on another. A Task can be broken down once more into assignments which would also have their own timed start and end date to be a successful completion.

It has been mentioned the resources how are the input to tasks, and they can include different types of them, as described in Chapter 4.5. Resources require planning, scheduling and management; and in IT development environment, consequently, trained personnel with support software that distributes and optimises the use of resources. The most important part of the resource is the personnel, and the most important resource management is planning. A list of different types of resources are required to be set up for each of the tasks before it can start. Resource planning is the detailed forecast in quantity to optimise the use within a forecasting model for predictable business deliverables and can harmonise within the life cycles of the many interacting systems with minimal managed issues. A Resource plan requires scheduling that enables effective and efficient distribution base on the schedule and requirement of the tasks. Although the resource allocation plan is an important tool for the

effective management of scarce resources, the optimisation of utilisation is the ultimate key in reality.

For optimisation of any process or resource management, there needs metrics, which are forms of measurement to reveal the variation between two attributes. But due to the complexity of the business operation, it is difficult to design a metrics system for the business to measure their performance, and other attributes. The nature of metrics is a set of numbers to show the hidden attributes of a task or an activity. And Quality metrics also measure processes and process capability instead of only simple count results.

CRM was reviewed to give the foundational aspects of CRM as a business centric conceptual introduction to the ServiceNow® CRM platform in EFX, discussed in later sections. Apart from being a business concept, it is also to be utilised as a management system, of people, processes, and technology that interact. CRM is a core enterprise system that mediates and generates value for a business through being a management tool for multiple elements, as process management and resource management, which are the two main factors discussed further in chapter 4.

Figure 2.3 (Customer Relationship Management Structure) shows a generic structure of a CRM system, which is the core foundation for an enterprise system. As CRM is used widely and uniquely in each environment and process, In EFX, ServiceNow® is highly customised according to the plan and design to provide tracking for management attention and workflow for members to follow. As the research shows for the ServiceNow® environment a summary figure 4.2(Observed IT service framework at EFX) gives the current CRM structure of EFX's customisation. The basic CRM function in software development environment is being used to control process, in relate to approaching to service automation as long-term goal. For its current process managing role, the CRM is at the stage of transition from product focus into process focus. The nature of the business of an enterprise is rather complex, data centric, less stable, and in a constant state of transition. As mentioned in section 2.3.3, "CRM is a business strategy to manage, select, and know customers, and for the extraction of long-term value from the customer relationship. It is strategic and a strategy, and connects the three elements of people, technology and processes. From a simple data perspective, a CRM has a multiple of processes to manage customer contacts and customer information."

Resource Management is also highlighted once again in context of CRM system. A big portion of the CRM function is to monitor the resource utilisation and provide transparency to the business. The procurement and distribution or allocation is proven to be the key successor to the enterprise systems. ServiceNow® function is the same as being defined in section 2.3.4, “One aspect of the CRM is to mediate the effective and efficient expenditure and distribution of resources within the enterprise system. The allocation of resources is an economic activity where supply and demand are managed in relation to the satisfaction of value. Some of the control features include the trade-off between participant parties, the balancing and the equilibrium is of competitors, the utilisation of cooperative games, and the strategic design of bartering and trading systems within the enterprise.”, where efficiency is made in resource utilisation. Resource levelling is a usual technique that can reduce both shortage and excess inventories.

To effectively manage resources, on demand data feedback and tracking for different resources are highly relied on. The goal is to maximum out the resource utilisation, ideally 100% to extend the potential productivity. However, it is not possible in reality, being a quality management problem. The balance of cost effectiveness is the key in this case, where reasonable cost can produce the most favourable resource utilisation rate. Again, the retention of skill groups and the capability for up skilling is a critical for an efficient and effective resource management system.

CMMI and quality improvement is the main focus of the research. CMMI has been evolving since it was first proposed, and now is covering many more fields and industries for capacity and maturity assessment. The strategy concerns in designing a resource model has been raised as the “key concerns on undertaking this research is to understand optimisation of resources in the work system.”. CMMI was introduced as a methodology to be applied to a current system to bring quality improvement and measurable effective results.

Stages of the five-maturity-level are discussed along with the implementation schedules available for each process areas, although not all process areas can be applied with our use case working environment. Structures and process for applying the five CMMI levelled model is explained, where basic functions are required to be performed, and each level of maturity contains different process areas. It was learnt that organisation and metrics will have varied impact on applying CMMI model, hence the CMMI model needs to be designed accordingly, with a template or tool. Figure 2.4 (CMMI Architecture) has the

CMMI terminology and structure that is used for CMMI application. The research shows that the CMMI framework can be adapted based on the structure shown and applied to EFX's work system as an activities and task assessment tool. As seen in the figure 2.4, the five maturity levels can be seen in each of the three process areas, which contains specific goals and generic goals. The specific practice goals include baseline set out of sub-tasks, specifications of the products and service, control and management, implications to the system, review of practices, objectives of practice goals, tracking of practices and references, all built into ServiceNow®, in alignment of the same baseline requirements, as well as the implications from generic practice goals. The structure is used later in section 4.7.2 for CMMI implementation design of the research practice.

Two outlined key organisational concerns are found in the work systems. Transformation from traditional business to enterprise system requires business process to be focused on in enterprise system, where CRM is adopted to control and provide detail of the process status of the business process. It is shown that capacity maturity is a process oriented measurement methodology that contributes valuable intelligence for the management of enterprise systems to make process and resource planning decisions.

The core dependency of business process is the resource input, and the optimisation of the resource utilisation is the only key for an optimised work system, because the resources are the key enabler for a business process to be achieved through tasks and activities. Resources need to be planed and allocated and by tools to utilise and negotiate the optimal use of resource. The estimation of business process based on qualitative and quantitative evidence is used to ensure the delivering of resource. Optimised resource distribution is delivered through optimal solutions in every situation as there is no perfect plan for all the different scenarios.

Therefore, the CRM system as the touch point of stability and tool for negotiating resource distribution is adopted in many business processes, where it smooths the business process management and influences the decision making around optimisation of resources in the work system. Applying CMMI in the CRM platform will enable a comprehensive vision for the business to manage and resource for quality improvement. Based on the previous discussion and research questions answered, CMMI is bringing the following optimisation value to the IT services.

- It ensures the quality and progress efficiency, through standardisation to the 'ad-hoc' software development processes.
- It will benefit the resource management. As the quality and progress is standardised, the waste on resource alteration and defects of the process is reduced, leading to a cost saving. This is an easier approach than applying patches after finding the process flow after the project finishes.
- It helps to bring the IT personnel to lift on their expertise. All the members involved in the process, from IT team, business team, management team to Operations team, will perform with professional and standardised method in completing their tasks.
- It solves the issue with human flow issue. Through tasks and processes improvement, and knowledge base sharing experience, the projects will no longer depend on the skill set of a person.
- It helps to improve the resource management level for the company and its employees, contributing to continuously improvement on efficiency. The company's performance metrics is also established through measuring and analysing development processes.

## **5.6 CONCLUSION**

In this Chapter 5, a comprehensive discussion was made based on the research findings presented in Chapter 4. This Chapter has answered the sub-questions formulated in Chapter 3, and also tested the hypotheses with arguments made for and against to draw a conclusion on whether each hypothesis is accepted, rejected, indeterminate or conditionally accepted. Based on all above statements, the research main question was answered and discussed. The difficulties encountered during the use of the CMMI tool to implement a measurement in the current work system was acknowledged, and an easy method recommended for IT service delivery resource management optimisation made.

Chapter 6 will conclude this thesis by summarising the research findings. The limitations of this research will be discussed, and recommendations for future research will be presented, in order to provide a link to further potential research in the field of further resource optimisation value CMMI can add in IT services delivery.

# Chapter 6

## Conclusion

### 6.1 INTRODUCTION

Through the previous chapters, the sequence has been followed to complete the research plan and methodology. In this chapter 6, first the contribution will be clarified, and consideration given to who will benefit from these findings. Further consideration is given to how the research can be valuable and critical to the work system in the use case. This includes, how the research is close to the IT environment and the importance of the research findings. In section 6.3 five open topics arising from the research process, and relating to the main research topic, I developed as proposals for further research. One topic is the business execution plans and cost effectiveness, one is further thoughts about the theory evidence through the research practice, one is extending potential methods for the same goal of the research, one is utilising the same approach to a similar process within the same environment, and the last one is to practice the same method in different field.

### 6.2 RESEARCH CONTRIBUTION

The research has been beneficial in many ways to both practice and theory. Because this research was undertaken as a singular case study in one workplace then the findings probably have limited ability to be transferred into other contexts. However, the general concept has been explored and shown to be useful. Consequently, other people can take the CMMI framework, in addition to the demonstration provided in this thesis and discover for themselves how it may be useful for process capability improvement. Based on the setup of the research it is necessary to limit the scope of the intervention initially. Once a singular process is benchmarked within any work system, then it is possible to take other processes on a case-by-case basis, for CMMI quality improvement. It has also been shown that the theory or a theoretical artefact can be taken from the literature and tested in a live work environment.

Another contribution from this case study is that it is shown the CMMI tool can be applied to a work process for better resource management decisions. It can be used for

optimisation of the allocation and distribution of resources. In one of the key areas the balancing and the improvement of capability can counteract the bottle neck affects that happen in and around scarce resources. For example, human resources are critical to any software development process and if they are a scarce skilled group that has many inhibitors with negative consequences for the overall business. The results of the experimentation undertaken in this research show that the CMMI tool implementation contributes towards resource management optimisation, which provides a positive effect on the IT software development and service delivery optimisation.

The results shown from this research are an improvement on the previous CRM system that only reported the status and progress of the software development. It lacked detailed statistics and evaluation of the workload status and performance of the tasks completed. Applying the CMMI measurement tool into the current use case environment improved the information quality that managers had access for decision-making. Much more could and should have been done to understand the full implementation of the CMMI tool but what has been achieved has been achieved within the resources and time constraints of the project. Before the adoption of CMMI, the resource allocation was purely relying on the business and project knowledge of the managers. The capacity and maturity of the people and team was ignored, and the subsequent problems of down time and bottle necks during the processes were apparent. After the application of CMMI assessment, the resource utilisation has been greatly improved, and if subjected to further quality improvement cycles the system could be optimised. The better vision of velocity and capacity makes the decision making and planning by management board easier, more precise, and more predictable.

To transform the theoretical CMMI knowledge into practice for improvements, requires a series of refined generic practice goals and specific practice goals according to the documents used and reported in chapter 4. These combined the real work system attributes with the theoretical requirements for measurement and evaluation the guideline provided in section 4.7.2 can be used by others and further expanded for other business processes. The GPs and SPs were run along with the configured ServiceNow® platform. This has created an obviously positive outcome. Both staff and managers now have a clear vision of their capacity and maturity levels on each of the tasks and can make effective adjustment on their prioritisation and resource allocation plan.

The highly customised dynamic report from CMMI assessment has the ability to continuously track and monitor the status and result of the work system. Each action is actively assessed by CMMI tool provided, rather than a static report, which does not usually give useful information for business process optimisation, as it lacks comparable scales. With the comprehensive dynamic breakdown report, many details are revealed which have never been represented to the business before. Taking this as the baseline, it enables many opportunities for the business to get better control over the process and resources, to know the weak spots of the processes and roles, to make confident decisions and detailed planning, and to predict the risk and flaws that might occur in any particular projects and processes.

The provision also provides the clear goals for people to upskill their ability, knowing the capacity being at a lower level, they can gain a higher level by training, study and visit trainers for the business knowledge. Overall the CMMI has opened a portal to the business and many potential optimisations become possible, including assessments for performance improvement utilisation.

### **6.3 OUTCOME HIGHLIGHT**

The outcome that can be highlight is on the area of the optimisation value can be carried out showing by the CMMI application to the current framework of SERVICENOW®. The weak points are exposed enables for more precision and efficient estimation and resource allocation. This is the key successor to the optimisation of an IT development process.

### **6.4 FURTHER POTENTIAL RESEARCH**

During the yearlong research and observing the result focusing on the outcome, apart from the theory being proved and evidence being collected and discussed, there are also many extra questions and further potential research possibilities. The following subsections outline some of these possibilities.

#### **6.4.1 Ideal CMMI Cost to Outcome Balance**

After the theory is proved with positive results explained in the discussion, the most important next step is to transform it into productivity through applying it into work systems. The problem is discussed in section 5.5 to provide the working solution for IT business to adopt an effective method. CMMI will benefit the organisation with a better vision of

capacity and maturity for team effort. However, there will be quite an initial investment and running cost for the implementation. As discussed in Chapter 4, to reach the 100% resource utilisation will cost the business a fortune and extreme effort of the personnel to realise. So, the question now is what is the breakeven point? How can the business calculate this? Can it be quantified? Is it industry or development methodology related? All the questions can be further explored and investigated to find answers. The patterns and answers from a formalised investigation is a way to evaluate the business process and find the best targets, for example, 95% resource utilisation with half of the cost of trying to achieve 100% resource utilisation rate. This will be a good research topic as without effective adoption with a forecasted payback, the theory cannot show its value.

#### **6.4.2 Different Focus on Capacity and Maturity**

CMMI considers capacity and maturity as a combined concept, although in practice, there are situations found that one is more focused over the other for certain tasks in general. A simple example is a mature person might not be capable for certain tasks. Maturity is the skill level of a person in its role, longer he is in the role, higher the maturity level he is for the role. The capacity will not grant the person higher maturity when the person is shifted to a new role. Capacity is the ability required to complete a task, including basics, such as intelligence, communication, logic, and creativity; and professional ability such as programming language and testing ability.

Bearing that in mind, some of the tasks in reality might focus on capacity more than maturity, and vice versa. It is important to justify the focus for the particular tasks and roles depending on the priority, urgency and critical level of the tasks in order to get the ideal result from utilising CMMI in real work systems and in a large organisation with complex human resource management.

#### **6.4.3 Further IT Quality Improvement Options**

IT service is all about delivery quality service and products in a timely manner. CMMI has great benefit for the management board to get clear vision of the work systems, to make the right management decision and plan, as I have discussed in chapter 5. And most of the software development environment are complex and CMMI can only solve some of the issues. For more issues in the development methodology, there will need more methods to contribute

for IT quality improvements. Also, even in the same fields multiple methods can be applied to further improve the quality of IT delivery.

#### **6.4.4 CMMI in Software Quality Assurance**

QA is a special process in the software development life cycle. Based on different software development methodologies, it has different approaches. In most cases, the QA process is throughout the whole software development life cycle. And according to different phase of the SDLC the QA approach and required tasks are different. Taking CMMI as being the generic tool for evaluation of the process and resource requires consideration. There will be a good match for them, but each process and task have to be considered on its own merits and interpreted for effective CMMI measurement. QA always has challenges when distributing resources and prioritise their use due to the nature of having many dependencies, and a well-designed and carried out CMMI assessment will add extra value and keep the QA team awareness sharp and provide much-needed detailed status information for QA planning their tasks and allocate resource. Hence, further research is required into the application of CMMI to software quality assurance.

#### **6.4.5 Resource Optimisation for IT Service Automation**

IT service Automation is a popular topic at the moment in IT service delivery. I have been doing research in IT service automation for a number of years. From my previous research on IT service automation, it is noticed that there are many IT business utilising SOA and SAAS that are in need of assessment tools for their automated processes as well as their software development process. There are actually several topics that can be derived in this area. For example, topics can be: how to integrate CMMI into service automation, or how can CMMI assessment feedback to the work system of IT automated service. There is also another topic that is whether the CMMI tool can be implemented into service automation, the fit with service automation, the CMMI assessment built-in possibility to the automated IT services process, and, automatic feedback for an automatic adjustment and control by one IT automated service system. By integrating CMMI tools into the automated IT service, the whole Service Oriented system will become a self-improving system, which will produce greater efficiency for the business processes.

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# APPENDIX

## AMENDMENTS

Marker	Issue number	Issues	Solutions
A	1	Definition of the research question comes too late.	Research question is put in Chapter 1 and justified.
	2	Organisation and the management structure explained and analysed too late.	Organisation information is put in Chapter 1.
	3	Research environment detail required in Chapter 3	Research environment described in Chapter3 now.
	4	General comments	The comments are noted for future improvements.
	5	General comments	The comments are noted for future improvements.
	6	Extending research and study	Paragraph is added to highlight the outcomes and future potentials.
B	1	Overall positive comments	No changes
C	1	Clarification of research	<ul style="list-style-type: none"> <li>a. Inserted clarification of terms and actions into Chapter 1 and Chapter 3</li> <li>b. This is an action research project where the questions and data emerge in practice. The distinction being made by the market fits a different</li> </ul>

			research approach, no change
	2	Availability of literature in area	Marker is correct regarding absence of literature regarding action and practice. My research is a contribution to fulfil the gap.
	3	Nature of study approach	This is an action-based research project in industry as stated in Chapter 1 and Chapter 3, which are not all the other approach the marker suggested.
	4	The criticalness of the outcomes	The purpose of the research is focused on expose the weak points of the process, which is described in Chapter 4. The optimisation however would have to be proven in quite a term of period, which is expected and will not be included in the deed.
	5	Reflection on significance	Clarification is added to Chapter 5 in discussion section.
	6	Proof reading required	Full review undertaken.

**Completion of Amendments:**

All key points addressed form each marker have been explained and amended in the original thesis as listed above.