

# **Exploring the Impacts of Organisational Change: A Structured Prediction Approach**

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## **Abstract**

This was a qualitative, single case study that investigated the operational and relational dynamics of a multifaceted change process within a large Australian company. The Company had an extremely complex organisation and supply-chain structure and often its entities were severely impacted by change in a number of different ways, at various levels within the organisation. This set in play a cause and effect scenario of dysfunctional events resulting in supply-chain procedural anomalies and operational inefficiencies. The literature revealed other industry types were also susceptible to change and had suffered operational inefficiencies as a result. This study adopted a multi-theoretical approach to explore the complexity of organisation change with a number of paradigms used to guide the data collection and analysis processes. Moreover, the study combined qualitative case study and systems analysis and design (SA&D) methods in the research design, which added to the quality and reliability of the research findings. The data analysis methods used included triangulation and conceptual modelling.

The literature revealed that, popular change management tools and frameworks had failed to deliver expected results. A key issue was their inability to decompose organisation entities to their lowest denomination (or their lowest measurable unit of change). This study used a mix of high-level and low-level formalisms to capture and assess the implications of an organisation change process, and to develop the automated change tool (ACT). This approach was a substantial advancement on current organisation change tools and frameworks, and other comparable products. A key benefit of the ACT is that it enables the automated derivation and assessment of the key change entities; policies, processes, systems, roles etc. implicated in a change process. Further, the ACT incorporates real-time data analyses and scenario building to accurately assess, predict, and communicate organisation change.

The researcher argues that these findings may be applied to extend organisation change theory. Moreover, these findings can be generalised outside of the case environment, and the ACT principles can be applied to resolve organisation change issues in other industry types.

## **Student Declaration**

“I, Robyn Watters declare that the PhD thesis entitled ‘Exploring the Impacts of Organisational Change: A Structured Prediction Approach’ is no more than 100,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography, references and footnotes. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own work”.

Signature:

Date: March, 2011

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# Chapter 1

## Introduction

### 1.1 Research Context

The organisation ethos as we know it today was shaped from the manufacturing industries of the industrial revolution (Drucker 1999; Hope & Hope 1997). Organisation theories, and their related management practices, were initially formulated through the Classical, Scientific, and Human Relations schools of management (circa 1700-1900s) to assist the operations of the industries of the industrial revolution (Crainer 1998; Morden 1996; Shafritz & Ott 1987). Management 'schools' of that period embraced a diverse range of organisation theories (and sub-theories), which in turn, were underpinned by an array of respective management practices, and organisation designs (or structures) (Crainer 1998; Drucker 1999; Morden 1996). Organisations of that era were heavily departmentalised and considered by early theorists to be necessarily isolated, 'static structures' (Shafritz & Ott 1987). In contrast, the Hawthorne Studies (1930s) theorists embraced Ludwig von Bertalanffy's general system theory (GST) whereby organisations were considered complex, dynamic, interrelated 'open systems' subjected to perpetual change (Shafritz & Ott 1987). Following World War II (WWII) the Tavistock Institute of Human Relations formally identified the 'socio-technical' concept where the organisation was viewed as a system of delicately balanced complex interdependencies (or 'technical and social sub-systems') that formed the organisation environment (Morden 1996; Trist & Murray 1990). The 'systems' approach foremost incorporated management practices that identified and analysed organisational elements and their interdependencies (Shafritz & Ott 1987).

Traditional organisation theories and management practices of the nineteenth century (C19<sup>th</sup>) were considered inappropriate because of the complex nature and intertwined relationships that underpinned organisations of the rising modern economy (Drucker 1999). Contemporary theorists leaned toward the

systems approach to gain better insight into the multi-function, corporate entities of the 1960s (Miner 1978). These multinational entities were driving local and international competition into the 1970s and 1980s with increased emphasis on operational efficiencies and environmental stability (Daniels 1994; Porter & Siggelkow 2008). Consequently, new management practices emerged; strategic, marketing, customer relations, change management, and technology innovations such as just in time (JIT) supply, and electronic data interchange (EDI) (Chang, Makatsoris & Richards 2004; Fredendall & Hill 2001; Ross 2004). During the 1990s, organisation structures changed dramatically with significant trends towards virtual private networks (VPNs), strategic alliances, and business process re-engineering (BPR) (Attaran 2003; Daniels 1994; Morden 1996). At that time, organisations became increasingly complex and management responded accordingly with the proliferation of sophisticated decision support systems (DSS) and management practice tools (Drucker 1999). In recent times, organisations have strived for invigorated BPR (Attaran 2003) and autonomic communications (Davy et al. 2006) to accommodate the 'virtual organisation' (VO). In the latter instance, management practices and frameworks were embedded within the systems to affect automated decision controls (Fokus 2004).

According to Morden (1996) the industrial revolution was the precursor of organisation change, a continuous change cycle triggered (or driven) by external or internal influences. Drucker (1999) viewed organisation change as a 'natural' and 'acceptable' occurrence, a sign of 'growth' and 'expansion', the organisation *raison d'être* manifested through innovation. Technology innovation had been pivotal in defining the modern organisation, principally through the adoption of integrated strategies, notably; automated and real-time transactional processing, and inter - and intra - organisation workflows (Chang, Makatsoris & Richards 2004; Fredendall & Hill 2001; Ross 2004; Sander & Schechter 2002). However, technology alone was not the primary innovator of organisation integration. A mix of inter - and intra - organisation elements and practices (incorporating the socio-technical spectrum) were required to ensure integration of the organisation system (Chang, Makatsoris & Richards 2004; Fredendall & Hill 2001). Similarly, contemporary organisation

theorists advocated the exploration of the interconnectedness of organisation elements (Cao & McHugh 2005), a practice not dissimilar to that proposed by the system theorists (Morden 1996).

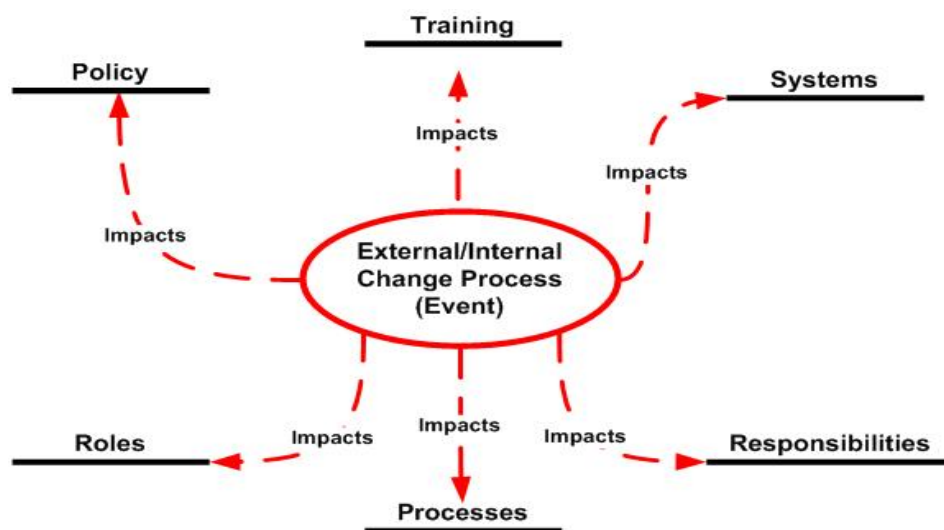
Organisations were subjected to change as a result of purposive or reactive behaviour (Miner 1978). Given the complexity of the modern operational environment, organisations had to be intentional in their planning and control of change (Miner 1978). Notwithstanding the plethora of organisational change management practices available, these often failed to deliver the desired or expected results (Cao & McHugh 2005; Coulson-Thomas 2008; Lang & Zangl 2008; Shafritz & Ott 1987). Similarly, the technology innovations, enterprise architecture (EA) (or enterprise modelling (EM)), had delivered less than successful outcomes (Bernus 2003a; Lang & Zangl 2008), while BPR had been used by business analysts with varying degrees of success (Nickerson 1998). ***The success rate of any change innovation or practice was questionable unless all interconnected elements were captured and analysed collectively to inform an overall change solution (Cao & McHugh 2005).***

## **1.2 Research Problem**

This study investigated the operational and relational dynamics of a multifaceted change process within a large Australian company (henceforth identified as the Company), with an extremely complex organisation and supply-chain structure. The investigation focused on the Company's supply-chain procurement activities, which were most vulnerable to external and internal change triggers. The Company, for a number of reasons, had been unable to respond readily to change leaving it in a state of constant flux. The investigation showed the Company was susceptible to various internal and external events with a number of its components stressed as a result of a change process. For example, the Company's policies, processes, responsibility arrangements, roles, training programs and [information] systems, were impacted in a number of different ways, at various levels within the organisation. This set in play a cause and effect scenario of dysfunctional events resulting in supply-chain procedural anomalies and operational

inconsistencies. The supply-chain components affected by the changes are illustrated at Figure 1.

The Company's attempts to respond to these changes led to further inefficiencies than was previously the case, with misalignment of supply-chain components and interdependencies. The Company had implemented various 'best practice' management frameworks and technology innovations with varying degrees of success. Clearly, the Company was unable to comprehensively and accurately assess and manage any changes to its supply-chain environment. The extent of the problem was recognised by stakeholders at the coal-face of the organisation but not at the executive level where the majority of the strategic decisions and subsequent organisation changes were executed.



**Figure 1: Supply-Chain Change Impact Components**

### **1.3 Research Objectives**

The research approach was based on the premise that any attempt to manage or understand organisation complexity or change should be underpinned by an automated solution (or decision system). The DSS was originally designed to provide both data and modelling assistance for semi-structured decision-making, which according to Alter (2006), evolved toward decision automation or knowledge management systems (KMS), and work systems. This study has taken the approach that, any DSS, or similar tool, would be redundant if it did not consider the relevant organisation components and interdependencies.



Therefore, the primary focus of this research was to present a specification of a meta-schema that captured and illustrated the dynamics of the key entities (including sub-entities) and their interdependencies implicated in an organisation change process.

Conceptual modelling covered a multitude of modelling methods and formalisms and was widely used in theory domains to illustrate and communicate respective frameworks, processes, and decision outcomes, to name but some. Conceptual modelling embraced both quantitative and qualitative formalisms. Qualitative-based organisation modelling evolved during the 1930s and has since been used to systematically illustrate the organisation structure, its components, and the dynamics of the component interdependencies. There has since been significant advancement in organisation-based modelling methods, formalisms and tools. Consequently, part of this study involved an evaluation of some common modelling frameworks and instruments to determine their capacity to capture and illustrate complex organisation interdependencies.

The evaluation included an assessment of some popular automated tools, which measured their ability to provide a comprehensive change management solution. The research proposed that a change solution should incorporate 'real-time' data analyses to assess, determine, and communicate change. However, real-time model-based scenario building, and sensitivity analysis, had yet to be incorporated into change tools or other like frameworks (Dewhurst, Barber & Pritchard 2002). The researcher argues that, for automated change tools to be effective they must be underpinned by formalisms capable of decomposing organisation entities to their lowest denomination (or their lowest measurable unit of change).

This study adopted a mix of modelling instruments to capture, illustrate and assess the implications of an organisation change process. The formalisms used to construct the high-level schemas and low-level meta-schema included; a cross-function process model (CFPM), cross-function decision model (CFDM), a hierarchical function model, hierarchical network model and network impact analysis model, an entity relationship diagram (ERD), and a proprietary-

based entity relationship (ER) model. The power of these models to capture, illustrate and assess the key organisation change components, their dynamics and interdependencies, was a decisive factor in the automated change tool (ACT) development process. A large proportion of this research involved the application of these instruments to develop the ACT logical schema and the relational database (ACT) [physical] meta-schema.

The ERD was generally regarded as a fundamental conceptual modelling tool, and was initially developed in the 1970s as a specification tool for database design (Chen, C, Song & Zhu 2007). The ERD has since evolved to become synonymous with 'understanding real world phenomena' using entities, attributes, and relationships to define organisational elements and their environment (Chen, C, Song & Zhu 2007). The ACT logical schema was presented in entity-relationship (ER) form (Chen, P 1976) to enable its ready transition to a relational database (the ACT). The rationale was that the ACT would provide an automated organisation change solution with the capacity to reduce the impact of 'soft' factors in the decision-making process. Reducing the impact of decision soft factors was achieved by implementing the ERD constraint principles (i.e. enforcing mandatory relationships to reflect the Company's business rules) on the ACT data structures. In addition, the ACT architecture supports a collaborative change assessment model, which renders the task of ignoring critical change impacts difficult.

An instantiation of the ACT for the Company's supply-chain processes (or part thereof) allowed the automated derivation of all policies, parties, processes, systems etc. (and their sub-entities) impacted by the change process. The knowledge and data required to construct the meta-schema was drawn, in part, from the Company's Australian Government revised 2008 Commonwealth Procurement Guidelines (CPG) implementation process analysis findings. Implications arising from the CPG change process were explored from the perspective of the Company's supply-chain operations. This was explorative research that posed the following questions:

1. What components are implicated in an (organisation) change process?

2. To what extent can a model or schema be used to effectively capture and illustrate these components?
3. Can the resultant schema be translated into a practical and responsive automated change tool?

Therefore, the research objectives were to:

1. Systematically capture, identify and simulate the entities and interdependencies implicated in an organisation change process.
2. Translate the outputs from '1.' above into a responsive and effective automated change tool.

The ACT in no way diminishes the importance of people in organisation change. Neither does the solution dispute the challenge presented by [decision] soft factors in organisation change, nor the need to address them. Rather, the ACT enables an effective change solution by means of the change assessment model, which serves to guide the change decision process through change agents (or SMEs). Further, specific business rules have been applied to the ACT data structures to alleviate [decision] soft factors. The emphasis here is on reducing the impact of [decision] soft factors in the change process, as opposed to replacing the need to consider them. It is intended that the tool will complement and underpin a comprehensive strategy that is holistic in that it encompasses the socio-technical aspects of change (i.e. social, technical and organisation components), and their interdependencies.

#### **1.4 Research Strategy**

In the absence of any intrinsic relevant research or hypotheses, an explorative research design was considered the appropriate approach from which to understand and resolve the research problem (Leedy 1997; Punch 2001; Williamson 2000b). Qualitative research provides the framework to observe, explore, interpret and communicate a social environment and its dynamics for the purpose of proposing a solution to a known problem (Coghlan & Brannick 2001; Williamson 2000b). Given the Company's size, and the magnitude and complexity of its supply-chain activities, a single case study was considered the appropriate research method (Yin 2009). Case studies are valued for their focus on real situations and problems and were commonly used in

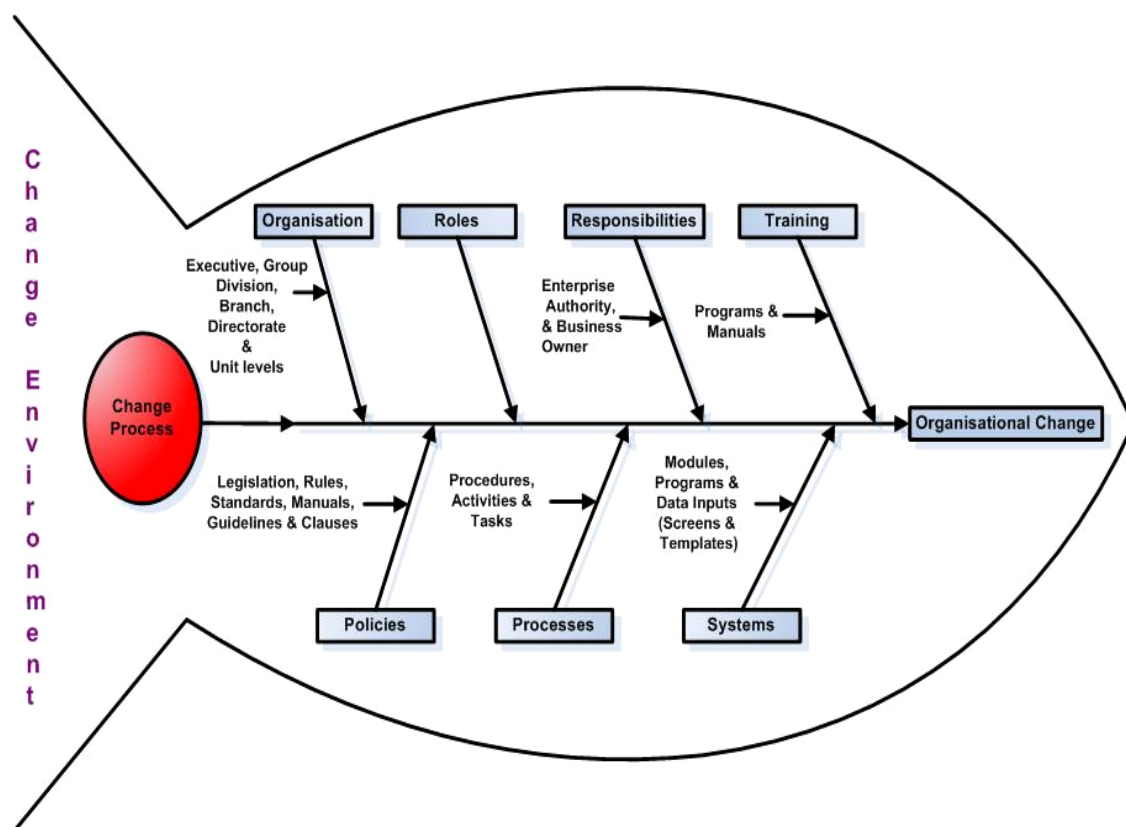
organisations as a collaborative approach to implement change programs (Coghlan & Brannick 2001; Schmuck 2006; Somekh 2006; Williamson 2000b), or to improve enterprise practices (Noran 2004).

This study incorporated a mix of data collection sources and instruments, which included; the Company's textual materials (historical and current documents) and artefacts (information systems (IS) for example), and open-ended and focused interviews. These data sources and instruments were chosen because of their ability to provide an accurate and reliable record of events within an environment (Creswell 2009; Myers 2006; Williamson 2000b; Yin 2009). The theoretical lens (literature review) was used to frame the study, embracing organisation theory and the related sub-theories: decision theory; organisation change theory; and, socio-technical theory. Technology theory and GST also contributed to the study's framework. The data that emerged from the data sources was analysed in accordance with emerging patterns or themes, together with a 'methods' and 'source' triangulation approach to validate the data, and to ensure its reliability (Creswell 2009; Punch 2001; Williamson 2000b; Yin 2009). The study also drew from systems analysis and design (SA&D) practices for the purpose of data collection and analysis, and to report the findings.

#### **1.4.1 Data Collection and Analysis**

The initial stage of the study involved a review of the literature using the theoretical lens as the guide. The data was analysed using the triangulation method to determine the common organisation issues or themes. The literature also confirmed that the Company's situation was not unique, nor exclusive to a particular industry type. There was evidence of performance inadequacies, operational inflexibility, misaligned policies and processes, and organisation behavioural issues cited in a diverse range of organisation environments. These issues were directly related to organisation change mismanagement and spanned 8 decades of organisation development (Becht, Bolton & Roell 2002; Chuter 2000; Drucker 1999; Earle 1940; Levin & Gottlieb 2009; Roark & Freemyer 2010; Ryden 2003; Searle 2006; Spector, Lane & Shaughnessy 2009; Wolf 2011).

The Company's textual materials and artefacts were examined next to contextualise the problem and draw out emerging patterns and themes. These data were compared with the literature findings to identify gaps in the data materials. The same analysis procedure was used to examine the interview data and confirm the data patterns, and draw out additional emergent themes. In addition, the Company's CPG implementation process was mapped using the CFPM and CFDM to identify those entities implicated in the CPG change process. Both models were analysed using the triangulation method. The data findings were compared with the literature, Company and interview data where comparisons were made and data anomalies remediated. The findings analysis identified the key organisation change entities (and sub-entities), which were the organisation components most vulnerable to change. These entities are illustrated at Figure 2 and reflect those components that need to be considered in an organisation change program.



**Figure 2: Key Organisation Change Components**

These entities were further examined using the high-level hierarchical models to identify entity interdependencies. Subsequently, a low-level ERD was used

to determine the dynamics of the entity interdependencies and to map the data to the lowest denomination, or single record instance. This was the technique used to ensure data integrity and to eliminate data redundancy. The entities were assigned attributes, which were normalised to third normal form (3NF). The normalisation process ensures the entities are mutually independent while the attributes remain dependent on each other (Burch 1992; Chen, P 1976; Simsion 2001; Yourdon 1989). The intent of the ACT logical schema (ERD) was to translate the design into a relational database (ACT).

The data analysis process (including the model and database development processes) was continuously validated to ensure reliability of the findings and the process itself (Burch 1992; Creswell 2009; Williamson 2000b; Yin 2009; Yourdon 1989). The ACT data structures were essentially underpinned by the ACT logical schema; however, translating the logical schema to the physical database required further data normalisation to affect data uniqueness. The ACT was developed in accordance with the SA&D process and its performance and value was measured against a number of predetermined user requirements.

#### **1.4.2 ACT Test, Evaluation and Reliability**

The ACT was tested in accordance with SA&D test case principles (Burch 1992). Black box testing was the 'system test' method used to measure user requirements satisfaction and system performance reliability (Burch 1992). A usability test was used to evaluate the ACT perceived ease of use. In the first instance, the ACT was populated with test data. The data was drawn from the Company's logistics management process hierarchy, specifically, the procedure 'determine method of procurement'. This particular procedure was recommended above others because it represented multiple CPG change actions. It also reflected the complexity of the procurement process because of the mix of cross-domain activity associated with the procedure.

The ACT reliability was tested using the predetermined stakeholder (user) requirements, with a number of stakeholders forming the user test group. The tests were performed using 'walkthroughs', which involved opening a series of ACT automated outputs (reports) and data screens. The stakeholder

requirements had been incorporated into a variety of ACT report outputs and data screens. The system test evaluated the ACT ability to readily input, store, and retrieve data using the reports and data screens. The system test and reliability results indicated that the ACT performed to the stakeholders' satisfaction, processing data and returning information in a reliable and timely manner.

The ACT usability test was performed in accordance with SA&D 'alpha' test case principles (Burch 1992) and was conducted using the same test group and walkthrough script. The test group was asked to appraise the ACT against a list of 'usability factors' (Burch 1992), with the results measured using the Likert Scale (Leedy 1997). The results of the test revealed some minor dissatisfaction regarding the ACT usability, which given the study timeframe, the researcher deferred to future research.

## **1.5 Summary of Findings**

The case findings have shown that organisations, largely, comprised of multiple entities, which support complex and dynamic interdependencies. The literature stated that organisations were ever changing complex systems, and organisation change practices and associated frameworks had not achieved the desired or expected results. Similarly, the Company had unsuccessfully implemented a range of change programs and other management and technology practices to remediate its change related problems. The findings revealed the Company's supply-chain environment comprised a complex network of entities and interdependencies, indicating that any assessment of potential change impacts was a far from trivial exercise. The Company had failed to engage a collaborative and comprehensive change assessment approach, which led to procedural anomalies and inconsistencies, and in some instances increased dysfunctional activities.

The systems theorists advocated a cohesive approach to manage and comprehend organisation complexity and change. Change management solutions needed to identify, capture and communicate change entities and interdependencies in order to effectively and efficiently manage change. The complexity of the case findings demonstrated that any attempt to manage

organisation change had to be underpinned by an automated change solution. A key benefit of the ACT was that it enabled the automated derivation and assessment of all key entities; policies, processes, systems etc. implicated in a change process (or event). This approach proved to be a substantial advancement on current organisation change practices and tools, and other comparable products. The ACT has demonstrated its capacity to systematically search the database for all possible key entity change impacts and convert the output into a report format, or a scenario model. Moreover, the ACT has confirmed its ability to capture the entity interdependencies to the lowest intersecting point (or lowest measurable unit of change).

Whilst the ACT does not reduce change complexity it enables more effective and rigorous change management practices. This was a critical feature, which was achieved using a scenario impact model, and a collaborative change assessment program that oversees the change decision process. Consequently, maintaining the ACT to manage and disseminate change data enables information to be promulgated to change agents organisation-wide. This action guarantees that change is extensively communicated, anticipated, and more important, its socio-technical impacts are understood.

This study has demonstrated its robustness and research quality by rigorously following the qualitative case study and SA&D processes; therefore, the research findings are deemed reliable. In addition, the research was framed using a number of theoretical perspectives, which has substantiated the external validity of the research findings. The research propositions that have emerged from this study have been applied to extend organisation change theory, and change management principles generally. Moreover, the findings suggest that the research outcomes can be generalised outside of the case environment. More significant, the researcher argues that the ACT principle can be applied to resolve organisation change problems in other industry types.

## **1.6 Significance of the Research**

The research findings have presented a logical and powerful argument for adopting the ACT (or its underlying principles) as an organisation change tool,



or simply as a method to manage organisation complexity. These findings significantly advance organisation change management practices. For instance, the solution enables change agents<sup>1</sup> (or decision-makers) to assess potential change impacts on an ongoing or case-by-case basis. The results can be readily communicated across the organisation, with the ACT change assessment model giving decision-makers the flexibility to consult other subject matter experts (SMEs) on a needs basis. The ACT solution also reduces the occurrence of soft factors (rational decisions) by applying critical business rules to the data structures. The outcome is a decision-making process that is non-rational whereby the decision reflects the organisation business rules rather than the emotive response of an individual. This is a vital ingredient in the decision process to ensure decision outcomes are primarily organisation focused. Finally, the ACT presents as a simple solution, underpinned by common theoretical principles, providing a practical and theoretical solution to organisation change management.

The key organisation change entity findings may also be applied to extend organisation change theory. The practical and theoretical knowledge gleaned from this research can be used by change (or organisation) theorists and practitioners to comprehensively assess and manage organisation change. In particular, the use of conceptual models to illustrate the complexity and dynamics of the organisation interdependencies is a valuable tool in organisation design. This is a significant aspect given the ACT ability to capture organisation authority and responsibility arrangements, which can then be mapped to the organisation structure.

## **1.7 Thesis Structure**

The thesis is structured as follows. Chapter 2 presents the theoretical lens used to frame the study and discusses the core developments and issues deemed pertinent to the research. The chapter also presents an evaluation of

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<sup>1</sup> Kurt Lewin was recognised as one of the early theorists who identified the need for change agents to lead, communicate and implement change (Levasseur 2001). The change agent's role is to champion change and minimise change resistance by providing 'visionary leadership' to enable change to be engaged as a process, rather than an organisation control (Levasseur 2001).

some common organisation management practices and tools. Chapter 3 provides an overview of conceptual modelling and organisation change. The chapter also evaluates some popular modelling methods and change management frameworks and tools. In addition, the modelling formalisms chosen to develop the ACT schemas and ACT database are explained and their selection is justified. In this chapter the ACT principles are also introduced. Chapter 4 presents the case study and case problem, and introduces the research problem in the context of the research scope, and in terms of the wider-literature. Chapter 5 outlines the research design methodologies and justifies the method chosen for the study. In addition, the chapter addresses the framework used to develop and test the ACT. In chapter 6 the case analysis findings, including the ACT test results, are presented and discussed. The findings are also discussed in terms of their contribution to a wider body of knowledge. Chapter 7 presents a brief review of the study, documenting the relevance of the findings to the research questions and the significance of the research findings generally. The chapter also contextualises the research propositions. Finally, the research limitations and directions for further research are also addressed.

## **Chapter 2**

### **Literature Review**

#### **2.1 Introduction**

Organisation theory was the theoretical lens used to frame the study. The literature surrounding organisation theory suggested that, organisation-based studies needed to apply a multiple theoretical approach to comprehend organisation complexities and dynamics. To that end, this study investigated those theoretical perspectives, frameworks and tools deemed pertinent to the research aims and research objectives. Consequently, in this chapter organisation theory and the sub-theories (or meta-theories) social-technical theory, organisation change theory and decision theory are discussed, together with general system theory (GST) and technology theory. The relationship between technology theory and organisation change is addressed in Chapter 3.

According to the literature, organisation theory was a composite of many theoretical perspectives, which evolved over time to support the burgeoning organisational environment. Shafritz & Ott (1987) found it difficult to construct a 'chronology of organisation theory' due to the diversity and overlap of the theoretical perspectives. Their view was that organisation theory was resurrected from the earliest foraging cultures to manage the growing industries of the industrial revolution. Organisation theory combined the theoretical perspectives; social sciences (incorporating sociology and psychology), science (incorporating mathematics and economics), and engineering (Pugh 1966; Shafritz & Ott 1987). Post-modern organisations adopted a multiple theoretical approach to organisation sustainability, embracing a range of theories, 'meta-theories' (theories about theories), principles and practices (frameworks), to manage the 'multiplicity of perspectives surrounding contemporary social, economic, environmental and governance obligations' (Edwards 2009, p 189).

The Bostrom, Gupta and Thomas (2009) view was similar where, from an information systems development (ISD) and implementation perspective, they articulated the significance of adopting meta-theories as a means of understanding and managing an organisation's socio-technical dynamics. Seemingly, what emerged was a complex hierarchical - yet matrix - arrangement of inter-related paradigms. For example, technology theory (considered a relatively new theory) evolved from the sciences and engineering disciplines (Denning & Freeman 2009). Technology theory in turn was supported by a number of frameworks; information technology management (ITM) (Huber 1984), systems engineering (SE) (Martin 1982) - or ISD (Nilsson, A 2005), enterprise architecture (EA) (PLAIC 2001), and information systems (IS) project management (Aubry, Hobbs & Thuillier 2008), to name but some. Some of these frameworks were also linked to the social sciences. Similarly, decision theory (and its associated frameworks) was an amalgam of the science and social science paradigms. Decision theory was also aligned with technology theory in the form of decision support systems (DSS).

The literature revealed that, historically, theoretical perspectives had been supported by related principles and practices (frameworks) and as industries evolved so too did their underpinning ideologies. The industrial revolution was the precursor of organisation change augmented by the adoption of technology innovation and associated management frameworks (Drucker 1999; Huber 1984; Morden 1996). Huber (1984) supposed that, evermore, post-industrial organisations had been designed with greater emphasis on decision-making, innovation and knowledge management. He added that these areas of perceived importance were supported by adopted, respective management activities. In this chapter the effectiveness and shortfalls of the key frameworks underpinning the paradigms investigated in this study are discussed for the purpose of identifying an effective organisation change management solution (or combination thereof). What follows is a brief chronology of the paradigms addressed in this study together with an overview and evaluation of popular respective frameworks.

## **2.2 Organisation Theory**

Organisation theory has been defined as ‘the study of structure and functioning of organisations and the behaviour of groups and individuals within them’ (Pugh 1966, p 235). The organisation ethos as we know it today was shaped from the manufacturing industries of the industrial revolution (Drucker 1999; Hope & Hope 1997; Pugh 1966). Organisation theories, and their related management practices, were initially formulated through the classical and scientific management schools (1700s to early 1900s) to assist the industries of the industrial revolution (Crainer 1998; Morden 1996; Pugh 1966; Shafritz & Ott 1987).

### **2.2.1 Classical and Scientific Management Schools**

Management schools of the classical and scientific era embraced a diverse range of organisation theories; neoclassical and classical, for example, and the related sub (or meta)-theories; management theory and decision theory (Miner 1978; Pugh 1966; Shafritz & Ott 1987). These sub-theories were underpinned by scientific management and administration frameworks, and management systems principles. These comprised, in part, division of labour, internal data capture and analysis, and time and motion (Drucker 1999; Miner 1978; Morden 1996; Shafritz & Ott 1987). Management schools of the time also predetermined the organisation design, which was largely hierarchical, and divisional (Shafritz & Ott 1987). The early theorists believed organisations should be designed as isolated, ‘static structures’ (Shafritz & Ott 1987).

### **2.2.2 The Human Relations Schools of Management**

In contrast, the Hawthorne Studies (1930s) theorists embraced von Bertalanffy’s GST whereby organisations were seen as complex, dynamic, interrelated, open structures, vulnerable to change (Pugh 1966; Shafritz & Ott 1987). During this period, the organisation sub-theories of organisation behaviour, human motivation, and power and politics emerged (Shafritz & Ott 1987). The core practices of participatory and human relationship management, and their underlying principles, namely, employee empowerment, productivity and efficiency gains also emerged (Shafritz & Ott

1987). System theorists of the time viewed the organisation as a series of hierarchical, interrelated complex sub-systems (Simon 1962).

### **2.2.3 The Tavistock Institute of Human Relations**

Following World War II (WWII), the Tavistock Institute of Human Relations extended GST and established 'socio-technical' theory. Socio-technical theory viewed the organisation and its environment as an open-system of delicately balanced complex, social and technical interdependencies (Emery & Trist 1965). Socio-technical relationships comprised the 'technical subsystem' (tools and techniques, processes and rules etc), and the 'social subsystem' (employees knowledge, skills, attitudes, and values and line of authority) (Pugh 1966; Trist & Murray 1990). The socio-technical theorists embraced both scientific and social science theories combining the sub-theories of cybernetics (control, communication and statistical theory) (Wiener 1961), information theory (Emery & Trist 1965), technology theory (Denning & Freeman 2009; Pugh 1966), and field theory (Lewin 1967). The core management principles of that era included: decision-making; organisation change; and organisation development, with the respective practices; strategic planning, group dynamics, change communication, and information management (Emery & Trist 1965; Shafritz & Ott 1987). The socio-technical theorists identified with a matrix structure organisation design (Emery & Trist 1965). Although the post WWII organisation theory perspectives continued to be influenced by the human relations schools (Shafritz & Ott 1987), traditional organisation practices remained firmly entrenched within the organisation ethos.

### **2.2.4 Post-Modern Theorists**

Post-modern theorists (1950s onwards) considered organisation theories and management practices of the nineteenth century (C19<sup>th</sup>) inappropriate because of the complex nature and intertwined relationships underpinning organisations of the rising modern economy (Drucker 1999; Huber 1984; Simon 1962). The view taken by Miner (1978) was that modern organisation theorists adopted the systems approach to gain better insight into the multi-function, corporate entities of the 1960s. These multinational entities were driving local and international competition through the 1960s-1980s, with increased emphasis

on operational efficiencies and stability (Daniels 1994; Porter & Siggelkow 2008). Prominence was given to understanding the organisation environment, mostly, for the purpose of control. To that end, corporations sought new management principles; competitive advantage, strategic and customer relations management, and marketing, for example (Porter & Siggelkow 2008). Supporting practices associated with these principles included; strategic alliances and best practices (Porter & Siggelkow 2008), and value add and technology innovation (Porter 1985). Technology innovations of the time incorporated point of sale (POS) (Porter & Siggelkow 2008), just in time (JIT) supply, and electronic data interchange (EDI) (Chang, Makatsoris & Richards 2004; Fredendall & Hill 2001; Ross 2004). The organisation design was mostly decentralised and/or 'collaborative' or 'vertically integrated' (Porter & Siggelkow 2008).

### **2.2.5 Information and Knowledge Management**

Technology innovation flourished during the latter part of the twentieth century (C20<sup>th</sup>) with the emergence of virtual private networks (VPNs), and business process re-engineering (BPR) (Attaran 2003; Daniels 1994). As organisations transitioned from industrial to post-industrial environments, there were significant changes in their structure, processes and use of technology (Huber 1984). According to Huber (1984), the literature supported the proposition that, post-industrial organisations were significantly different, more complex, knowledge insatiable, and increasingly turbulent because of the nature of their ever changing environment. He also predicted that, as post-industrial environments evolved they would become even more complex and changeable. Consequently, in the twenty-first century (C21<sup>st</sup>), there has been substantial technology advancement with invigorated BPR to accommodate globalisation and the virtual organisation (VO) (Attaran 2003), and innovation with development of integrated autonomic communications (Davy et al. 2006).

The information and knowledge age (see Tapscott 1998) witnessed a dramatic change in organisation design. The composition was evermore complex and management principles responded with the proliferation of sophisticated IS and management tools (Drucker 1999; Huber 1984). Presently, the emphasis is on

agile systems (Nilsson, F & Darley 2006) and knowledge management (Alter & Browne 2005). Accordingly, management frameworks have been embedded as workflows or process flows within IS to affect automated decisions and control (Fenstermacher 2005; Fokus 2004). Management frameworks used included, in part; governance and compliance controls, quality management systems (QMS), risk management and performance evaluation (Harding & Popplewell 2001), key performance indicators (KPIs), critical success factors (CSFs), and data quality management (DQM) (Otto et al. 2007). These frameworks were heavily reliant on high-level document-based controls and generic best practices, and failed to consider the uniqueness of the interrelations between elements within the organisation (Buchanan et al. 2005; Fredendall & Hill 2001). Consequently, most programs were unsuccessful because they were implemented and administered in isolation of other requisite practices and with little understanding of an organisation's interdependencies (Cao & McHugh 2005).

## **2.3 Decision Theory**

### **2.3.1 Pre - and Post Industrialisation**

Decision theory had its origins in the sciences, specifically mathematics and economics, enveloping 'statistical' and 'probability' theories of the seventeenth century (C17<sup>th</sup>) (Jeske & Werner 2008; Miner 1978). A variety of decision theories and associated decision-making frameworks emerged from organisation theory, science theory and social science theory (Tarter & Hoy 1998; van Luitgaarden 2009). Classical organisation theorists adopted decision theories, which were grounded on quantitative 'outcome' and 'probability' forecasts, to improve economic decisions (Jeske & Werner 2008; Miner 1978; van Luitgaarden 2009). Quantitative-based decision theories relied on hand-drawn schemas and matrices to communicate the decision outcome (Jeske & Werner 2008; Miner 1978). These techniques were perhaps the first attempts to model organisation activities, a practice that embraced 'cognitive theory' and evolved with increasing complexity into the C21<sup>st</sup> (Grinyer 2000).

There was much debate surrounding the origins of the 'cognitive revolution' and its influence on decision theory. Hark (2010) attributed Otto Selz's work



(early 1900s) on cognitive functions as the pioneer of cognitive psychology. More specific, Selz's work on the theory of creative thinking; the semantics of complex relations, deductions from data, and the application of reflective experience, trail-blazed decision analysis theory research (Hark 2010). The events of WWII heightened awareness of the importance of the cognitive process in decision-making, raising interest in the study of cognitive theory (Pasmore & Khalsa 1993). However, it wasn't until developments within the Carnegie Institute of Technology (circa 1950s) that cognitive psychology was integrated into the organisation decision process (Augier & March 2001). At that time, Simon's research had defined the relationship between organisation behaviour and individual decision-making, and problem-solving processes (Simon 1997). Post-modern theorists considered traditional decision processes inappropriate and sought a more cognitive approach to organisation decision-making (Augier & March 2001; Simon 1952).

Herbert Simon of the Carnegie Institute of Technology revolutionised post-modern decision theory. Drawing from Albert Wiener's information and communication theory (cybernetics), and von Bertalanffy's GST, he formulated the theory that the organisation was an integrated 'decision-making information system' (Mockler 1968, p 53). The work of Trist and Lewin was also instrumental in delivering insights into group and environment interactivities, and behaviour dynamics (Pasmore & Khalsa 1993). Although Simon (1952) recognised the value of an integrated decision approach, he viewed organisation control as necessary to deliver a program of procedures to effect 'coordination', 'communication' and 'review' within the decision process. He also noted that controls without rigorous and effective accountability and compliance measures lowered the level of ethical standards amongst employees.

Acknowledgment of the cognitive process in decision-making led to an increased emphasis on controlling the decision process rather than the decision outcome (Huber 1984). The psychological and sociological issues endemic in the organisation decision-making process were collectively labelled 'organisation behaviour theory' (Pugh 1966). Understanding organisation

behaviour became a pertinent issue in the face of increasing economic complexity and unpredictable decision outcomes (Pugh 1966). Organisation decision-making continued to be the focus of organisation theorists, many of whom believed it was synonymous with power, politics and authority (Mathieson 2007; Shafritz & Ott 1987).

### **2.3.2 Post Modern Era**

A number of evolutionary decision theories and decision methods were developed to manage the complexity of the organisation decision process (Augier & March 2001; Pugh 1966). These theories were economic-focused, scientific and socially grounded, and included 'game theory' and 'agency theory', together with the methods 'problem solving', and 'risk' analysis (Augier & March 2001; Pugh 1966). The nature of the organisation environment (essentially economic) meant that traditional economic decision theories were still prevalent in post-modern decision-making processes (Jeske & Werner 2008; Pugh 1966). However, these had been broadened to integrate other theoretical perspectives; GST, social science theory, and technology theory (Jeske & Werner 2008; Pugh 1966). Huber (1984) had predicted that decision-making in post-modern organisations would be more 'frequent', 'faster' and more 'complex'. Huber (1984, p 934) noted that the affect of the phenomenon would lead to, in part, demand driven 'advanced communication and computing technologies, improved decision-group technologies and structures, and decision process management'. He also foreshadowed the rise of technology in the decision-making process and the importance of timely and accessible information throughout the decision process.

Of importance was Huber's (1984) acknowledgement that the increasing complexity of the decision process would require organisations to seek input from a variety of subject matter experts (SMEs) and other 'partisans'. He believed the end result would better serve and formalise the decision process. Nilsson and Darley (2006) stated that organisation complexity would grow in the wake of agile, responsive systems. They added that, decision makers evermore were inundated with a multitude of data and information in their decision-making processes. They stressed that organisations needed to be

proactive in the face of changing demands and consider both holistic and specific outcomes in their decision processes. This was an important factor and one the researcher considered in the automated change tool (ACT) development process. Organisations had continuously sought decision theories, frameworks and tools to assist them with the decision-making process (Huber 1984; Nilsson, F & Darley 2006; Uppington & Bernus 1998).

### **2.3.3 Decision Methodologies**

As noted, organisation decision methods originated in the C17<sup>th</sup> when hand-drawn schemas and matrices were used to communicate the decision process and projected decision outcomes (Jeske & Werner 2008; Miner 1978). Since then, a plethora of decision methods, tools and models emerged, mainly for the purpose of controlling the decision process (Akkermans & Bertrand 1997). This approach was described as the decision-making 'bureaucratic model' (or organisation control) (Shafritz & Ott 1987; Simon & Thompson 1991). Simon and Thompson (1991) viewed organisation control as a program of various constraint procedures. Similarly, Miner (1978) believed constraints were aimed at standardising the decision process through planning and control. For example, 'standard operating procedures' (SOPs), and 'rules' (laws and policies) were used by organisations to facilitate less complex, non-rational decision-making (Shafritz & Ott 1987; Simon & Thompson 1991).

Organisations also adopted QMS to facilitate a common problem-solving and decision process culture (Fredendall & Hill 2001). QMS evolved in the 1920s from the scientific method 'quality control' and comprised a series of generic, international standards and best practices (Fredendall & Hill 2001). The QMS quality control tools included; check-sheets, cause-and-effect-diagrams, graphs, control charts, histograms, and scatter diagrams (Fredendall & Hill 2001). These types of decision frameworks were criticised because they consisted of universally-targeted documentation as opposed to the unique procedures required for various industry types and different cultural environments (Buchanan et al. 2005; Fredendall & Hill 2001).

#### **2.3.4 Decision Soft Factors**

Post WWII saw a significant increase in organisation decision complexity and decision participant numbers (Huber 1984; Watson & Brown 1978). Subsequently, there was a heightened awareness of the decision-making cognitive process (Pasmore & Khalsa 1993). Finkelstein, Whitehead and Campbell (2009) discussed the negative influence of emotive decision-making on the organisation decision process. Their assessment was based on the notion that decision-making was a non-rational process because 'decisions were really acts of judgment made by people' (2009, p 1). Empirical studies have shown that individuals focus differently on information, which can be attributed to the individual's 'age', the 'affect' and 'context' of the problem (Jeske & Werner 2008). Pugh (1966) described decision-making as a mix of 'psychological' and 'sociological' influences, while Tarter and Hoy (1998) stated that individuals were incapable of rational, complex decisions because of their cognitive limitations and hidden biases. These decision-making anomalies were referred to as soft factors and have been the subject of a great deal of analyses and simulation (Mathieson 2007; McGrath & Uden 2000). Most of the attention has been aimed toward their capture and representation (McGrath & Uden 2000), and more recently, their remediation (Mathieson 2007).

#### **2.3.5 Decision Tools**

Post-modern organisations adopted a variety of decision tools to address their decision-making concerns. The tools adopted included; simulation modelling (task-based prototyping) and linear programming (planning and scheduling) (Miner 1978), Monte Carlo (multi-criteria decision-making (MCDM)) for group decisions) (Cervone 2009; Huber 1984), and program evaluation and review technique (PERT) (planning and scheduling) (Miner 1978). These decision tools were mostly grounded in quantitative techniques and were intended to improve organisation decision-making. The tools provided predetermined or pre-programmed statistical calculations, or two dimensional mathematical modelling, which was based on manipulated or secondary data (Miner 1978; Nickerson 1998). Nickerson (1998) described these types of analyses as

'model based' scenario building, which he considered different to the analysis performed by DSS.

Enterprise architecture (EA) (or enterprise modelling (EM)), was an exception to the two dimensional decision modelling tools. A holistic EA solution comprises an array of simulated perspectives and, in its entirety, is presented in a three dimensional form (Bernus 2003a). EA originated from the science and engineering discipline but was adopted by the manufacturing industries of the 1970s as a decision tool to optimise performance (Bernus 2003a; Harrison & Varveris 2007; Porter & Siggelkow 2008; Weston 1998). More recently, organisations have used EA as a decision tool for managing change (Bernus 2003a; Harrison & Varveris 2007; Porter & Siggelkow 2008). EA solutions were largely graphic in form and communicated mostly quantitative information because of the modelling instruments used to present the solution. In addition, holistic EA solutions were considered too costly and difficult to control with EA implementations often deemed irrelevant to the problem in question (Perks & Beveridge 2004).

There were similarities between the decision tools of the C17<sup>th</sup> and those of the C20<sup>th</sup> and C21<sup>st</sup> in that they were limited in scope (in terms of providing a holistic organisational perspective), were quantitative and economic specific in terms of outcome, and relied on two dimensional schemas (or models) to communicate the decision process and outcomes.

## **2.4 Decision Systems**

### **2.4.1 Management Information Systems (MIS)**

A DSS provides the computation of unstructured data to support the decision process for the purpose of better decision outcomes (Martin 1982). Quantitative and qualitative decision systems were introduced in the 1950s to improve operational planning and production control in the manufacturing industries (Banker & Kauffman 2004; Miner 1978). The proliferation of information technology (IT) from 1950s onwards saw decision systems implemented across a variety of organisations - at various levels - to perform and support a range of decision-making activities (Banker & Kauffman 2004;

Drucker 1999). However, early decision systems (MIS) failed because they did not have the capacity to store, retrieve, and process data (Huber 1984). These activities were considered the core technical functions needed to extract information from raw data (Huber 1984).

Sprague and McNurlin (1986) reported that, during the 1960s-1970s, there was a lack of conformity within organisations concerning the implementation of information technology products, services and standards. This situation may have contributed to the problems surrounding MIS data sharing between various organisational departments. At the time, the onus was on the decision-maker to mitigate any risk associated with inconclusive or inconsistent information by using his or her due-diligence (Miner 1978). Miner's view was that most organisation decisions were based on inadequate or insufficient data and, therefore, decision-makers were obliged to draw on scientific theoretical values to ensure the integrity of the decision outcome. This seemingly over reliance on the human cognitive process was more than likely the demise of early MIS.

#### **2.4.2 Decision Support Systems (DSS)**

The next generation of MIS were branded DSS (Huber 1984; Power 2008). DSS were considered more effective than their predecessors because they integrated the core functions of storing, retrieval and processing of raw data to extract information (Huber 1984; Power 2008). Similarly, Nickerson (1998) described DSS as performing 'sensitivity analyses' on reusable primary (raw) data stored in a database as opposed to the non-reusable secondary data used in mathematical modelling or MIS. Likewise, Alter (2006), described DSS as providing both data and modelling assistance for semi-structured decision-making. DSS outputs consist of a variety of formats that includes tables, text, pie charts, and other modelling instruments (Power 2008). Huber (1984) hypothesised that technology innovation would advance the decision process by enabling the right mix of decision-makers to participate, as required, with no additional resource impact. DSS enabled high capacity data storage, and advanced telecommunications enabled multiple, geographically dispersed

decision-makers to be simultaneously involved in the decision process (Banker & Kauffman 2004).

DSS remained underpinned by classical decision theories and adopted prescribed models to process data and retrieve information (Limayem & DeSanctis 2000). As noted, DSS were implemented for the purpose of economic gain and for this reason they were moulded in the fashion of quantitative decision tools. However, there was greater flexibility in the ability of DSS to capture and process a wider selection of data. DSS were adopted by a multitude of industry types to support decision-making, but in some instances their ability to value-add to the decision process became questionable (Banker & Kauffman 2004). Banker and Kauffman (2004) indicated that such limitations could be attributed to the inadequacies of the DSS analysis and design process. DSS primarily draw on 'hard' data such as production, sales, and other operational figures (Huber 1984). As discussed, the DSS were reliant on humans to interpret processed information. To reiterate Martin (1982), DSS were designed to support the decision-maker, rather than 'automate the decision outcome'. However, some decision-makers perceived DSS as adding perplexity to the decision process rather than simplifying it (Limayem & DeSanctis 2000). They stated that, some (specifically MCDM-based) DSS adopted overly sophisticated decision models, which decision-makers found too complex to comprehend and, hence, either avoided using them, or utilised them incorrectly.

### **2.4.3 Knowledge Management Systems (KMS)**

The next generation of DSS were labelled KMS (Huber 1984; Simon 1990a), executive information systems (EIS), or business intelligence systems (BIS) (Clark, Jones & Armstrong 2007). KMS evolved from attempts to simulate the cognitive process (Simon 1990a), drawing from soft data (or human judgements) stored in the system's knowledge base. In addition, the availability of qualitative scenario modelling made it easier to replicate human responses (Huber 1984). There was also a trend toward a more flexible, automated DSS that better serviced the needs of information users and decision-makers (Rouse 2007)). The trend was attributed to an increased focus on providing

stakeholders' with improved knowledge management and information accessibility (Rouse 2007). In addition, there was a push for KMS to provide an information service that was more 'human-centred' (Nilsson, A 2005).

Agile systems are the present decision process management trend (Nilsson, F & Darley 2006; Rouse 2007). Agile systems improved knowledge management through heightened data integrity, controls, timeliness and flexibility (Fenstermacher 2005; Fokus 2004; Rouse 2007). The result was that users were able to effect automated decisions using information drawn from multiple domains via seamless, interconnected access points (or sub-systems) (Fenstermacher 2005; Fokus 2004; Rouse 2007). Consequently, Rouse (2007) believed agile systems better served the information needs of stakeholders. This contrasted the role of early DSS, which serviced individual users or user groups (Rouse 2007). Importantly, Rouse (2007) noted that agile systems adopted a less complex approach to information communication by choosing artefacts widely used and understood within the organisation. For example, spreadsheets were often used to report the decision process and outcomes (Rouse 2007). This was a significant factor as information users would be more inclined to adopt an automated decision system that demystified the decision process in a manner they felt comfortable with (Clark, Jones & Armstrong 2007).

## **2.5 Technology Theory**

### **2.5.1 The Computing Paradigm**

Technology theory was a recently established paradigm, underpinned by a mix of theoretical perspectives that included mathematical sciences, natural sciences, and the engineering sciences (Denning et al. 1989; Denning & Freeman 2009; Rosenbloom 2004). Three key competencies emerged from the theoretical perspectives (Denning et al. 1989), which are shown at Table 1 together with the respective theory and corresponding principle. These competencies were considered 'interchangeable' and 'intertwined' attributes of the early computing science (CS) discipline (Denning et al. 1989). These competencies were recognised as facilitating various technical innovations (Denning et al. 1989), which are outlined at Table 2.



Competency	Theory	Principle
Identification and substantiation of relationships between entities or 'objects'.	Mathematical sciences	Theoretical development
Application of relationships to inform 'predications' about real life situations.	Natural sciences	Abstraction or modelling
Implementation of relationship 'instances' to achieve decisive outcomes.	Engineering sciences	Design

**Table 1: Key Competencies**

Technical Innovation	Competency	Theory	Principle
Statistical analysis and scenario building.	Identification and substantiation of relationships between entities or 'objects'.	Mathematical sciences	Theoretical development
Complex systems, local area networks (LANs) and wide area networks (WANs).	Application of relationships to inform 'predications' about real life situations.	Natural sciences	Abstraction or modelling
'Microcircuitry' and software design.	Implementation of relationship 'instances' to achieve decisive outcomes.	Engineering sciences	Design

**Table 2: Key Competencies and Technical Innovation**

Computer science also evolved to include a number of technology categories, which included, in part:

- programming languages;
- system architecture;
- database and information retrieval;
- software methodology and engineering; and
- human-computer communication (Denning et al. 1989; Lee, J 1996).

Consequently, there was much debate concerning the taxonomy of CS, with the argument that it was no longer computation centric but rather, information process-based (Denning et al. 1989; Lee, J 1996). They concluded that, CS with its broadened principles and problem-solving techniques had become an all encompassing system of practice and, therefore, was a paradigm in its own right. In light of the developments within the CS domain, and the emphasis on information processing as opposed to 'computing machines', Denning and Freeman (2009) amended their key competencies (outlined in Tables 1 and 2)

to reflect this trend. They described the new paradigm as more reflective of the 'dynamic' environment, which consisted of multiple 'implementations' and 'influencing' 'interactions'. The revised competencies are shown at Figure 3.

These categories were considered essential for the development and advancement of internet-based technologies, which transpired through the 1990s onwards (Denning & Freeman 2009). Escalating complexities demanded an integrated approach to technology design with the categories of internet technologies, 'web science', 'mobile computing', 'cyberspace security', and graphical user interface (GUI) regular design considerations (Denning & Freeman 2009).

Initiation	Determine if the system to be built (or observed) can be represented by information processes, either finite (terminating) or infinite (continuing interactive).
Conceptualization	Design (or discover) a computational model (for example, an algorithm or a set of computational agents) that generates the system's behaviors.
Realization	Implement designed processes in a medium capable of executing its instructions. Design simulations and models of discovered processes. Observe behaviors of information processes.
Evaluation	Test the implementation for logical correctness, consistency with hypotheses, performance constraints, and meeting original goals. Evolve the realization as needed.
Action	Put the results to action in the world. Monitor for continued evaluation.

**Figure 3: The Computing Paradigm (Denning & Freeman 2009, p 29)**

Over the past decades the emphasis had shifted to organisation-based knowledge management and information processing. This triggered debate concerning the terminology that had developed within the computing paradigm, for example, the terms IT (Denning & Freeman 2009) and IS and SE (Iivari 2005), to name but some. The concept of CS has devolved to embrace these terms; however, the distinction and relationship between CS, IT, IS, and SE remains in dispute (Denning & Freeman 2009; Iivari 2005). The researcher has taken the approach that all of these terms fall under the umbrella of technology theory and thus, are referenced herein in the context of the literature.

## 2.6 Technology Innovation

Organisations tended to adopt management principles and technology tools associated with a given era (Miner 1978). Although CS was considered a relatively new discipline, developments in computing (or mechanical computation) were linked to the industrial revolution with Charles Babbage's C19<sup>th</sup> 'calculating engine' (Campbell-Kelly 2009; Lee, J 1996; Roegel 2009). Pre-WWII technology innovations included analogue computing instruments (such as Bush's 'Differential Analyser') that were used to perform mathematical calculations (Campbell-Kelly 2009). The events of WWII triggered improvement in the calculation speed of computing instruments, which led to the development of the vacuum tube 'electronic computer', dubbed the Electronic Numerical Integrator and Computer (ENIAC) (Campbell-Kelly 2009; von Neumann 1981). Computing devices of this period were mostly mathematical and engineering focused, and hardware based (Campbell-Kelly 2009).

The first electronic digital computers, one of which was named the Electronic Discrete Variable Automatic Computer (EDVAC), were developed Post WWII (Campbell-Kelly 2009; Lee, J 1996; von Neumann 1981). The importance of this advancement, from a theoretical perspective, was threefold. First, the emphasis on the 'theory and logical design of the equipment' (von Neumann 1981) was seen as a dramatic shift away from traditional mathematical, engineering and hardware focused machines. Von Neumann's description of the EDVAC computer architecture was a conscious attempt to integrate, while at the same time isolate, components within the machine environment. He labelled the computer architecture components 'memory', processing unit, input 'organs', output 'organs', and, control mechanisms (Campbell-Kelly 2009). Campbell-Kelly (2009) reported that, von Neumann's approach identified individual machine components, which could be altered without changing the physical structure of the machine. He added that the logic of the design also identified relationships between the components. Von Neumann (1981) also ignited the concept that these machines were dynamic, complex systems comprised of interdependent components. His adoption of the term 'organ' suggested these considerations were drawn from the complexities of the human system.

Second, of further theoretical importance was the inception that von Neumann's computer architecture was as 'a universal information processing machine' (Campbell-Kelly 2009). Von Neumann's description of the machine computation process was based on neuroscientists' theories of the 'logical operations of the brain', hence, his reference to the term memory etc (Campbell-Kelly 2009). The work of other notable theorists, aside from the neuroscientists and engineers, were also instrumental in designing the machine logic (von Neumann 1981; Wiener 1961). For example, the mathematician, Norbert Wiener's cybernetics theory, and the psychologist Kurt Lewin's unravelling of the gestalt laws of psychology, among a great many other scholarly contributions, contributed to replicating the human cognitive process in machine computation (Wiener 1961). It was during this period that natural sciences theory was incorporated into CS, alongside science and engineering.

Third, the collaborative and delegated approach to problem solving was also of theoretical importance. As noted, a range of SMEs were called upon to reconcile the human cognitive process and machine computations associated with the EDVAC design, and other computers of the same period. The practice of including a mix of SMEs in ISD has continued into the C21<sup>st</sup>. In addition, von Neumann's work outlining the theoretical developments of electronic computing, planning and problem coding (von Neumann 1981), and architecture design (Campbell-Kelly 2009), were instrumental in shaping the CS principles outlined by Denning et al. (1989), shown at Tables 1 and 2.

### **2.6.1 Technology Innovation and Theory**

Organisations, by their nature, respond to the demands of their immediate environment and use the frameworks and tools available to them at a given point-in-time. The events of WWII created a surge in research and development in a multitude of domains. Organisations grew in complexity alongside demands for IT facilitated, operational enhancements. The rise of technology theory was similar to the evolution and adaptation of organisation theory, meaning, organisations had grown in complexity alongside the theories and tools required to understand and control it. For example, post-modern

organisation theorists adopted GST (or socio-technical theory) to understand the organisation mechanics and behaviour (Shafritz & Ott 1987). Similarly, von Neumann when developing the EDVAC machine essentially adopted GST to investigate the intricacies of the human-machine cognitive process. GST was cited as the philosophy underpinning the technology framework systems analysis and design (SA&D) (Denning & Freeman 2009; Markus, Majchrzak & Gasser 2002), and EA (Bernus 2003a). GST was adopted as the paradigm from which to 'observe', 'construct' 'design', and 'imitate' naturalistic information processes for ISD (Denning & Freeman 2009; Markus, Majchrzak & Gasser 2002). This dependency continued into the C21<sup>st</sup> (Nilsson, A 2005). Von Neumann's method was perhaps what Nilsson (2005) described as the 'multi-perspective' approach to ISD.

Since WWII there has been a concerted effort to rigorously define and control technology theory through a range of theoretical and practical frameworks. There was also the additional objective of better aligning technology products with organisation requirements. To that end, a plethora of frameworks emerged with some embracing 'multi-perspectives' (or principles) from other theoretical domains (Nilsson, A 2005). These frameworks are discussed, in part, in the following section.

## **2.7 Technology Frameworks**

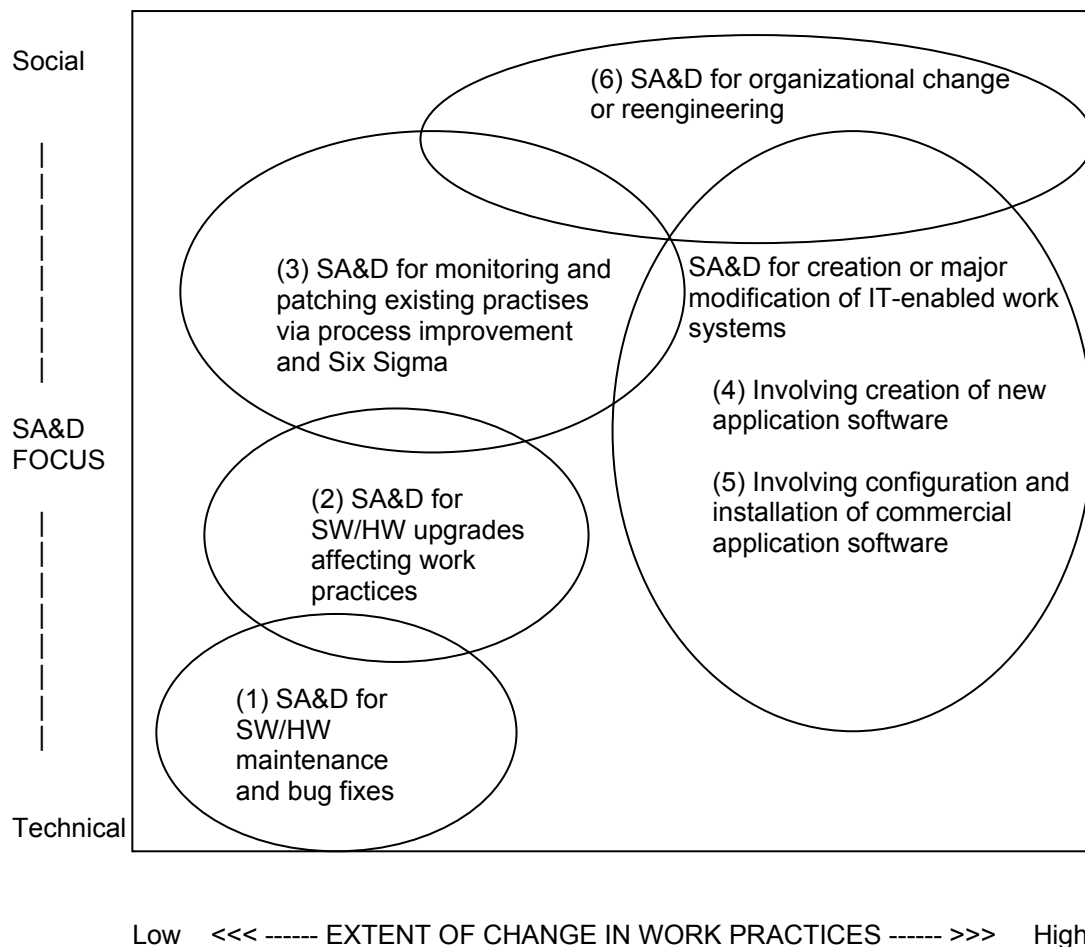
### **2.7.1 Project Management Methodologies (PMM)**

Early ISD frameworks were mostly based on engineering principles, such as project management (PM). PM evolved in China in 486 BC as an engineering framework and has since been adopted globally as a methodology to manage and construct ships, cities, canals, dams, railroads, atomic bombs, military weapons and their platforms, and more recently, internet technologies (Cleland 2004). According to Cleland (2004), the first articulate article outlining PM methods was written by Daniel Defoe and appeared in 1697. However, it wasn't until the 1920s that organisation theorists adopted PM principles to improve management practices (Aubry, Hobbs & Thuillier 2008; Cleland 2004; Lee, J 1996). Early engineering projects and some management practices had adopted PM principles. However, their application in IT was not formalised until

the late 1950s when Paul Gaddis recognised their benefits as a tool for managing IT activities (Cleland 2004). It could be argued that von Neumann had taken a PM approach in planning, designing and developing the EDVAC machine. Despite its use in these areas, PM was not considered a discipline in its own right until the 1960s (Cleland 2004). From that point forward its application to ISD and organisation change became widespread (Cleland 2004).

### **2.7.2 Information Systems Development (ISD) Methodologies**

Kolltveit, Hennestad and Gronhaug (2007) defined IS projects as having different characteristics to engineering projects. They believed this was attributed to the systemic complexities and implementation issues surrounding ISD. Complex organisation IS implementations required extensive organisation change because their objectives were generally linked to organisation optimisation (Kolltveit, Hennestad & Gronhaug 2007). A range of ISD related methodologies emerged to effect these changes including; Capability Maturity Model (CMM) (Banker & Kauffman 2004), SE (Boarder 1995), Systems Development Life Cycle (SDLC) (Yourdon 1989), SA&D, Joint Application Development (JAD), Rapid Application Development (RAD) (Burch 1992; Martin 1982), and the meta-methodologies provided by Goepp, Kiefer and De Guio (2008). The majority of these frameworks were described as GST grounded while some were seen as socio-technical focused (Lui & Piccoli 2007; Nilsson, A 2005). The latter ISD frameworks (SA&D for example) enveloped more than the technical aspects of IS, they embraced human factors, and the interface between humans, information, and processes (Alter & Browne 2005; Burch 1992). Figure 4 illustrates the complexity and interplay between the social and technical aspects of ISD in a change environment. Alter and Browne (2005) demonstrated the impact of change on organisation work practices, which they interpreted as falling largely within the social range of the SA&D focus. This aspect is discussed further in section 3.4.



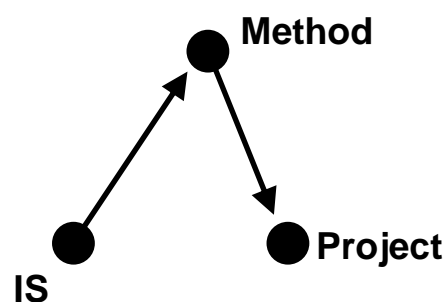
**Figure 4: The Range and Scope of SA&D Contexts (Alter & Browne 2005, p 5)**

Burch (1992) believed ISD methodologies should embrace the following core phases:

- information planning;
- business analysis;
- business and systems design;
- construction; and
- implementation.

He considered these phases as all-encompassing in relation to ISD user involvement. However, over the past two decades a number of alternative methodologies have evolved (Markus, Majchrzak & Gasser 2002; Nilsson, A 2005). More recently, the Goepp, Kiefer and De Guio (2008) 'contingency' approach to ISD (shown at Figure 5) incorporated a mix of modules from PM and ISD methodologies. Their intent was to tailor an overarching framework to

better serve the needs of the organisation and the task at hand. ‘Simple’ projects were managed using compatible ISD and PM deliverables, while complex programs were processed using a mix of prescribed methodologies (Goepp, Kiefer & De Guio 2008). Put simply, the nature of the IS problem determined the ISD module(s), which in turn, decided the PM deliverables. The contingency approach was devised in lieu of the widespread dissatisfaction with ISD methodologies (Goepp, Kiefer & De Guio 2008). Traditional methods were deemed too rigid, while contemporary methods were seen as overly ad-hoc having minimal, or no, designated activities to manage the overall process.



**Figure 5: Contingency Graph of an Unexploited Mode (Goepp, Kiefer & De Guio 2008, p 227)**

Included in the mix of alternative ISD methodologies were the methods designed to deliver agile technology solutions (Alter & Browne 2005; Lui & Piccoli 2007; Rouse 2007). The latest surge in technology-driven business solutions delivered a proliferation of ‘modern’ ISD frameworks designed to facilitate rapid organisation change (Conboy & Fitzgerald 2007), and IS flexibility (Nilsson, A 2005). Conboy and Fitzgerald (2007), and Abbas, Gravell and Wills (2008) noted that, agile methods (RAD for example) originated in the late 1980s as a technology innovation tool. While the concept of agile solutions was second-hand, a recent observation was their requirement to be grounded in theoretical perspectives (organisation theory and technology theory for example) to ensure robustness and uniformity of the ISD process (Conboy & Fitzgerald 2007).

### **2.7.3 Enterprise Architecture (EA)**

The EA framework originated in the 1970’s from the engineering discipline and was used to simulate and optimise manufacturing and distribution systems



(Bernus 2003a; Weston 1998). More recently, EA has been used to simulate and optimise organisational structures, business and decision processes, information flows, and information and communication technology (ICT) environments (Bernus & Uppington 1996; Koumpis & Roberts 2003; Vasiliu & Browne 2003). EA was considered the conduit for organisation interoperability, and a key enabler for meeting performance objectives (Harrison & Varveris 2007). However, many organisations found implementing and sustaining comprehensive EA solutions cumbersome, time consuming, overly complex, and expensive (Bernus 2003a). EA evolved to embrace a plethora of modelling frameworks that were used to conceptualise the enterprise (Bernus 2003b; Noran 2004). These frameworks were defined in terms of their application, or representation of the organisation components (Bernus 2003b; IFIP-IFAC Taskforce 1999; PLAIC 2001). The frameworks included:

- GRAI (Graphs with Results and Activities Interrelated);
- FORMIS (Framework and Open Reference Model for Information Security);
- CIMOSA (Computer Integrated Manufacturing Open Systems);
- Zachman (Information Systems Design Architecture);
- TOGAF (The Open Group Architecture Framework);
- PERA (Purdue Enterprise Reference Architecture); and
- GERAM (Generalised Enterprise Reference Architecture Methodology) (Dewhurst, Barber & Pritchard 2002; Doumeingts 1995; IFIP-IFAC Taskforce 1999; Noran 2004; PLAIC 2001).

Business process modelling (BPM) (or BPR) are popular EA frameworks (Attaran 2003), while service oriented architecture (SOA) (Minoli 2008) and Method Engineering (ME) (Winter 2007) are topical frameworks gaining momentum among academics and practitioners alike. The latter frameworks provided scalable architecture solutions examining only those components deemed relevant to the problem at hand (Minoli 2008; Winter 2007). As discussed, agile and contingency ISD methodologies adopted a similar approach. Enterprise Integration (EI) is another architecture framework gaining popularity (Chen, D & Doumeingts 2003; Molina et al. 2005; Naudet et al. 2010). EI focused on integrating all layers within the organisation (or

enterprise) with the core layers defined as business, knowledge, and ICT (Chen, D & Doumeingts 2003).

EA was underpinned by a range of modelling methods and related standards that were governed by the International Standards Organisation (ISO) and World Wide Web Consortium (W3C), to name but some (Chen, D & Doumeingts 2003; Molina et al. 2005; Naudet et al. 2010). A combination of modelling methods was needed to comprehensively map the organisation environment (Kosanke 2004; Noran 2004; Schmitt et al. 2004). Moreover, the preferred framework (or modelling method) was essentially user choice, taken in consideration of the task at hand, the frameworks in place within the organisation, and the available resources (Noran 2004). In contrast, Dewhurst, Barber and Pritchard (2002) questioned the ability of EA frameworks to truly replicate the organisation dynamics. They believed EA had limited ability to provide real-time information because of an over reliance on inert simulations. This issue is discussed further in section 3.5.

## **2.8 Theory and Practice**

The literature revealed a number of theoretical perspectives underpinned the organisation environment with these perspectives developing in profundity and diversity alongside the evolving organisation. Theoretical perspectives of the industrial revolution were economic driven and their relevance to the post-modern organisation had been questioned. As a result, a variety of theoretical perspectives and meta-theories were amalgamated to support the organisation transformation. For example, post-modern organisation theorists combined the theoretical perspectives of the social sciences, science (including mathematics) and engineering. Hence, the works of von Bertalanffy, Weiner, von Neumann, Lewin, Trist and Murray, among others, were instrumental in reshaping the organisation environment and its behaviour. A variety of meta-theories and frameworks evolved from their work. Consequently, the organisation was controlled by a series of meta-theories comprising a range of principles and practices (or frameworks). The literature suggested a meta-theoretical approach was required to manage and understand the complexities and dynamics of the organisation. However, often the underlying frameworks

proved ineffective because they were implemented and administered in isolation of other requisite practices, and with little understanding of the organisation uniqueness.

The industrial revolution was the precursor of organisation change triggered by economic growth and technology innovation. The events of WWII were also instrumental in furthering technology innovation, changing the modus operandi of post-industrial organisations. From this point forward there was greater emphasis on decision-making, innovation and knowledge management. Organisations faced major challenges with increased demand for knowledge and technology solutions. During the 1980s, when IS were accepted as strategic organisation tools, a variety of ISD frameworks and IT controls were developed to better manage and integrate IS with the organisation needs. Often these controls were perceived as ineffective.

Technology innovation was pivotal in defining the modern organisation principally through the adoption of complex, inter-organisation processes, notably, automated, real-time transaction processing and workflows. The recent move toward agile systems has seen management principles and IS controls embedded into workflows. The rationale behind the move was to affect automated decision-making through integrated process control. However, the literature acknowledged that technology was not the primary innovator of organisation integration. A mix of interrelated elements was required to effect organisation integration and control. What emerged through the literature was a progressive awareness of the interconnectedness of the organisation elements. This awareness can be attributed to the approach proposed by GST and socio-technical theory. However, concerns remained regarding the ability of frameworks to control or manage organisation change. This aspect is explored in Chapter 3.

## **2.9 Chapter Summary**

The literature revealed the shortcomings associated with transitioning theory to practice. Whilst the wider literature acknowledged the complexity of the organisation environment there was minimal explicit literature demonstrating how these complexities might be holistically managed and controlled.

Consequently, there was only limited practical understanding concerning the impact of organisation controls (including theoretical perspectives) in a change environment. The approach taken in this study was that a framework should be holistic and flexible to accommodate organisation change, yet remain grounded in theory to ensure its robustness and uniformity across the organisation.

The primary focus of this research was to present a preliminary specification of a conceptual model (schema) describing the key organisation entities and interdependencies impacted by a change process. The derived model was translated into a relational database with an instantiation of the database allowing the automated derivation of the key entities implicated in a change process. The knowledge and data required to construct the models and database (ACT) were captured through a case study that investigated a change process within the supply and logistics operations of a large Australian company. The case study is presented in Chapter 4 with the research analysis findings discussed in Chapter 6.

The following chapter presents an overview of conceptual modelling together with an evaluation of popular modelling methods. Particular attention is given to the formalisms used to map the change process and develop the ACT. In addition, organisation change theory is discussed in the context of existing change frameworks and tools, modelling methods, and related paradigms (e.g. GST, socio-technical theory, and technology theory). These paradigms and those already mentioned, underpinned the ACT conceptual models and database development. The benefits of adopting conceptual models and automated tools to remediate organisation change are discussed, and unambiguously established, in Chapter 6.

## **Chapter 3**

### **Conceptual Modelling and Organisation Change**

#### **3.1 Introduction**

Conceptual modelling originated from scientific theory (specifically mathematics and engineering theory), and covers a multitude of modelling methods and formalisms. Organisation modelling can be traced to the seventeenth century (C17<sup>th</sup>) when hand-drawn schemas and matrices were used to communicate decision processes and outcomes. Neoclassical and classical organisation theories were the key influences of that era with conceptual modelling predominantly quantitative, predictive and goal-oriented. Modelling remained largely quantitative until the 1930s when organisation theorists embraced general system theory (GST) where organisations were considered complex, dynamic, interrelated structures. During this period social science emerged as an influential theoretical perspective. Organisation theorists embraced a combination of scientific, naturalistic, and social science theories including the derived paradigms of cybernetics, socio-technical theory, and field theory. The influence of these theoretical perspectives continued into the twenty-first century (C21<sup>st</sup>) with enterprise integration (EI), autonomic communications, and information and knowledge management high on the organisation agenda. Organisation modelling also evolved, embracing qualitative methods and formalisms to systematically illustrate the organisation structure, its components, and the dynamics of their interdependencies.

Qualitative modelling was widely used in theory domains to illustrate respective frameworks. For example, decision theory, organisation theory, and technology theory used models to illustrate the respective frameworks of risk management, strategic management, change management, enterprise architecture (EA), and information systems development (ISD), to name but some. Over time there has been significant advancement in organisation-focused modelling methods, formalisms and tools. In this chapter, the value and relevance of these instruments are explored in terms of their ability to

predetermine and manage a change process (or initiative). To that end, key modelling methods, frameworks and tools were drawn from technology theory and change theory, and evaluated in accordance with their capacity to resolve and illustrate complex organisation interdependencies. Therefore, an integral part of this research was to explore the ability of conceptual models to effectively capture and illustrate organisation change entities and their dynamics.

This research proposes that a change solution should incorporate 'real-time' data analyses to assess, determine, and communicate change. The benefits of automated change tools have been previously addressed by practitioners and academics. However, real-time model-based scenario building, and sensitivity analysis, has yet to be incorporated into a change tool. Existing automated tools were considered too constrained by embedded formalisms, and incapable of providing holistic change solutions. This chapter presents an evaluation of some common automated tools, which were assessed in terms of their ability to provide a comprehensive change management solution. This research proposes that, for automated change tools to be effective they must be underpinned by formalisms capable of decomposing organisation entities to their lowest denomination. The criticality of determining organisation change impacts, and how it is performed, is illustrated using the 'Library Loan' example. The example also highlights the importance of choosing modelling methods and formalisms appropriate to the task at hand.

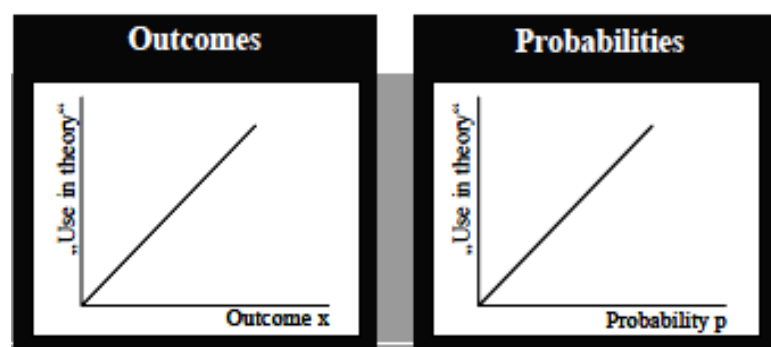
This study adopted a mix of modelling instruments to capture and illustrate a change process and its impacts. The purpose and benefits of using conceptual models as problem-solving tools are demonstrated using universal instruments. The application of these instruments to develop the automated change tool (ACT) logical schema and physical meta-schema, and the transition from a conceptual model to a relational database (ACT) are addressed. The formalisms used to construct the high-level schemas and low-level meta-schemas included; a cross-function process model (CFPM) and cross-function decision model (CFDM), a hierarchical function model, hierarchical network model and network impact analysis model, and an entity

relationship diagram (ERD), and a (proprietary) database meta schema. The power of these models to illustrate a change process and capture organisation complexities and interdependencies is established. Further, the capacity of modelling solutions to reduce the impact of soft factors in decision-making is also addressed. The ACT conceptual models and ACT functionality are demonstrated in Chapter 6.

There are a plethora of popular conceptual models cited within the wider literature. This study has included only those deemed pertinent to the research objectives.

### 3.2 Conceptual Modelling

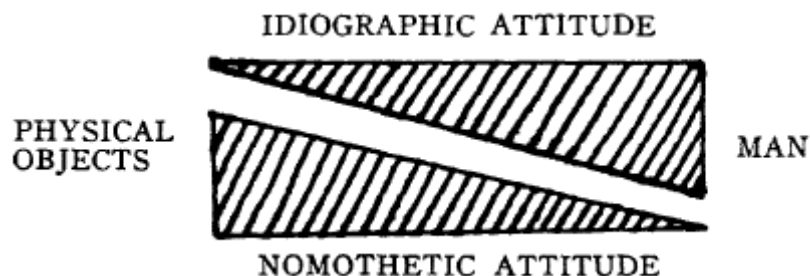
As noted, organisation conceptual modelling was traced to the C17<sup>th</sup> when hand-drawn schemas and matrices were used to communicate decision processes and outcomes (Jeske & Werner 2008; Miner 1978). The scientific and classical management schools drew from neoclassical and classical organisation theories (Miner 1978; Pugh 1966; Shafritz & Ott 1987). Accordingly, their modelling methods were defined as quantitative, predictive and goal oriented (Simon 1990b). The simplistic format of early quantitative models is demonstrated at Figure 6. Conceptual modelling remained largely quantitative until the 1930s when, as noted, organisation theorists embraced GST to better understand the complexity, dynamics and behaviour of the modern organisation (Pugh 1966; Shafritz & Ott 1987; Simon 1962).



**Figure 6: Expected Value Leibniz 1678 cited in (Jeske & Werner 2008, p 1)**

During the 1930s, social science emerged as a theoretical domain. At that time, organisation theorists embraced the scientific and social science theories,

combining cybernetics (Wiener 1961), GST (von Bertalanffy 1979), information theory (Emery & Trist 1965), technical theory (Pugh 1966), and field theory (Lewin 1967). By the mid twentieth century (C20<sup>th</sup>), most organisation theorists had adopted qualitative modelling to illustrate the organisation structure and its components. Moreover, pro-systems theorists adopted conceptual modelling to identify the interconnectedness and dynamics of the organisation elements (Shafritz & Ott 1987). Figure 7 emphasises the shift from qualitative to quantitative modelling where formalisms captured more variables and were social science, rather than economic, based. As noted, qualitative modelling was associated with a multitude of theoretical perspectives; decision theory (Akkermans & Bertrand 1997; Simon 1990a), organisation theory (Shafritz & Ott 1987), technology theory (Pugh 1966), and the respective frameworks; strategic management (Porter 1985), strategic change (Ginsberg 1988), change management (Carter 2008), ISD (Yourdon 1989), and EA (Bernus 2003a). The adoption of conceptual modelling as an integral organisation artefact lead to the development of organisation focused modelling methods and formalisms.

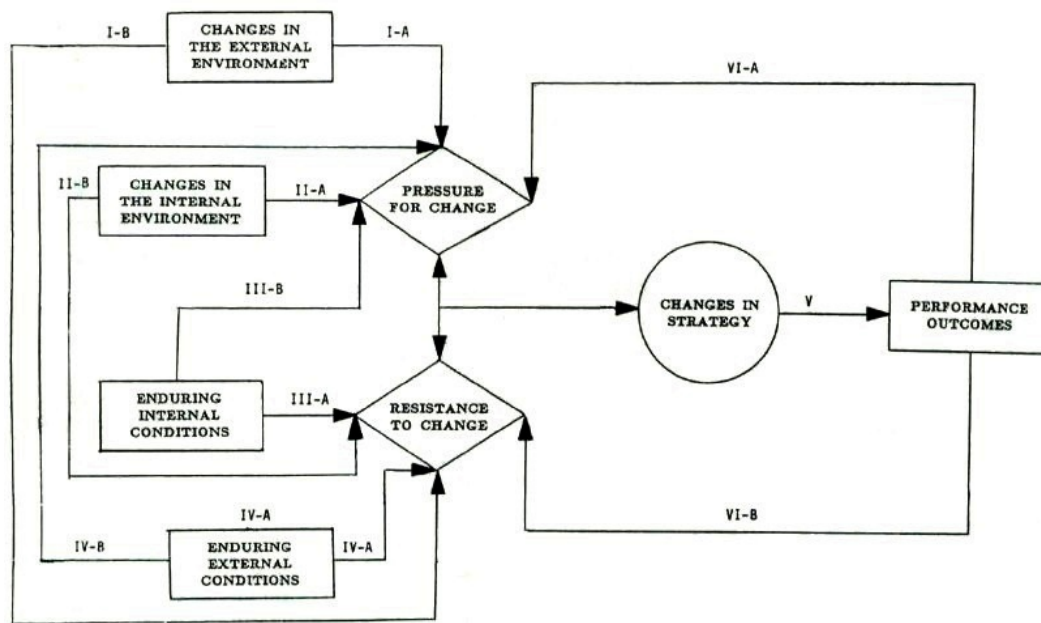


**Figure 7: Diagrammatic Representation of Nomothetic and Idiographic Attitudes (von Bertalanffy 1951, p 25)**

Herbert Simon (1990b) described modelling as the abstraction and separation of 'essential' elements from the 'dispensable', the capture of a 'simplified picture of reality' for the purpose of goal oriented prediction and prescription. Importantly, he made the distinction between predictive and prescriptive modelling. Predictive modelling was synonymous with the temporal, numerical analysis of engineering structures or scientific empirical data, while prescriptive modelling was tantamount to the 'symbolic', textual, or graphical depiction of 'hierarchic' complex social systems (Simon 1990b). He attributed the rise in

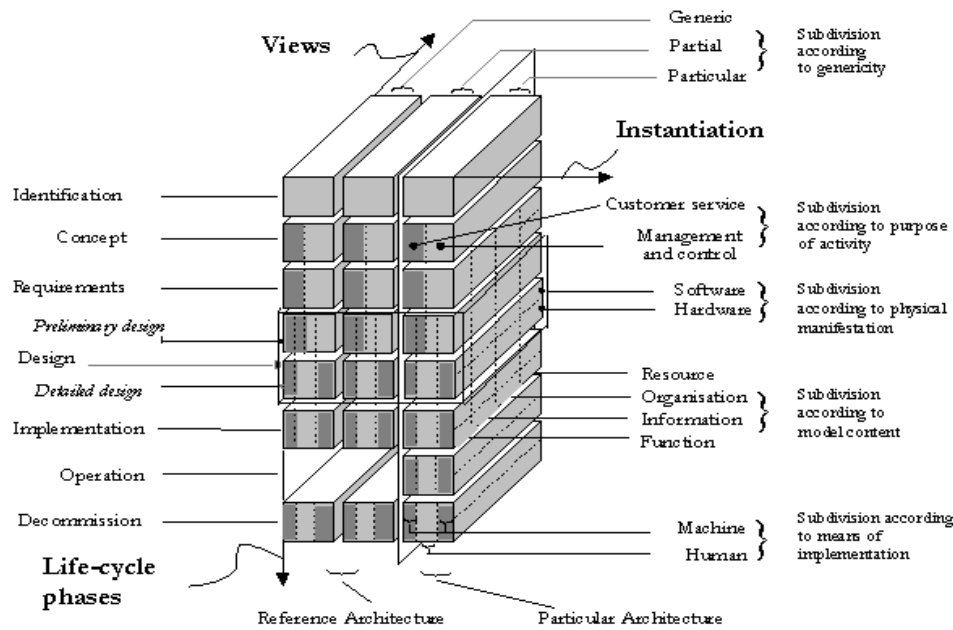


the adoption of prescription modelling to the need to include multiple variables in complex system analysis, advancement in computer technology, specifically, graphical qualitative processing capability, and, increased interest and research in human cognitive theory and systems complexity. It should be noted that, the researcher uses the term predictive or predict to describe the ACT ability to predetermine change implications and they are not used in the way intended by Simon (1990b).



**Figure 8: A Framework for Modelling Changes in Strategy (Ginsberg 1988, p 563)**

Ginsberg's (1988) strategic change model, shown at Figure 8, illustrated the development and complexity of qualitative, prescriptive modelling during the late C20<sup>th</sup>. For example, Ginsberg used a process model to map the dynamics and variables associated with a change process. The model was graphical and textual, and considered the human cognitive complexities. Similarly, the GERAM EA model shown at Figure 9 was used to capture the complexities and components considered in an organisation change process. More importantly, the GERAM model was three dimensional, which was a significant advancement compared to Ginsberg's model.



**Figure 9: Generalised Enterprise Reference Architecture Methodology (GERAM) with Modelling Views (IFIP-IFAC Taskforce 1999, p 22)**

According to Simon (1990b, p 7), ‘modelling was a principal tool for studying complex systems’. A complex system was described as comprising ‘a large number of parts that interact in a non-simple way’ (Simon 1962, p 468). The study of complexity, or ‘complexity theory’, originated from the natural sciences in the late C20<sup>th</sup> and was adopted by organisation theorists to understand organisational behaviour, specifically, organisational change (Burnes 2004a). Complexity modelling originated from scientific theory, specifically mathematical theory and engineering theory (Miner 1978; Wierzbicki 2007). It was described as the ‘simplification’ of complex themes and the identification of critical components (Miner 1978). Karl Popper [1965] (in Fawcett 1999) stated that, the conceptual (theoretical) model was the essential precursor to robust theory development. Consequently, conceptual modelling has had a long and productive association with the sciences, making valuable contributions through theoretical constructs and theorems (von Bertalanffy 1951).

Conceptual modelling embraced many modelling methods including; data modelling, knowledge modelling and ontology modelling (Dillon et al. 2008), complexity modelling (Miner 1978; Wierzbicki 2007), and theoretical modelling

(von Bertalanffy 1951). According to Noble and Biddle (2006), conceptual modelling covered a multitude of modelling methods and formalisms used to conceptualise and organise organisation information needs. This research was concerned with the application of specific modelling methods and formalisms to resolve a complex socio-technical problem. It was not concerned with the semantics surrounding the categorisation of modelling methods or practices. Fawcett's (1999, p 3) explanation that 'each conceptual model provided a different lens or perspective for viewing the phenomena within the domain of inquiry of a particular discipline', implied conceptual modelling was universal in terms of the modelling methods and formalisms that it embraced. Therefore, the approach taken here is that conceptual modelling is an umbrella term for a number of modelling methods and formalisms.

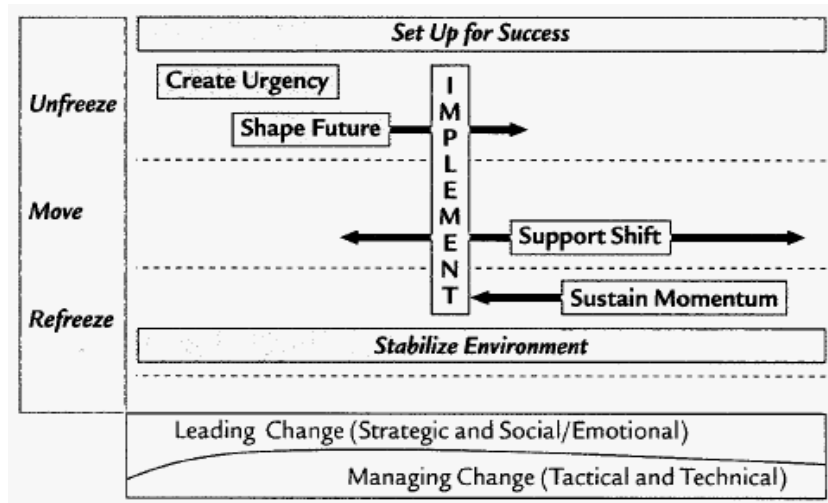
An integral aspect of this research was to explore the application of conceptual modelling in organisation change. Thus, the intent was to investigate the modelling methods, frameworks and formalisms adopted by practitioners and academics to understand and manage change, and to evaluate their effectiveness. What follows is an overview of organisation change theory, which includes a summary of the instruments used by organisations to manage change.

### **3.3 Organisation Change Theory**

Change was described as a transformation of a shape or form (Ginsberg 1988). Drucker (1999) viewed organisation change as a 'natural' and 'acceptable' occurrence. Change was a sign of 'growth' and 'expansion', a process of innovation: the *raison d'être* (Drucker 1999). Morden (1996) cited the industrial revolution as the precursor of organisation change. It was a continuous change cycle triggered (or driven) by external or internal influences (Morden 1996). Post-industrial organisations were substantially different to their predecessors and, as a result, were highly susceptible to change (Huber 1984). Evermore, organisations needed to be intentional in their planning and control of change, given the complexities of the modern operational environment (Miner 1978). Huber (1984) noted that, post-modern organisations needed to continually align their 'structures', 'processes' and 'technologies'

with the changing environment to ensure survival. He said organisation complexity would rise from an insatiable appetite for knowledge, and increasing component interdependencies. Henceforth, change management became a key management principle among organisation theorists. In light of Huber's (1984) comments, the fundamental issue was that change could impact organisation structures, processes and technologies. Of significance was the ability of technology theory and change theory to predetermine organisation change impact. Importantly, the dominant decision-making approach (or approaches) within an organisation should be a major determinant of change management strategies employed (McGrath & More 2001).

Change theory made a significant contribution to modern organisation theory. Change theory was attributed to Kurt Lewin's work on field theory, and was adopted by post-modern theorists to control and understand change (Buchanan et al. 2005; Burnes 2004a, 2004b; Carter 2008; Coghlan & Brannick 2004; Pasmore & Khalsa 1993). Lewin's 'three stage' model was deemed one of the earliest and successful organisational change models, advocating a planned and incremental approach to organisation change and organisation behaviour (Buchanan et al. 2005; Burnes 2004a, 2004b; Carter 2008; Coghlan & Brannick 2004). Lewin's work on 'group dynamics' played an integral role in change management programs, considering group behaviour, rather than the individual, as pertinent in organisation change (Burnes 2004a, 2004b). Despite criticisms from various quarters concerning the appropriateness of Lewin's 'simplistic' model to the modern complex organisation, the relevance of Lewin's work continued into the C21<sup>st</sup> (Burnes 2004a, 2004b). Carter's (2008) adaptation of Lewin's three stage change model shown at Figure 10 was testament to this.



**Figure 10: Kurt Lewin's (adapted) Three Stages of Organisational Change (Carter 2008, p 21)**

Bertalanffy's GST was a major contributor to change theory. His work promulgated the systemic analyses and rationale of the social and technical factors indicative of the organisation environment (Trist & Murray 1990). For example, GST promoted the 'analysis of internal processes in organisations', and the analysis of organisation components and 'interdependencies', in relation to its environment (Emery & Trist 1965, p 21). GST also viewed the system and its environment as living objects and, in accordance with the laws of nature, was subjected to constant change (von Bertalanffy 2008). This was a significant contribution to change theory as it highlighted the domino effect of change, where changes in one sub-system or component could affect changes in another. Further, GST demanded the organisation be viewed as a system comprised of a series of interdependent and dynamic sub-systems.

Bertalanffy's, and Lewin's work greatly influenced Trist and Murray's (1990) socio-technical theory as it chiefly embraced these two perspectives. Socio-technical theory drew from the social sciences, engaging in 'building social science capabilities into the organisation', for the purpose of alleviating increasing 'macro or meta-problems' of a social nature (Trist & Murray 1990, p 12). Socio-technical theory was an important development for organisation change practices. It highlighted the interdependence of social systems, and technical systems, with each requiring equal consideration, especially in a design or change environment (Pasmore & Khalsa 1993). The socio-technical

theoretical perspective has underpinned many subsequent theories and frameworks (Burnes 2004a, 2004b; Denning & Freeman 2009; Morner & von Krogh 2009). Some of these frameworks are discussed in this study.

Post-modern theorists adopted a range of theories to understand and control the changing organisation (Miner 1978). From these theories emerged a succession of related practices (Burnes 2004a; Shafritz & Ott 1987). For example, during the 1970s and 1980s numerous strategic change frameworks were developed (Ginsberg 1988). In the 1980s, strategic change was concerned with leveraging competitiveness and innovation (Burnes 2004a; Drucker 1999). In the 1990s, the focus was establishing and maintaining strategic alliances spurred by globalisation (Porter & Siggelkow 2008). Change strategies of the C21<sup>st</sup> were aimed at facilitating the virtual organisation (VO) (Attaran 2003), with an increased focus on technology supported business agility and flexibility (van Oosterhout et al. 2007).

### **3.4 Technology Theory and Change**

Organisation change was described as a natural phenomenon of industrialisation that needed to be planned and managed (Drucker 1999; Ginsberg 1988). Change practices needed an 'end-to-end' perspective where the impact of change was holistically assessed (Coulson-Thomas 2008). The wider literature acknowledged that, post-modern organisation change was decidedly more complex. Thus, organisation change demanded a multi-theoretical approach to effect absolute domain integration. The role of technology innovation in organisation change, and the adoption of multiple theoretical approaches to manage the complexities and dynamics of these changes, has been discussed in the wider literature. However, the value of adopting technology theory, to assess and manage organisation change has been given little attention, with the exception of EA and other like frameworks. While these frameworks have made considerable contribution to the design and optimisation of complex manufacturing systems (Weston 1998; Zachman 1996), they have had limited success as instruments of organisation change. This issue is further discussed in section 3.5.

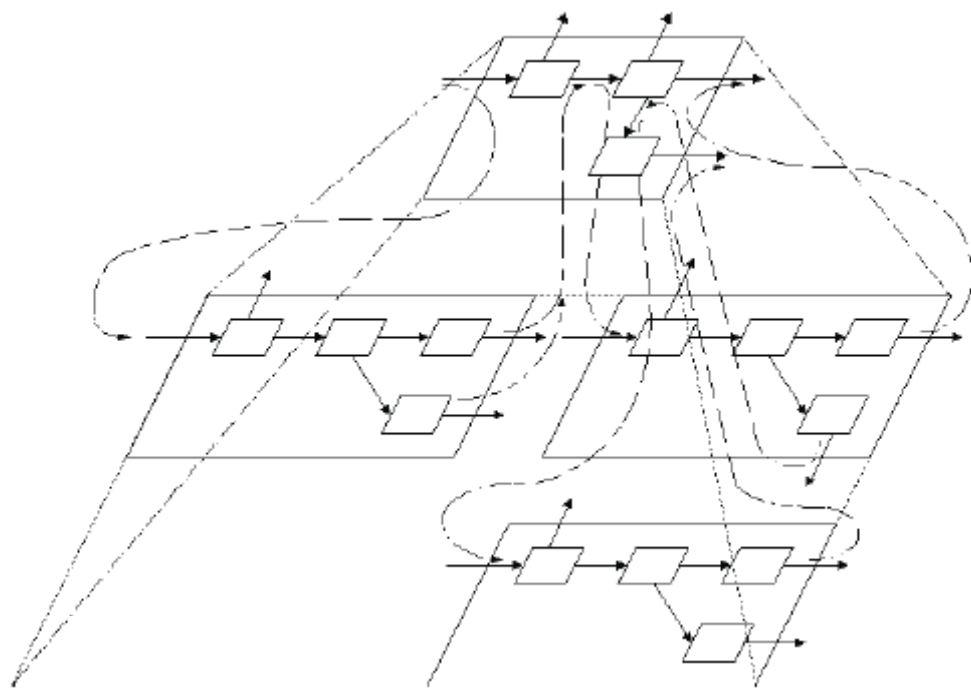
The Ginsberg and GERAM models shown at Figures 8 and 9 were examples where technology theory had contributed to the understanding of organisation change. For example, Ginsberg's process model illustrates sequential change considerations, the significance of which would have been lost using a text format alone. Similarly, translating the context of the GERAM model into a text format would have defused all significance. Another example where modelling formalisms have contributed toward a better understanding of organisation change was the Small and Downey (2001) enterprise change model. Small and Downey (2001) used a high-level IDEF(0) model to illustrate the change activities and interdependencies involved in a change program. While their model was informative, in that it articulated respective change issues and identified the interconnected tasks, the model was limited in its scope to capture the dynamics of these tasks. For example, it did not illustrate the lowest measurable unit of change. The importance of this function is addressed in section 3.6.3.

Another example where technology theory had been used to manage organisation change - at least from a systems perspective - was ISD. This study adopted the systems analysis and design (SA&D) framework to develop the ACT. SA&D was a highly accredited framework used in the design, development and implementation of information systems (IS) (Yourdon 1989; Alter & Browne 2005). The framework consists of a composition of various processes, practices, tools and concepts (Alter & Browne 2005). As noted, SA&D principles were derived from traditional ISD concepts and socio-technical influences. The socio-technical influence stems from the recognition of user involvement in systems development (Burch 1992), and human factor considerations (Alter & Browne 2005).

Alter and Browne's (2005) interpretation of the SA&D methodology (shown at Figure 4, Chapter 2) was a contemporary assessment of socio-technical related organisation change factors. For example, they measured the extent and rate of interplay between the social and technical aspects of systems related change, and organisation change triggers. Potential changes were weighted against their impact on work practices, which were assessed from a

mix of technical and social considerations (Alter & Browne 2005). Alter and Browne's (2005) interpretation of SA&D activities were mostly IS focused, but importantly, they highlighted the socio-technical issues associated with organisation change.

As discussed, ISD frameworks were implemented with the vision of managing change within the IS domain (Markus, Majchrzak & Gasser 2002; Nilsson, A 2005; Yourdon 1989). The wider literature showed that ISD methodologies evolved with the changing organisation. EA frameworks too evolved to support the modern organisation. Figure 11 illustrates how EA has evolved to accommodate a modern flexible organisation, capturing only those entities deemed pertinent to the task, using a simple, yet comprehensive format (Dewhurst, Barber & Pritchard 2002). The General Enterprise Model (GEM) defined the organisation as comprising high-level and low-level domains (or sub-systems) and interdependencies. This is an exceptional example of how GST has influenced modelling formalisms.



**Figure 11: The Hierarchical Structure (Dewhurst, Barber & Pritchard 2002, p 421)**

ISD and EA frameworks were, mostly, integrated wholly or in part using a project management program. Rarely was one framework implemented in isolation of the other. The ISD and EA association was based on the overlap



between their respective methods. Each used the modelling formalisms underpinned by the international standard organisation (ISO), governing process and data mapping terms of reference (Bernus 2003a). However, notwithstanding advancements in technology theory frameworks, more than half of IS projects failed (Cerpa & Verner 2009; Goepp, Kiefer & De Guio 2008; Kolltveit, Hennestad & Gronhaug 2007; Santa et al. 2009). The literature suggested the failure was linked to inappropriately defined requirements (Alter & Browne 2005), budget and timeframe overrun, (Goepp, Kiefer & De Guio 2008), and misalignment between 'technology innovation effectiveness' and 'operational effectiveness' (Santa et al. 2009, p 158). Similarly, Mertins and Jockem (2001) claimed an 80% failure rate among reengineering projects was attributed to inappropriate methodologies and tools. This suggested there were some deficiencies in the technology frameworks and controls used to manage IS projects.

### **3.5 Change Practices and Tools**

As discussed, the growing complexity and changing nature of the organisation environment prompted organisations to seek more analytical and practical methods for managing change (Cao & McHugh 2005; Ginsberg 1988; Rahimifard & Weston 2007). Subsequently, there has been an evolution of organisation change practices aimed toward change control (Burnes 2004a; Cao & McHugh 2005; Ginsberg 1988). For example, Cao and McHugh (2005) adopted a systemic and multiple methods approach to organisation change. They focused on three organisational constructs; process, function and structure (incorporating authority lines, regulatory and resource controls), and culture, power and politics. Their approach consisted of managing objective (hard), and subjective (soft) factors (Cao & McHugh 2005). For instance, business process reengineering (BPR) and Total Quality Management (TQM) were considered appropriate for managing process change, while contingency and transaction cost economics were deemed suitable for managing organisation function and structure (Cao & McHugh 2005). The subjective factors - culture, power and politics - were dealt with using (unspecified) cultural and political change methods (Cao & McHugh 2005).

QMS, TQM, and Six Sigma, were programs implemented to control organisation compliance through universal best practices (Buchanan et al. 2005; Fredendall & Hill 2001). As discussed, the majority of these programs were considered too generic to be wholly effective (Buchanan et al. 2005; Fredendall & Hill 2001). A major weakness was the inability of these practices to accommodate an organisation's operational uniqueness (Buchanan et al. 2005). Burch's (1992) view was that these frameworks targeted process improvement rather than organisation change. Change programs were criticised because they were generally implemented with little understanding of the organisation environment and its operations (Cao & McHugh 2005). Carter (2008) suggested that communication, and training should be included in the organisation change assessment.

Communication was an important factor in 'live' and 'mechanistic' systems (Wiener 1961), and its relevance to the organisation has been firmly established (Emery & Trist 1965). Weiner's work on cybernetics influenced a range of theoretical domains; natural and social sciences, organisation theory, and technology theory. Communication was seen as an essential component of organisation activity (Huber 1984; Simon 1997), with change communication viewed as a vital and fundamental organisation practice (Coulson -Thomas 2008; Levasseur 2001). The strategic placement of change agents within the organisation was an integral part of the change program. Change agents ensured change was widely communicated, anticipated and its impact understood (Carter 2008; Coulson-Thomas 2008). Burnes (2004a) argued that, this phenomenon was previously explored and tested through Lewin's work on 'group-base behaviour'. He added that, its recent resurgence was an attempt to understand organisation complexity, particularly in a change environment. Conceptual modelling was considered a vital component of organisation communication (Miner 1978; Jeske & Werner 2008).

The capacity of change programs to implement an overall change solution was considered questionable unless the objective and subjective factors were captured and analysed collectively (Cao & McHugh 2005; Lang & Zangl 2008). The implementation of QMS frameworks, for example, was seen as an attempt

to override organisation soft factors (Coulson-Thomas 2008). The capture of cognitive (soft) factors was a practice developed by Kurt Lewin in his analysis of social factors affecting organisation change (Carter 2008; Coghlan & Brannick 2004; Burnes 2004a). Since then, there have been numerous studies covering human cognitive factors, or organisation behaviour as it became known. Organisations adopted a variety of decision tools and DSS to redress the problem. Lang and Zangl (2008) stated that, in a change environment, sophisticated tools should be designed to capture both the 'objective' (hard) and 'subjective' (soft) factors. Similarly, Mathieson (2007) proposed that, a combination of technology theory and social science theory, specifically, automated modelling and analysis tools, would neutralise the decision process. In other words, applying incremental logic (cause and effect) to analyse each action derived from the decision process would help defuse soft factors (Mathieson 2007).

Coulson-Thomas (2008) recognised the failure of topical change programs - such as those discussed in this section - to adequately manage organisation change. He concluded that, successful change relied on logical and quality decisions, and measuring and communicating the impact of change would ensure the right course of action followed. Coulson-Thomas (2008) proposed that such a phenomenon could be achieved through an automated decision tool. The Dewhurst, Barber and Pritchard (2002) position was similar based on their assessment of EA simulations, which they saw as mostly inert. In their opinion, an effective organisation model should provide multiple domain perspectives while incorporating 'real-time' data analyses. Sensitivity analyses would enable real-time data extraction through add-on tools, object oriented local application processing ('OOLAP') for example, and extend model capability through report outputs (Dewhurst, Barber and Pritchard 2002). As noted, real-time model-based scenario building and sensitivity analyses have yet to be incorporated into EA or other frameworks. However the benefits of automated change tools have long been recognised (Mayer, Painter & Lingineni 1995).

It should be noted here that, within some quarters, change tools, change practices, and change frameworks were labelled as interchangeable terms. However, in order to differentiate between automated change tools and non-automated change practices, the following distinctions have been applied. First, automated change tools are defined under two categories; software that provides sensitivity analyses on primary data stored within a repository (database), and, software that provides model-based scenario building derived from secondary data inputs. Second, non-automated change practices are static frameworks, which includes; symptoms-causes-outputs-resources-effects (S.C.O.R.E.), strengths weaknesses opportunities threats (SWOT), Six Sigma, balanced scorecard, key performance indicators (KPI), TQM and QMS, to name but some.

Automated EA change tools included, but were not limited to, integrated enterprise modelling (IEM), method of object oriented business process optimisation (MO<sup>2</sup>GO) (Jankovic et al. 2007; Mertins & Jaekel 2006), applications integrated project (ATHENA IP), process organisation product (POP) and other methodologies (or data exchange tools) (Jankovic et al. 2007). These particular tools were product, order, and resource oriented but were also workflow or business process focused with the ability to store, exchange, and extract different organisational views (models) (Jankovic et al. 2007; Mertins & Jaekel 2006; Mertins & Jochem 2001). Although these tools enabled the automated derivation of model-based scenarios, they were not generic models, meaning, they were restricted by design to the operations of specific domains or industry types. In addition, these tools did not provide sensitivity analysis on real-time primary data, nor did they provide automated report outputs. A combination of both factors would enable all organisational parties, processes, systems etc. impacted by change to be captured and reported.

### **3.6 Modelling Methods and Formalisms**

Modelling methods were defined as a series of simulations with specific views (Bernus 2003b; Williams 1994). For example, the Integration DEFinition (IDEF) standards comprised a suite of 'special-purpose methods' used to

communicate various enterprise views and solutions (Mayer, Painter & Lingineni 1995; Noran 2004; Shen et al. 2004). These modelling methods included, but were not limited to, function modelling, data modelling, and process modelling (Mayer, Painter & Lingineni 1995; Noran 2004; Shen et al. 2004). Modelling methods consisted of special-purpose instruments (formalisms or languages) used to analyse and illustrate a particular problem or view (Bernus 2003a; Mayer, Painter & Lingineni 1995; Noran 2004; PLAIC 2001). Consequently, modelling methods were chosen in accordance with their respective ISO guidelines or *modus operandi* (Dewhurst, Barber & Rogers 2001; Kosanke 2004).

A number of comprehensive and descriptive organisation modelling methods and formalism evaluations have been undertaken over the past decade (Bernus 2003b; Molina et al. 2005; Noran 2004; PLAIC 2001; Shen et al. 2004; Tatsiopoulos, Panayiotou & Ponis 2002) and, more recently (Grossman, Schrefl & Stumptner 2008; Khoury 2007). The wider literature suggested traditional modelling formalisms were tailored in response to a requirement for integrated real-time information (Grossman, Schrefl & Stumptner 2008; Kamble 2008; Khan, Kapurubandara & Chadha 2004). A large part of the challenge had been the effectiveness of formalisms to provide the required level of detail and domain integration to accomplish enterprise collaboration (Chen, D & Doumeingts 2003; Naudet et al. 2010). Formalisms that permitted lower-level modelling or meta-models (meta-schemas) were deemed more suitable to the task (Berki, Georgiadou & Holcombe 2004; Naudet et al. 2010). Meta-schemas were essentially models defining low-level models (or sub-systems) within the relational hierarchy (Naudet et al. 2010; Thi & Helfert 2007).

The consensus was that, modelling formalisms were constrained by their representation of specific organisation views (Bernus 2003a, 2003b; Shen et al. 2004). Therefore, a combination of modelling instruments was required to establish an overall organisation perspective (Bernus 2003a, 2003b; Noran 2004; PLAIC 2001; Shen et al. 2004). Some common threads had to be observed to ensure model quality, irrespective of the instruments used (Burch 1992). The common threads were defined as communication (the cohesive

abstraction of concepts to facilitate communication between stakeholders), experimentation (iterative design that allowed stakeholders to evaluate and reconfigure), and prediction (provide a complete and coherent representation of purpose and goal) (Burch 1992). The work of Thi and Helfert (2007) extensively discussed the concept of model quality and meta-model quality.

Consequently, this study adopted a multi-formalism approach to capture, illustrate and communicate an organisation change process, and develop an automated change tool.

### **3.6.1 Process Modelling**

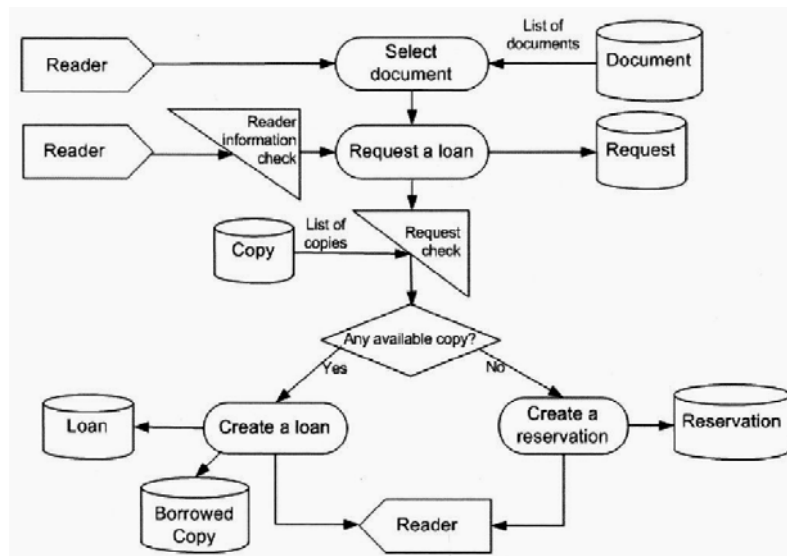
Historically, professionals and academics used process modelling to evaluate and optimise manufacturing operations, and determine information flows (Berki, Georgiadou & Holcombe 2004; Bernus 2003a; Noran 2004). More recently, process modelling has been used to map business processes IS interfaces (Berki, Georgiadou & Holcombe 2004; Molina et al. 2005; Naudet et al. 2010). Process modelling was widely used in EA to illustrate the organisation environment (Chatha, Ajaefobi & Weston 2007; Noran 2004; PLAIC 2001), and in ISD methodologies to elucidate data requirements for systems development (Alter & Browne 2005; Shen et al. 2004; Yourdon 1989). As discussed, process modelling formalisms were underpinned by requisite ISO guidelines. Bernus (2003a, 2003b), PLAIC (2001), and Noran (2004) have provided comprehensive examples of these standards and their application. However, confusion remains regarding the semantics of modelling methods and formalisms. For example, some literature classified process modelling as all-embracing while others categorised formalisms according to their dynamics, purpose (data or process centric), and level of integration (high-level or low-level).

The position taken herein was that process modelling covered several core formalisms that included; the IDEF series (Chatha, Ajaefobi & Weston 2007; Shen et al. 2004), petri nets (Grossman, Schrefl & Stumptner 2008; PLAIC 2001), unified modelling language (UML), data flow diagrams (DFD) (Thi & Helfert 2007), extended mark-up language (XML) (Dillon et al. 2008; Liegl 2009), and multi-level (Gelman 2005) and network (Bernus 2003b) hierarchical

models. Models were differentiated by their respective libraries (or 'symbols'), which from a systems perspective, represented the common artefacts; system inputs and outputs, and 'sources' (persons, organisations, departments, and IS) (Burch 1992). Bernus (2003b) and PLAIC (2001) have compiled comprehensive lists of process modelling formalisms and their associated symbols.

Burch (1992) considered the key aspect of modelling was modularising a system (or objects) into manageable parts. The example he provided was based on manufacturing assembly lines where each component was independently developed but united by a common interface. Burch (1992, p 33) interpreted this practice as systemic modularisation, a process that 'reduced complexity, increased simplicity and improved maintainability'. He also believed the practice would greatly benefit ISD. The modularisation supposition proposed all components within a system be identified and analysed to determine interdependencies (or common interfaces). Similarly, EA, and other like methods, decomposed organisation components to their lowest denomination (or sub-system) by abstraction using formalisms. Taking this approach, in an organisation environment, allowed each component, and component relationship, to be assessed and managed in terms of performance, efficiency, duplication, and potential change impact.

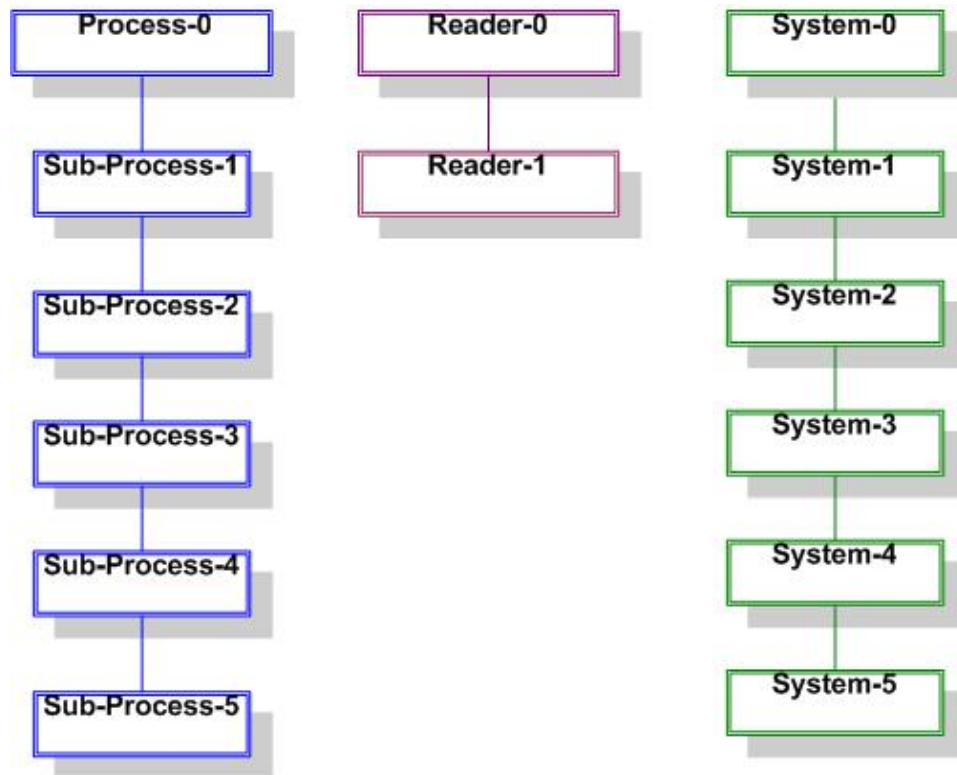
An example where process modelling has been used to identify and modularise a process activity is the 'library loan' example illustrated at Figure 12. In this example, a high-level process was decomposed and compartmentalised into paralleling activities. Seemingly, if a change occurred within the library loan process, the practitioner would be conscious of potential impacts on modules within that process.



**Figure 12: Create a Loan Process Model (Thi & Helfert 2007, p 10)**

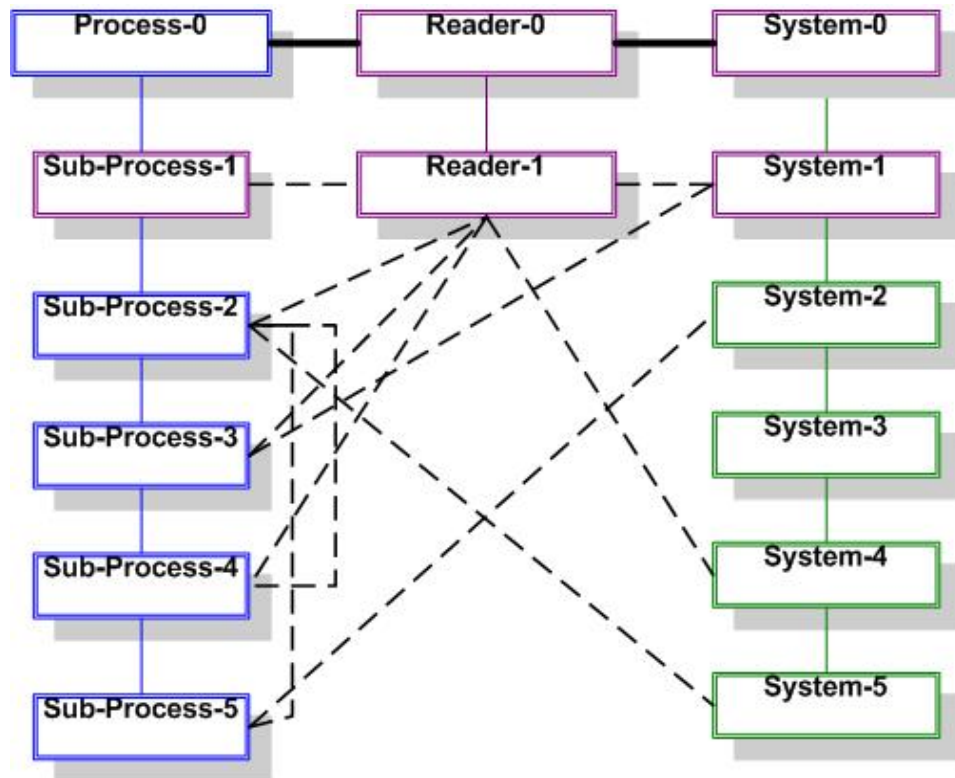
In reality an organisation has multiple components (modules) involved in a variety of processes. Grouping the components into an ordered arrangement provided a greater insight and approach for managing the component sub-levels (or layers). For example, converting the library loan process model, shown at Figure 12, into a hierarchical function model, shown at Figure 13, enabled the 'library loan'(0) activities to be grouped according to their sub-processes. The sub-processes have been labelled and numbered; 'select document'(1), 'request a loan'(2), 'create a loan'(3), 'reader information check'(4) and, 'request check'(5), etc. In grouping these components the entities 'reader'(0) and IT 'system'(0) (or repository) were identified. Five systems were identified in the library loan example, which were labelled as sub-systems; 'loan'(1), 'copy'(2), 'reservation'(3), 'document'(4), and 'request'(5). The researcher made the assumption that, in reality there would be multiple readers using the loan system; accordingly, the entity 'reader' was divided into sub-levels. Given the library loan example was a high-level process model, it would be prudent to assume that within each sub-process there would be related lower-level activities and tasks. Although these sub-levels were not reflected in the hierarchical function model, the reality was that such phenomena do exist.





**Figure 13: Hierarchical Function Model**

The hierarchical function model was valuable in that it indentified and grouped the library loan components and their sub-levels. However, the model failed to elicit the interfaces between the components and component sub-levels. The hierarchical network model, shown at Figure 14, provided a more accurate and dynamic perspective of the library loan process. For example, the network model identified the components process(0), reader(0), and system(0) as descriptors or high-level components (or entities) involved in the library loan process. These entities were demonstrative rather than party to the process dynamics. Put simply, the core entities of process(0), reader(0), and system(0), were components of the library loan process; however, the process dynamics or entity interfaces occurred at the entity lower-levels, i.e. sub-process, sub-system, and reader instances. The hierarchical network model was informative in representing the process dynamics, which otherwise would have remained opaque.



**Figure 14: Hierarchical Network Model**

Analysis of the library loan interactions can be described as follows:

0. entities reader(0), process(0) and system(0) comprise the library loan process;
1. reader(1) interacts with sub-process(1) and system(1);
2. reader(1) interfaces with sub-processes(2) and (4), and system(4);
3. sub-process(2) triggers sub-process(5) which interfaces with system(2);  
and
4. sub-process(3) interfaces with system(1) etc.

Inevitably, this analysis must be repeated for all components within the library process and, moreover, analysis must be continued down through the component sub-levels. Add the fact that there may be other entities (or parties) participating in the process and interfacing at various sub-levels, it is clear that complexity increases exponentially with the number of entity instances and sub-levels involved in the process. While the model shown at Figure 12 was an over simplification of a real phenomenon - given the example was based on one reader and one process instance, whereas in reality there would be multiple processes and other involved parties - it demonstrated the multiplicity

of interfaces and dynamics of the library loan process. The formalisms shown at Figures 13 and 14, defined and illustrated the interactions between entities and the entity sub-level. However, the models were limited in their capacity to accurately depict complex, multiple entity instances and multi-layer interdependencies. The practice of capturing and illustrating these complexities was better suited to a relational model.

### 3.6.2 The Relational Model

Relational modelling, foremost, was ISD focused with a primary function to develop a schema (conceptual model) of data requirements, consisting of 'entities', 'relationships' and 'attributes' (Chen, P 1977, 1983b; Shen et al. 2004; Yourdon 1989). Bagui and Earp (2003) made the distinction between conceptual models and schemas with the former considered abstract and the latter described as more complete. The position taken in this study builds on Fawcett's (1999) supposition (see section 3.2), where a conceptual model was deemed an umbrella term for all formalisms. An entity was described as a subject against which data was stored, a relationship was a link between the entities, and an attribute was a characteristic of an entity (Bagui & Earp 2003; Chen, P 1983b). The entity, relationship and attribute combinations are illustrated at Figure 15. Relationships were dependencies defined, in part, in terms of specific business rules or constraints (Bagui & Earp 2003; Bernus 2003b; Chen, P 1976; Mayer, Painter & Lingineni 1995). Relational formalisms abstract, describe, and logically portray data and relationships, generally with a view of mapping to a physical database (Bagui & Earp 2003; Chen, P 1976, 1983a).

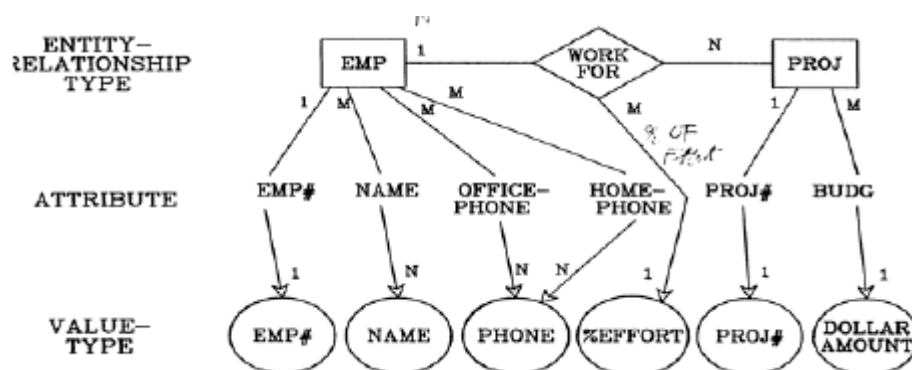
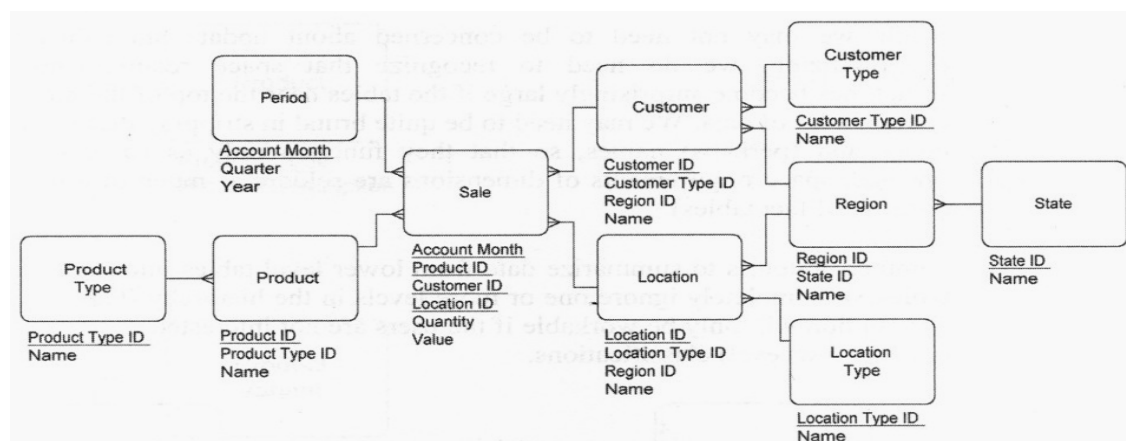


Figure 15: An Entity Relationship (ER) Diagram (Chen, P 2002, p 299)

The ERD, IDEF(1X), and UML (or similar) were the most common models used to capture the uniqueness and complexity of data relationships (Bernus 2003b; Chen, P 2002; Kamble 2008; Shen et al. 2004). Entity relational formalisms were used in ISD to establish the uniqueness of elements and their relationship status (Bagui & Earp 2003; Burch 1992; Chen, P 1976; Simsion 2001; Yourdon 1989). The IDEF(1X) formalism paralleled ER models in terms of functionality even though the symbolic references were slightly skewed (Chen, P 2002). UML was considered valuable as an object-oriented software development tool; however, its application in defining low-level interactions between entities was said to have limited functionality (Chen, P 2002; Noran 2004). Examples of ERD and IDEF(1X) data models are shown at Figures 16 and 17, respectively.



**Figure 16: Snow Flake Schema (Simsion 2001, p 407)**

As discussed, over the decades ER formalisms were used to simulate and remediate organisation change and to facilitate EI. It was also established that the suitability of specific modelling types to comprehensively capture and illustrate organisation change was based on consideration of the task at hand (Noran 2004; Shen et al. 2004; Uppington & Bernus 1998). Further, it was noted that deliberation should be given to the modelling methods and formalisms already adopted by an organisation, and the resources allocated to the project (Noran 2004). Consequently, some researchers have adopted a 'horses for courses' approach, whereby different formalisms were engaged to model specific organisational aspects depending on their suitability to solve the problem (McGrath 1997; Noran 2004). The ER formalism adopted for this

study was the ERD and, apart from its relational data-centric qualities (Chen, C, Song & Zhu 2007), was chosen because the case participant was familiar with the modelling method and the researcher was skilled and experienced in ERD modelling.

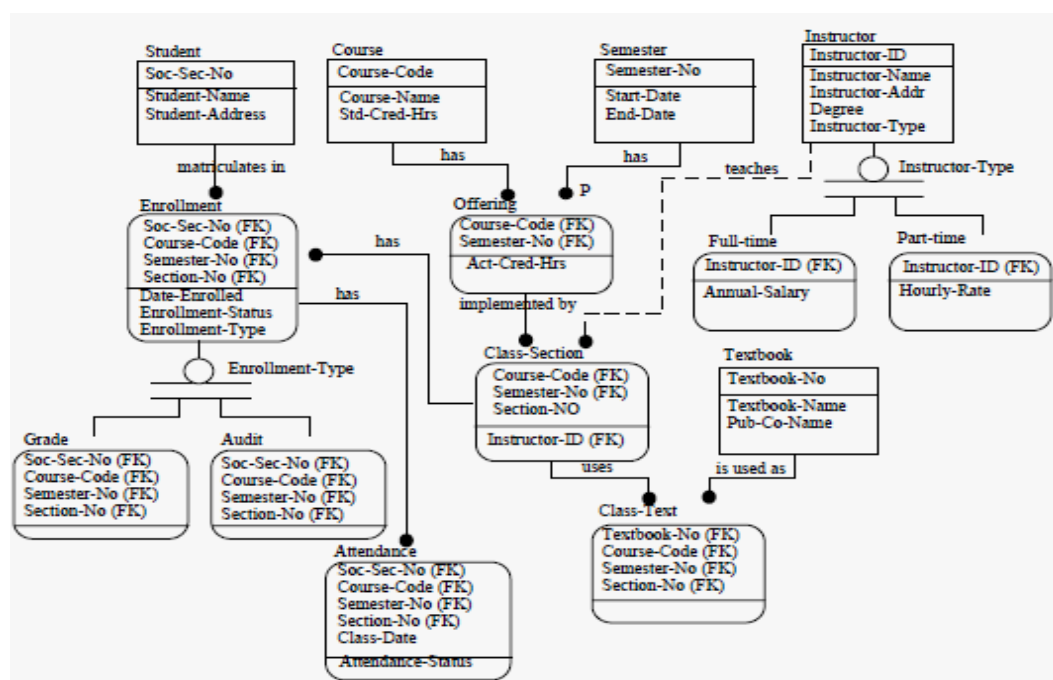
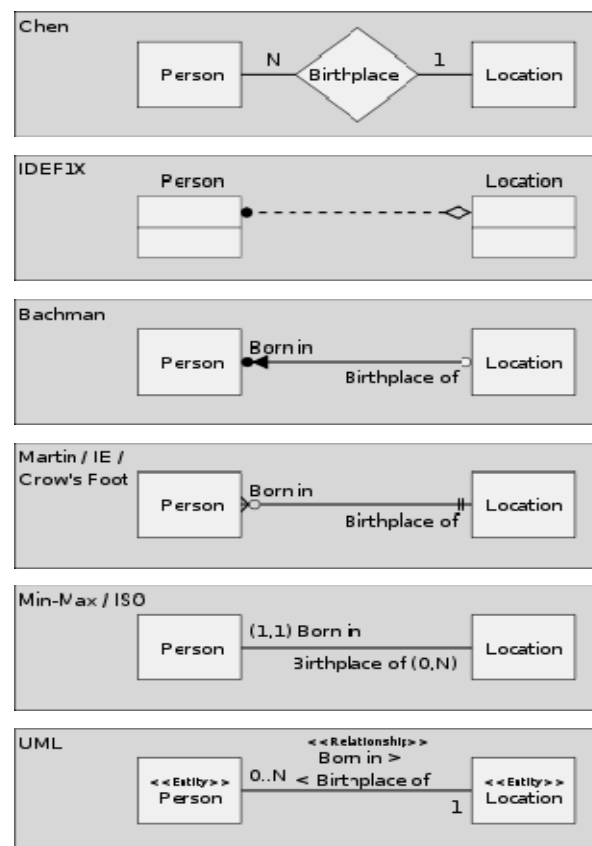


Figure 17: Example of Phase Three Function View Diagram (Brown 1993, p 106)

### 3.6.3 Entity Relationship Diagram (ERD)

The ERD was regarded as the primary conceptual modelling instrument, and was developed in the 1970s by Peter Chen as a specification tool for database design (Bagui & Earp 2003; Bernus 2003a; Chen, C, Song & Zhu 2007; Chen, P 1977, 1983a). The ERD has since evolved to become synonymous with 'understanding real world phenomena' using entities, attributes, and relationships to define the organisation environment (Chen, C, Song & Zhu 2007; Chen, P 1976). The ERD essentially documents the database design (Casey, Lahey & Cater-Steel 2000; Chen, P 1977), providing a 'blueprint' for data storage (Bagui & Earp 2003). Various versions of ER models have emerged, including; extended entity relationship (EER) (Hartmann & Link 2007; Roddick, Ceglar & de Vries 2007), higher-order entity relationship model (HERM) (Thalheim, Schewe & Ma 2009), generalising conceptual multidimensional data models (GCMD) (Kamble 2008), the 'Barker' and 'Oracle' models (Bagui & Earp 2003), generalised entity relationship model

(GERM), binary entity relationship model (BERM) (Chen, P 1983b), and many others (Chen 1983b). Consequently, the entity 'notations' vary between each ER modelling approach (Bagui & Earp 2003; Simsion 2001; Chen 1983b). However, the models' underlying principle of simplifying reality remained the same. Figure 18 demonstrates some examples of ER notation. The 'crow's foot' ER convention was the notation chosen for this study (see Martin 1982; Simsion 2001). ER notations were normally prescribed through particular ER modelling tools (Bagui & Earp 2003; Simsion 2001). Indeed, the database tool used to develop the ACT meta-schema, and the application used to construct the ACT logical schema, used proprietary-based ER notations.



**Figure 18: ERD Notation Examples (Roeing 2006)**

Notation was the expression used to describe and illustrate the 'entity sets' (or model components) 'cardinality' and 'constraints' (Bagui & Earp 2003; Chen, P 1977, 1983b; Simsion 2001). Cardinality refers to the relationship status between entities or 'the number of objects participating in a relationship within the model' (Yourdon 1989, p 240). The cardinality may be 'one-to-many', 'many-to-many', and 'one-to-one' etc. with the former describing the

relationship as one instance to many instances, the next multiple-to-multiple instances and the latter, one instance to one instance (Bagui & Earp 2003; Simsion 2001; Yourdon 1989). Notations were also used to communicate the data or information requirements for users, analysts, and technical teams (Casey, Lahey & Cater-Steel 2000; Chen, P 1983a). Determining entity cardinality was critical, especially when mapping from the logical model to the physical database (Burch 1992). This was particularly important with relational databases where data was mapped to the lowest denomination, or single record instance, to ensure data integrity and to avoid data redundancy (Burch 1992). Consequently, many-to-many cardinalities were decomposed to their lowest level to reach one-to-many or a one-to-one relationship status, a single record instance. This process was known as normalisation (Chen, P 1976).

Normalisation was the process of 'organising data into tables' to eliminate redundancy and enhance data integrity (Simsion 2001; Burch 1992). Normalisation was associated with defining the 'conceptual information structure', 'separating information about entities from information about relationships' (Chen P, 1976, p 12). Normalisation was based on defining entity 'structural dependencies' (Chen P, 1976) whereby entities were mutually independent and entity attributes interdependent (Burch 1992; Simsion 2001; Yourdon 1989). Assigning key attributes (or primary keys) to entities was a vital part of the normalisation process. Primary keys were assigned to each entity as a unique identifier for both entity and attribute values (Burch 1992; Chen P, 1976; Simsion 2001; Yourdon 1989). The required detail or level of data normalisation was the subject of much debate (Chen, P 2002). Some practitioners argued that fifth normal form (5NF) and sixth normal form (6NF) were necessary for sufficient normalisation (Simsion 2001). Others argued that third normal form (3NF) was adequate to remove data redundancies and anomalies (Burch 1992). An example of the normalisation levels as specified by Burch (1992) are shown at Table 3.

Normalisation Level	Description
1NF	Elimination of repeating attributes Non-key attributes are dependent on the primary key
2NF	2NF subsumes 1NF Removing non-key attribute dependencies
3NF	3NF subsumes 2NF Removing transitive dependencies

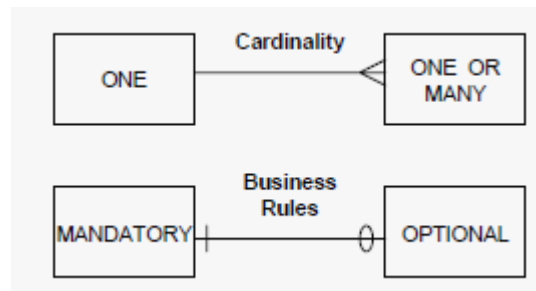
**Table 3: Data Normalisation Levels**

Constraint modelling was another critical form of ER modelling notation. Constraint modelling was applied to entity relationships to enforce organisation business rules (Chen, P 1983a; Khan, Kapurubandara & Chadha 2004; Simsion 2001). Simon (1954) viewed constraints as authority and responsibility controls used by organisations to enforce business rules or goals. Constraint items included; policies, rules, procedures, agreements, standards etc, which collectively, 'initiate, enable, govern, and limit the behaviour of objects and agents to accomplish the goals or purposes of a system' (Mayer, Painter & Lingineni 1995, p 1). Bagui and Earp (2003) viewed constraint modelling as incorporating both cardinality and 'optionality'. A constraint (or optionality) referred to the mandatory existence of one-or-more corresponding records, logically connected using the appropriate constraint notation (Bagui & Earp 2003). An example of constraint and cardinality modelling - using the crow's foot convention - is shown at Figure 19. The example can be translated as follows:

- The relationship cardinality is one, and one-to-one or one-to-many; and
- The constraint relationship is mandatory and optional.

This is an important aspect of database design whereby all corresponding records can be retrieved sensibly and purposefully, within the terms of reference defined by the organisation's business rules.





**Figure 19: ERD Symbols (Casey, Lahey & Cater-Steel 2000, p 15)**

Khan, Kapurubandara and Chadha (2004) described two streams of constraint modelling; systems requirements constraints (SRC), and business requirements constraints (BRC). They believed BRC were lost in the transition from the logical to the physical model and, hence, were not fully tested or supported during the systems implementation phase (Khan, Kapurubandara & Chadha 2004). Khan, Kapurubandara and Chadha (2004) adopted an extended ER modelling approach to compare, validate and test the logical and physical models throughout the systems development life cycle (SDLC). This modelling approach was implemented to remediate the BRC problem. The Mayer, Painter and Lingineni (1995) position was similar where they used the IDEF9 instrument to map the relevant organisation constraints against the IS requirements. They believed ISD required a thorough understanding of all related constraints to ensure the system behaved as expected. Entity relational formalisms were considered key instruments for diagnosing ISD and constraint-driven change, especially where potential change impacts were not implicit (Mayer, Painter & Lingineni 1995). An assumed insignificant policy or procedural change could inadvertently affect a multiplicity of entities, domains and constraint items resulting in a domino effect of organisation-wide changes (Mayer, Painter & Lingineni 1995).

Of significance was the Mayer, Painter and Lingineni (1995, p 55) view that organisations expended much energy and resources 'on managing the effects of change, and not the change process itself'. They proposed mapping constraint relationships, and adopting automated tools, to 'proactively manage change,' thus reducing its impact (1995, p 55). To that end, this study consolidated all appropriate constraints into the logical model (ACT schema) and physical database (ACT) using the ER constraint conventions. Moreover,

ER modelling had been used previously to capture organisation social issues (subjective or soft factors) (see McGrath 1997). This study adopted ER constraints to enforce the Company's (among other) business rules and alleviate the occurrence of organisation decision soft factors. Taking this approach ensured the ACT was robust, organisation and user focused, and capable of predicting changes and assessing related decision outcomes. The benefits of embedding business rules to alleviate decision soft factors, and how these were incorporated into the ACT, are addressed in section 6.4.2.1. The ACT schema and meta-schema development process are detailed in Chapter 6.

### **3.7 Justifying the Modelling Method**

Part of this study involved an evaluation of accredited frameworks, modelling methods and formalisms, and change practices, to comprehensively capture, illustrate, and communicate an organisation change process. The evaluation was based on the literature findings, the researcher's enterprise modelling experience, and the research problem (or task at hand). The literature showed a multiplicity of methods and formalisms had been deployed to resolve a range of organisation change and integration issues. Low-level relational and qualitative formalisms were deemed more suitable to the task of resolving complex organisation change events or integration requirements.

A major failing of EA implementations was the unyielding commitment required from organisations in terms of unlimited resources and time. The time and resources required to implement an overall EA solution often outweighed any benefits. Initial analysis of the case data revealed a multitude of complex and opaque interdependencies, which could not be adequately captured and simulated using a single modelling method or formalism. Given the complexity of the case problem, EA was considered a possible solution; however, the resources could not be guaranteed for the life of the project. In addition, it was unlikely an EA solution could have been implemented within the research timeframe. Another issue was the case participant's history of failed EA attempts, with the exception of process modelling, which had been implemented in the context of IS requirements specification.

Organisations implemented a range of analytical and practical programs such as; BPR, TQM, QMS, and Six Sigma, for example, for the purpose of performance enhancement and change control. However, most failed because they were too generic, and process improvement focused rather than change focused. Successful change relied on organisation-based quality logical and objective decisions. Effective decisions could be realised if change impacts were predetermined, measured and communicated through an automated change tool. An effective change tool had to provide integrated domain perspectives, real-time model-based scenario building, and sensitivity analyses via qualitative report outputs. These products were not available in existing EA or organisation change frameworks, or other like tools.

This research proposed that any attempt to predetermine or manage change had to be underpinned by an automated solution (or decision tool). The practical example (library loan) demonstrated the merits of modelling formalisms to illustrate organisation components and their interdependencies. The example also justified the instruments selected and their application to the research aims. Adopting a mix of high level schemas enabled the identification and capture of the key entities implicated in an organisation change process. A low-level ERD (ACT) schema was used to determine the dynamics and interdependencies of the change entities, and to develop the automated change tool (ACT). The conceptual model specified in this study was, essentially, data-centric and the ERD was widely-recognised as the instrument for transitioning a logical data model to a physical database. Consequently, an instantiation of a database for a specific organisation and its operations (or part thereof) allowed the automated derivation of all parties, processes, policies, systems etc. implicated in a change event. The end product was a comprehensive, qualitative report-based decision change tool. The solution, to some extent, also alleviates the occurrence of soft factors in the change decision process. The ACT conceptual design and functionality are detailed in Chapter 6.

### **3.8 Chapter Summary**

Conceptual modelling has had a long and productive association with a number of theoretical perspectives. Of particular interest to this research was organisation theorists' adoption of conceptual modelling to resolve or illustrate organisation phenomena, specifically organisation change. The relationship between conceptual modelling and theory development was vast and wide. Each paradigm; GST, organisation theory, socio-technical theory, technology theory, decision theory, and change theory, for example, adopted respective modelling formalisms to illustrate their underlying principles. The literature distinguished between qualitative and quantitative models, and prescriptive and predictive models, with specific model types linked to explicit theoretical perspectives.

Organisation theorists used a mix of quantitative and qualitative modelling with the latter more popular with post-modern theorists in the wake of the cognitive revolution. Technology theory embraced qualitative and prescriptive modelling in line with the integration of human (cognitive) factors into related frameworks. An important issue that emerged was the relevance of established theories, specifically, socio-technical theory and GST, to the post-modern organisation. Both theories continue to underpin a number of disciplines and respective frameworks. Consequently, the approach taken was to consider those theories, together with their underlying frameworks and modelling methods, deemed relevant to the research problem and research objectives.

Organisations have been in a state of perpetual change since the industrial revolution with organisation theorists devoting much energy to its understanding, management and control. Socio-technical theory was an important development for change theory because it highlighted the organisation social and technical components. Consequently, the complexity and dynamics of these components presented a number of challenges for post-modern organisations. This chapter has shown that attempts to comprehensively and effectively manage change have failed, despite the range of change frameworks and related tools available. The results of an evaluation covering popular change and technology theory frameworks, their modelling

methods, formalisms and tools, revealed change solutions needed an end-to-end perspective where the impact of change was holistically captured, measured and assessed.

The conclusion drawn was that technology theory, principally the modelling methods and formalisms used by SA&D, were the instruments required to develop an integrated change solution capable of proactively managing change and related decision outcomes. The practical example described in this chapter, justified the formalisms selected to develop the ACT schemas and physical database. The chapter confirmed that a change solution had to be automated and capable of predetermining and measuring change through real-time model-based scenario building and sensitivity analyses. In addition, the solution had to communicate change impact (or change decision outcomes) using qualitative report outputs in a format that was easily understood.

The following chapter presents the case study and case problem, and introduces the research problem in the context of the research scope.

## **Chapter 4**

### **Case Study: Background**

#### **4.1 Introduction**

This chapter presents the case study, describing the case participant, which for ethical reasons is referred to as the 'Company', and introduces the case problem. The chapter is divided into two core sections. The first section titled 'Case Participant', outlines the Company's current organisation design, describing its structure, governance, regulatory frameworks, decision structure, and core business components. The second section titled 'Background', provides an historical overview of the Company based on patterns that emerged from the interview materials and the Company's textual materials. This section illustrates the complexity and velocity of change that has impacted the Company since its amalgamation in 1901 to 2010. Both sections provide an insight into the Company's core business practices and related government initiated management reforms, and their impact on the Company. The systemic repercussions of these enforced changes are further discussed within the section titled 'Case Problem'. This section also reflects on the management frameworks and tools adopted by the Company, and their appropriateness to resolve complex change issues within a fragmented environment. The section titled: 'Research Problem' summarises the key issues underpinning the research problem and introduces and justifies the research scope. The 'Conclusion' provides a summary of the case study and reflects on the constraints that hindered the Company's attempts to anticipate and remediate change impact.

#### **4.2 Case Participant**

The Company was chosen as the case participant for a number of reasons. First, it met the criteria of an Australian owned organisation, or at least based in Australia, for ease and continuity of access. Second, it had to fit the description of a large organisation, a definition provided by the Australian Bureau of Statistics (ABS) (2007), where 200 or more employees constituted a

'large employing business'. Third, the case participant had to exhibit complex and diverse business characteristics under the terms of reference provided by the ABS (2009). For example, a complex organisation was described as having one or more business components responsible for reporting data for similar economic activities ABS (2009). Qualities of this type were deemed important from the research perspective of identifying the complexities and dynamics of the organisation interdependencies, especially those involved in a change process (or change initiative). Exploring the dynamics of change within a large, diverse, socio-technical organisation would provide a window of opportunity from which to explore the systemic and chaotic nature of change. In addition, the researcher is a Company employee, which also influenced the choice of participant. The researcher has been involved in the implementation of various business improvement programs, and business and logistics information systems (IS) projects. Consequently, the researcher had first-hand knowledge of the issues affecting the Company's supply-chain and corporate environments<sup>2</sup>.

The case participant is a large, Australian Government agency heavily engaged in complex, supply-chain (logistics) activities. The Company's supply-chain is underpinned by a seven tiered hierarchy consisting of multiple functions (or high-level processes), sub-process, procedures, tasks, activities and transactions. The core functions include, but are not limited to, acquisition, supply, and sustainment. These functions cover supply management, procurement/acquisition, repairs and equipment management, warehousing and distribution, and storage management. Each function is an amalgamation of multi-domain policies, processes, IS, and authority and responsibility arrangements. The functions are dependent on a shared services model. The supply-chain environment comprises approximately 123 IS, many of which are legacy systems. These systems support a massive number and variety of business processes, that criss-cross the Company's vast geographical

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<sup>2</sup> All case study statements and assertions presented in this chapter were derived from Company documents – including policies, procedural documentation and general files. Most of these are classified and I am not in a position to indentify them precisely. Should the reader require more information on any aspect covered here, he or she should contact the author. Where actual quotes from Company documents are used, these are cited as, for example, (Policy Document 101, 1987).

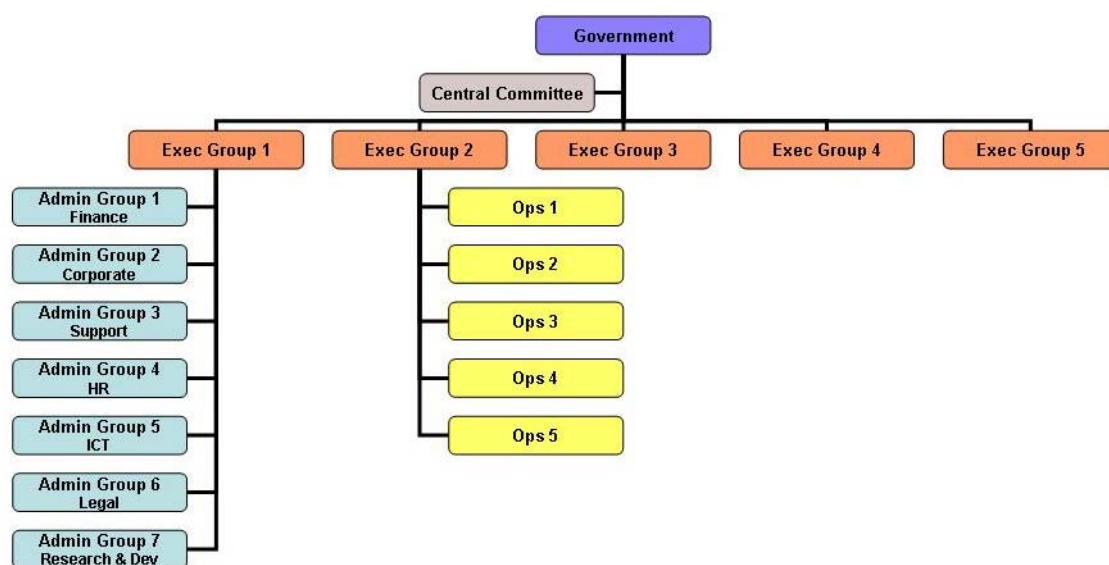
expanse. Most of the supply-chain processes are transaction dependent and hence, are system-based.

The Company has a current annual budget of AUS \$104.4 billion and is supported by 77,500 operational personnel and 16,000 administrative staff. The Company is a component organisation consisting of five executive groups, seven administrative groups and five operational groups. The executive group heads are representatives of the Company central committee (CCC), which reports directly to the Government. The administrative groups are the corporate nucleus supporting the Company's core business, while the operational groups are the Company's core business providers. The Company's core business is the acquisition (procurement) and distribution of equipment (supply items), which is performed by the operational groups on a national and global level. The Company supports over 18,500 different supply items and has in excess of 4,000 separate product lines. The inventory is valued at more than AUS \$80 billion, and is stored at 24 different national sites. Supply items vary from high-end capital equipment to pencils and pens. The Company's core business depends on an efficient and effective supply-chain environment. As noted, the Company operates under a shared services model covering finance (including procurement), human resources (HR), information communication technology (ICT), legal, and other corporate support functions. All Government agencies have been designed (or redesigned) around a service provider (or shared services) model. The current high-level Company structure is illustrated at Figure 20.

The Company's structure is administrative and operational oriented, and is overseen by a diarchy arrangement. According to the Encyclopaedia Britannica (2010), a diarchy is a system of 'double government', 'or a division of the executive branch into authoritarian or responsible sections'. The group hierarchy consists of numerous divisions, branches, directorates and units (or systems program offices (SPO)) dispersed between 150 locations globally. Each group has seven or more management layers embedded within their respective structure. Over the decades, the operational and administrative groups developed individual cultures, which were often described as 'rule-



bound’ and ‘tribalistic’. Moreover, there were cultural differences between the divisions and, in some instances the differences were evident at the unit level. These cultural disparities are still prevalent within the current structure. The Company is governed by a number of high-level government and international boards and committees, and controlled by various regulatory frameworks. The frameworks include but are not limited to policies, legislation and standards, which are administered by respective international, Commonwealth, State and local authorities. In addition, there are a plethora of committees and boards convened at various levels within the hierarchy with representation from different management levels. All Company committees and boards are oversighted by the CCC decision outcomes and directives. Over the decades there have been concerted efforts to reduce and streamline the Company’s committee structures and member representation.



**Figure 20: Company High-Level Structure (2010)**

The Company embarked on a program to minimise bureaucracy, improve decision-making turn-around-time, and promote decision autonomy by delegating corporate (or shared services) responsibilities to middle and lower management. Delegating responsibilities in a shared services model required the clarification of accountability and responsibility arrangements for each support function (or service). These arrangements were introduced to ensure ‘principles of personal responsibility and consequences for outcomes, clarity of roles, and clarity of communications about decisions and actions’ (Company

Report 01, 2007). The Company implemented its accountability program across the organisation delegating responsibilities and authority in accordance with designated roles. Despite the Company's good intentions, finance was the only administrative group that had an effective governance and compliance program. This was a legacy of the government's stringent control over the Company's finance activities. The Company embraced various other control programs, which included popular management and information technology (IT) frameworks and related tools. However, these programs often failed because accountability and responsibility arrangements were not enforced and compliance was not rigorously tested. Conversely, the Company's operational activities were heavily governed by a multiplicity of regulations leaving little room for misrepresentation.

### **4.3 Background**

#### **4.3.1 1900s – 1920s**

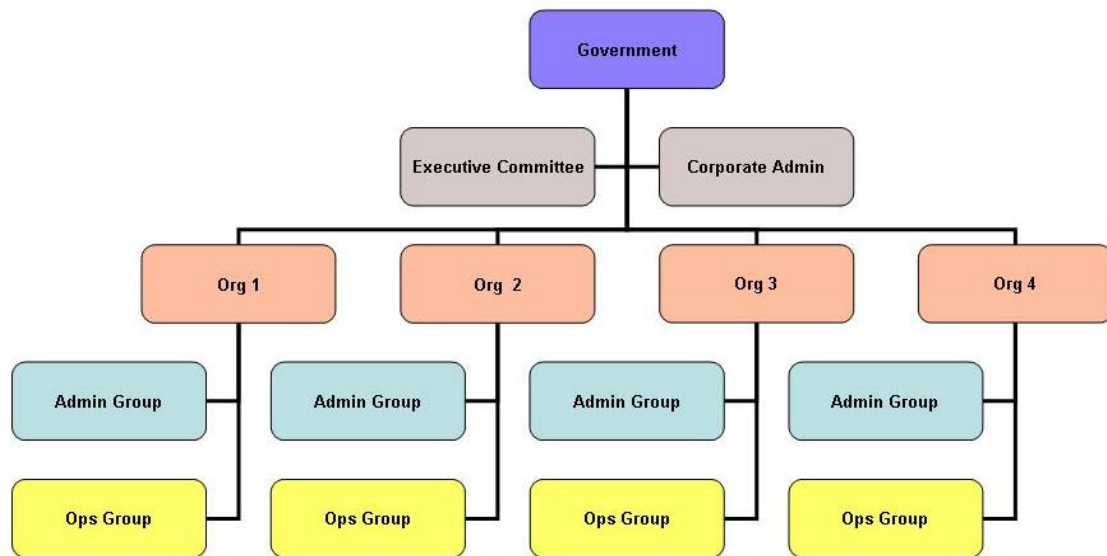
The Company was established in the early 1900s following an amalgamation of four similar but geographically dispersed organisations. Each organisation comprised two core groups, operations and administration, with the Chief Officer (CO) of each reporting to a common executive body. The executive body was the 'legal master' of the organisations, responsible for implementing decisions and policies executed by the Company's international governing bodies and the government of the day. When the Company amalgamated in 1901, it adopted the existing organisational design, effectively abdicating its role in any decision and policy-making activities. At that time, the Company administered 70,000 personnel, a number of facilities, and a range of equipment, stores and contracts. By default, the Company had inherited a complex, bureaucratic, dysfunctional structure besieged with internal divisions, and vested interests driven by external controls and influences.

The executive body had grown in stature to twelve personnel and became the Company's core administrative office. Decisions affecting the Company remained externally-driven and targeted individual groups rather than the Company as a whole. Policy and decision-makers disregarded the Company's overall operational requirements resulting in continual administrative changes

led by high profile personnel seeking personal gain. Consequently, the Company's administration came under scrutiny and the government of the day appointed numerous committees and inquiries to investigate its 'faults and deficiencies' (Company History 02, 2001). The ensuing reports criticised the Company's administrative approach and proposed a number of initiatives to address these concerns. One initiative was the need for greater independence from 'social and political influences' (Company History 02, 2001). To that end, the executive body looked abroad for administrative models from which to base its own, and the Company's, management principles.

A new administrative model was established to oversee the executive body and the Company, with new boards and committees engaged to oversight the new arrangements. However, these new bodies were subjected to continual structural and representative changes and remained under the control of the government of the day, or in some instances, international parties. The restructure resulted in the executive body being renamed the administrative group, and expanded to include the Company's clerical, professional and assets (equipment and supply items) departments. The Executive Committee (EC) was established in its place. By 1918, the Company's administrative staff numbers had increased to 1483, with operational numbers escalating to 330,000. The Company structure at the decade's end is illustrated at Figure 21. The Company's annual budget at the time was AUS £34,210,852. However, the restructure did little to improve the Company's performance and disposition with a number of issues outstanding, which included:

- no input to related policies or strategies;
- geographical dispersion;
- misadministration and corruption;
- staff ineptitude; and
- poorly managed equipment and supply items.



**Figure 21: Company High-Level Structure (circa) 1920s**

Twenty years following the Company's amalgamation, its core business was recognised as acquisition (procurement of assets (or supply items)) and supply item management (system of supply). The Company's system of supply was criticised by government, the public sector and private industry for its dubious and 'chaotic' accountancy and stocktaking practices. Consequently, the Company was inundated with adverse performance reports, which laid blame on its 'structural weaknesses', failure to 'modernise its operations', and the 'personalised and autocratic' decision-making process (Company History 02, 2001).

#### **4.3.2 1930s – 1950s**

By the 1930s, the Company had been further restructured in an attempt to streamline its administrative operations. It was subjected to severe 'downsizing' - a legacy of the Great Depression - with operational personnel reduced to 37,000 and administrative staff to 140. The Company's annual budget was also capped at AUS £5 million. The Depression had a profound impact on the Company. Most nations suffered dearly but Australia was one of the hardest hit with hundreds of thousands of people living in poverty and a 32% unemployment rate, second only to Germany (Company History 02, 2001). During this period, the Company had reached its 'nadir', with the administrative and operations groups at logger-heads over scarce funds and

resources. The severe staffing constraints, wage cuts and funding shortages reflected the overall general climate of the Depression. Entire divisions were abolished with their functions redistributed elsewhere in an effort to maintain efficiencies. However, these cost saving exercises brought the Company to its knees and did little to increase efficiencies. Ironically, the number of governing committees and boards had increased dramatically resulting in a blurring of responsibilities and reporting lines between these and the EC. The Company's governance configuration adversely affected its overall performance with misalignment of authority and reporting lines, and policy and decision-makers. Policy and decision-making, largely, remained the responsibility of the government and international parties.

Thirty years after its amalgamation the Company remained plagued by the same problems:

- continual structural change;
- inconsistent and excessive authority and reporting lines;
- absence of accountability;
- external control of its aims and goals;
- no input into policy and/or decision-making;
- staffing and funding inadequacies; and
- communication shortfalls.

During this period, financial management had become a major issue. Consequently, a separate group was created to provide greater control and accountability over the Company's activities. At this time, the Company's accounting procedures were aligned with those of the British Westminster administrative system to ensure greater transparency of the Company's activities. The redistribution of functions, together with the abolition and recreation of groups within the Company structure, created information management issues. As a consequence, the respective groups inherited over fifty legacy filing systems and, in the confusion, the Company lost valuable records, which affected its administrative activities over the following years.

By the 1940s, the aftermath of the Great Depression had eased and the Company's operating budget was extended to AUS £14.5 million. During this

time, the Company's operational groups had doubled in size and its administrative staffs were better trained and qualified. Greater attention had been given to information management as a result of the Company's escalating committee and boards, which numbered 64. The most strategic committees and boards remained under the control of international interests.

#### **4.3.3 1950s – 1990s**

By the 1950s, the majority of the Company's administrative processes had been modelled on the British Westminster system. Consequently, paper trails were excessive and communication between committees, boards, and the Company's groups were non-existent or ineffective. The incessant number of committees and boards created information bottlenecks with decision turn-around-time taking months to years. The Company's acquisition (procurement) principles were considered chaotic and devoid of any long-term planning considerations. The Company's situation was difficult because, effectively, it comprised six separately administered groups with duplicated procedures, support services, reporting lines, and authority and responsibility arrangements. Its structure was considered by historians to be incoherent, complex, unwieldy and constantly changing (Company History 02, 2001). By the mid-1950s, there was some relief from international control with the government of the day taking ownership of key policies and decision-making.

With a change of government leadership (Menzies to Holt) in 1966, the Company's administrative groups were geographically centralised to improve communications and decision-making, and establish clear authority and responsibility arrangements. At that time, the Company comprised 5,980 administrative staff and 83,500 operational, was overseen by 28 committees and boards, and absorbed 2.8% of the gross domestic product (GDP). Harold Holt had all but severed administrative ties with Britain, adopting American operational standards instead, which included the implementation of certain management practices. Many of the reform decisions were politically motivated and based on the outcome of reviews of the Company's performance, structure, strategies, and policy and decision-making. The reports were often influenced by the vested interests of the political players of the day. Outcomes

that did not guarantee personal benefit were ignored despite any recognised Company advantages.

The Company's ICT environment was predetermined by its manufacturing industries and equipment acquisitions. Its administrative processes were manual and its operational activities comprised a mix of automated and manual procedures. The administrative and operational functions were far from integrated. The Company's push for sophisticated ICT, together with its American alliance, brought significant changes to its operational groups. For example, the Company's first computer centre was established to automate and methodically manage the groups' maintenance frameworks; reliability availability and maintainability (RAM), and configuration management (CM), for example. By the end of the 1960s, the Company had geographically centralised its administrative groups enabling some administrative functions to be computerised and relocated within the new computing centre. Until then, HR tasks and supply transactions were manually executed and coordinated by the respective operational groups, which were dispersed across 162 national locations.

A number of mini-mainframe computers and local mini-computers were implemented to centralise and automate HR tasks. However, these systems remained physically and logically independent because of the procedural differences between each of the groups. Consequently, coordinating the Company's net transactions proved an arduous task given the number of disparate systems. Nevertheless, the Company benefited from computerised data implementing mathematical modelling and scenario building as strategic operational and corporate tools. For example, modelling was used to determine the strategic and monetary value of capital acquisitions. Inevitably there was much angst among the operational group heads who considered it a violation of tradition and independence.

During the Whitlam Government (early-to-mid-1970s) period in office, the Company experienced some long overdue changes with the first formal analysis of its procedures, and authority and responsibility arrangements. The Company was finally in a position to plan its policy requirements and analyse

procedural change impacts. The procedural analyses acknowledged the need to streamline information flows between groups, committees and boards to effect informed decisions and promote cultural change. As a consequence, the number of committees and boards was reduced to thirteen; albeit, the committees were supported by twenty-one sub-committees. Restructuring was seen as the avenue for cultural change. The Company's overall structure was revamped with the operational and administrative groups' authority and responsibility arrangements, and reporting lines, redrawn to incorporate them under respective executive bodies. This was an attempt by the Government and the Company to enforce compliance across the organisation. The organisation-wide analysis facilitated the professionalisation and training of administrative staff, which enabled them to fulfil required skill-based competencies, something that had been lacking over the decades. The old political stalwarts vehemently rejected change and, subsequently, vested interests still remained. The Whitlam Government's reign ended in 1975 with the Fraser Government at the helm until 1983. At that time there were 69,000 operational staff and 33,000 administrative staff dispersed across the nation. The Company's annual budget was set at AUS \$1900 million equating to 3% of the GDP.

The Company experienced its most dramatic restructuring in the mid 1980s under the Hawke Government (1983-1991). The greatest change was the diarchy arrangement implemented to effect collaborative management and policy and decision-making. This arrangement was introduced to unify, and give equal standing to, the Company's administrative and operational executive bodies. The Company was becoming less reliant on international control and the dual rule was implemented to equally proportion strategic policy and decision-making responsibilities between the administrative and operational executives. Both executive bodies reported to a renewed senior EC, which acted as the conduit between the Government and the Company. Under the arrangement the administrative executive managed five groups; strategic policy, supply, facilities; HR and finance (incorporating procurement). The operational executive managed three groups; Ops 1, Ops 2, and Ops 3. This structure remained much the same into the twenty-first century (C21<sup>st</sup>).



Apart from sharing decision-making responsibilities, the new structure was also established to standardise procurement processes across the organisation.

To date, the procurement decisions and processes had remained under the jurisdiction of each operational group. Self interest and political 'predilections' were seen as the major drawbacks with the groups' procurement policy and processes considered opaque and inefficient (Company History 02, 2001). The authority and responsibility arrangements mandated for the administrative groups were not enforced on the operational groups. Consequently, there was an absence of standardised and integrated procurement procedures across the organisation and the operational groups remained unaccountable for their actions. Procurement arrangements continued to be a key issue and the Company took a financial management approach to control the anomaly. The administrative executive was granted jurisdiction over the operational groups' procurement activities, creating a series of power struggles between the two parties. These struggles continued into the C21<sup>st</sup>. The finance (administrative) group was reformed to accommodate the Government's financial management mandates and to ensure the operational groups' received efficient and effective support, accordingly. The main objective was to integrate the Company into a single organisation. However, there were clear structural and functional differences between the operational and administrative groups. Consequently, the Company continued in its attempts to standardise its financial activities and apply more rigour to its procurement processes.

By the late 1980s, the Company was described as 'top heavy' with 31,377 administrative staff, 200 committees, and 60,000 operational staff. The supply (administrative) group managed more than 1.6 million supply items valued at several billion dollars. Decision-making remained, exclusively, a high-level committee activity and the Company's management practices had suffered because of this. For example, there was no room for innovation or consultation within the hierarchy, which adversely affected personnel work ethics. Although the Company was considerably less fragmented than had previously been the case, outstanding issues included the lack of clarity and continuity surrounding authority and responsibility arrangements, and administrative staff roles. There

were still problems with stock control, and government review recommendations produced a long list of required changes. The objective was to promote a change-responsive organisation that collectively analysed strategic, political, financial and operational issues. Over the decades, the Company's change responses had been largely reactive. This was notionally driven by push scenarios whereupon the Company was granted little time in which to effect the required changes, which generated some hostility.

The Company operated one of the largest supply-systems in Australia, which was, effectively, a package of seven separate systems. By the late 1980s, the Company was one of Australia's leading computer users. Its annual administrative (business) systems budget exceeded AUS \$100 million, with over 1000 separate local area networks (LANS), 40,000 personal computers (PCs), four large mainframe data centres, and 1% of its administrative workforce involved in full-time ICT support. During this period of technology growth a number of disparate systems emerged and, in response, the Company embarked on an elaborate program to:

- rationalise disparate systems;
- upgrade existing supply, HR and finance systems;
- decentralise administrative computing by adopting full networked capability; and
- implement an IT program for long-range strategic planning and central control of technical standards.

The IT program was designed to standardise the Company's computing needs 'allowing decentralisation along functional lines providing effective vertical and lateral interactions between different functions' (Company Magazine 03 September, 1989). The program was also the Company's first business IT architecture and information technology management (ITM) initiative. The initiative, aimed at standardising the Company's computing environment, was expected to 'set the direction of its computing into the next century' (Company Magazine 03 September, 1989).

The Company also developed the majority of its software requirements 'in-house' with some commercial programs sourced from the wider IT sector. Most

of the in-house developments were too complex to be manually managed and computer aided software engineering (CASE) tools were used to assist with project design and decision-making. CASE tools supported ISD simulation, document control and information modelling. Capital equipment (operational) ISD programs, together with their supporting policies and tools, remained under the firm control of the operational groups. The Company's computing services division (CSD), an administrative group division, was responsible for implementing ITM initiatives and controls on behalf of the administrative executive. Consequently, the administrative groups' ICT remained embedded and controlled by the ITM policies and standards implemented by the CSD. The operational groups considered CSD a bureaucracy and their ITM programs and ICT controls were deemed intrusive and were ignored.

#### **4.3.4 1990s – 2000**

During the period 1990 to 2000 under the Hawke, Hawke-Keating, and Howard respective governments, the Company endured further restructuring through the outsourcing of its non-core (administrative and operational) services. Administrative staffing levels were reduced to 25,300 making a total of approximately 60,000 employees. Some ICT, facilities and legal services were outsourced while supply items were sourced exclusively from the global private sector. The Company's manufacturing industries and the majority of its research and development (R&D) organisations were considered non-core services and either sold off or decommissioned. The outsourcing initiative was Government-directed change driven by management efficiencies and cost effectiveness. The administrative and operational groups, and their executive bodies, were restructured in accordance with the financial management improvement program (FMIP) requirements, which were part of the efficiency and effectiveness initiative.

For example, project-based Program Management and Budgeting (PMB) initiatives formed part of the FMIP requirements and were introduced to provide 'a coherent framework of management initiatives that would lead to increased accountability, greater devolution, improved corporate planning and management, enhanced reporting, and improved information systems'

(Company History 02, 2001). The PMB initiatives were applied to the Company's organisational design (structure), management programs, and the acquisition (procurement) of capital and non-capital supply items. Put simply, PMB was a management philosophy aimed at dissecting organisations into a number of programs, with each responsible for its own objectives, operations and performance. However, the PMB outcomes were less effective than expected with an estimated reduction of 32% of capital equipment projects and major ISD project overruns.

Acquisition programs (where capital equipment and complex IS solutions were developed or procured over a period of time and managed as a project) had less than successful outcomes. Company-led mid-stream technical and design changes were blamed for the cost overruns. This was a pattern that continued into the following decade. The Government invested AUS \$3 billion per year over the decade in the Company's capital equipment and major IS projects. These projects came under continued scrutiny with deficiencies in project management competencies seen as a contributing factor to project failure. The Company introduced project management training competencies covering Prince2 Project Management Methodology (P2PMM), and Capability Maturity Model Integrated (CMMI), for example, to overcome the issue. Program performance reporting and compliance was introduced in accordance with the FMIP, at which time, project planning and reporting tools (CASE, and to some extent, Rational DOORS) were implemented to support the initiative. In addition, the Life-Cycle Costing (LCC) methodology was adopted as an all inclusive a-to-z cost-management strategy for both capital equipment and IS projects.

The Company adopted other management practices (frameworks) and tools as an adjunct to the PMB framework. The management practices included; Key Performance Indicators (KPIs), Key Expected Results (KERs), and Balanced Score Card (BSC). These practices combined strategic, performance and goal-based management initiatives. The FMIP and PMB were Government-led initiatives that mandated and enforced performance reporting, compliance, and accountability across the organisation. However, these objectives were not

rigorously imposed by the Company's many program management offices (PMO). The Company had suffered with the decrease in both administrative and operational staff and these cost-cutting exercises had severely weakened the Company's strategic and operational independence. For example, the operational groups were unable to purchase or replace aging equipment. The Government's FMIP had become a policy of economy rather than efficiencies. The Company's greatest problem was the lack of continuity and loss of corporate knowledge, which was a consequence of the widespread staff reductions.

By the end of the 1990s, technology was firmly entrenched in the Company's activities. Technology experts were asked to participate in strategic planning working groups (WG) and the EC included technology experts among its strategic specialists for the first time. Technology was seen as the primary enabler for improving administrative and operational performances. Given the Company's geographical and ideological diversity, corporate reporting became a priority and technology was seen as the delivery medium. The Company invested heavily in Management Information Systems (MIS) and Decision Support Systems (DSS) to accommodate project program and financial and procurement corporate reporting. These systems were also used to measure the Company's overall performance. The Company invested AUS \$38 million in its finance system and AUS \$44 million on its core supply-system.

During this period, the Company had invested more in ICT than any other Australian organisation. However, capital equipment and ISD projects remained under the control of the respective administrative and operational groups. For example, finance systems were the responsibility of the finance group, HR systems were the responsibility of the HR group, while supply-systems were commissioned and controlled by the respective operational groups (Ops1, Ops2, etc). As noted, capital equipment programs remained the responsibility of the relevant operational group. Implementing a common ICT architecture proved difficult because of the diversity of the ownership associated with the Company's capital equipment platforms and enterprise systems (ES).

#### **4.3.5 2000 – 2010**

By the year 2000, the Company's operating budget was set at 1.8% of the GDP. It underwent further downsizing with rationalisation of staff numbers, divisions, committees, and geographical locations. The reductions were part of a shared model arrangement where, as noted, services such as finance, HR, ICT and legal, for example, were standardised across the organisation to streamline processes, reduce duplication, and maximise resources. Under the restructure the supply (logistics) group was transferred from the administrative group to the operational group and assumed the role of a shared (or common) service. The intent was to standardise, streamline, and remove the complexity surrounding the operational groups' procurement and supply practices. However, after many reviews and process mappings, it was apparent that each operational group had unique needs and, where these needs were justified, separate practices and processes remained. Nonetheless, the Company endeavoured to consolidate its procurement processes under a single policy, using a single supply-system that supported multi-million dollar equipment items. However, the task proved unachievable and, in some instances, the operational groups continued to manage their supply items using respective supply-systems. Consumable items (pens and paper etc) were removed from the supply-system and purchased using alternative methods, credit card purchases, for example. These methods were also covered by the Company's financial authority and responsibility arrangements.

The Company's financial arrangements were separated into procurement and finance with procurement devolved to another administrative group (corporate) to govern. However, the finance group, through its CEO, remained the procurement authority, while the responsibility (business owner) role was delegated to the CEO corporate. The finance authority had ultimate control of all policies, related materials and outcomes. Corporate, as the business owner, was responsible for creating and implementing procurement policies, processes and outcomes. The financial and procurement arrangements were governed by the Australian Government Financial Management Accountability (FMA) Act 1997. These arrangements were consolidated into the Company's

corporate business model and promulgated through a number of frameworks aimed at improving:

- decision-making structures;
- policy visibility, currency and consistency;
- corporate reporting;
- logistics (supply) processes; and
- service delivery.

The frameworks underpinned the services (or functions) of finance and procurement, legal (incorporating contracting), ICT, logistics (supply), strategic policy and planning, to name but some. These frameworks formed part of the greater Business Excellence Framework (BEF) (see SAIGlobal 2007) and comprised a multiplicity of integrated management practices such as; QMS, BSC, ISO 9000, risk management, corporate governance, to name but some.

By the mid-2000s, there was concern over the Company's fragmented structure and a determined effort was made to integrate its administrative and operational activities. The Company's ICT interfaces, specifically, its information (or transaction) interactions became key integration objectives. The difficulty of 'separating the [Company's] business systems from its operational systems' (Company Journal 04, 1996) was first raised in 1996 as an information management issue. With the central control of ICT relaxed, the groups operated with a greater degree of independence, a situation that exasperated the problem. Consequently, knowledge management was the initiative adopted to sustain an organisation learning culture. There was a notable shift in emphasis from ISD to information integration. The Company implemented a Business Intelligence (BI) solution (see IBM 2005) to capture and process data from its disparate systems. The solution comprised a mix of commercial-off-the-shelf (COTS) and modified-off-the-shelf (MOTS) technologies, which were web-based software (middleware), analytical software tools, and data storage products. The BI solution formed the basis of the Company's knowledge management environment and incorporated other products; Quality and Environmental Performance System (QEMS), for

example, which provided a repository for most of the Company's policies, processes, and procedures.

The Company invested heavily in its knowledge management systems with the intent to capture, store and disseminate organisation data as meaningful information. These systems were meant to assist with administrative decision-making. However, they often failed to deliver the information required to make informed and timely decisions. Consequently, corporate reporting was, mostly, manually-executed because of the lack of system integration. Where these activities were automated they were confined to secondary data analysis only. However, the operational groups had implemented a range of computational modelling tools to effect and simulate decision-making outcomes: these tools were activity and operational specific. The Company rekindled its organisation-wide IS architectural program in an attempt to integrate its ICT environment. The program was met with hostility when the administrative and operational groups considered it an attempt by CSD to regain control of the ICT environment. By the end of the decade, the Company's attempts to implement an IS architectural framework had been reduced to a common corporate network and application layer comprising a wide area network (WAN), LANs and PCs. The network configuration provided a basic interface only with most systems connectivity relying on manual data uploads or batch-file data transfers.

During the later part of the decade, the government reviewed the Company's ICT environment, recommending a series of changes aimed at improving ICT governance, compliance and efficiency. In response, the Company established governance branches throughout the organisation. The branches were responsible for implementing and overseeing a number of ICT frameworks and related practices, which included; Information Technology Infrastructure Library (ITIL), IS, CM, QEMS, and ICT program reporting. These initiatives were supported by policies, processes, training, and authority and responsibility arrangements. However, notwithstanding the good intentions, these programs were ineffective for a number of reasons. They were grossly under resourced,



lacked management commitment, and were viewed by both the administrative and operational groups as an unnecessary overhead.

In addition, the Company implemented various Government sponsored organisation change management (OCM) frameworks, which were initially implemented by consultants, to manage both the social and technical aspects of change. These frameworks were underpinned by the key organisation theorists Kurt Lewin, Fred Luthans, Tom Burns, and George Stalker (Company Training Manual 05, 2003). The frameworks proposed a socio-technical approach to organisation change, considering the factors of people, structure, physical attributes, and technology. The frameworks were supported by organisation-wide training programs and readily-available training materials, and were tailored to suit the respective Government agencies. These programs were management focused and aimed at overseeing and alleviating change anxiety in employees. Over the decade the Company's change programs became more business oriented and the key driver was remediating resistance to change to ensure the transition proceeded. In these instances the change philosophy was drawn mostly from the works of John Kotter and Leonard Schlesinger (Company Training Manual 05, 2003). The Company's change management authority and responsibility arrangements were delegated to the HR group.

Later in the decade, the Company's change programs were expanded to oversee transformation of the ICT environment. OCM programs piggy-backed a number of corporate (business) and logistics ISD projects aimed at business process improvement and service model alignment. The OCM programs brought renewed interest to the socio-technical aspects of ICT change. For example, the technical components captured included business and logistics processes, which were examined for potential change impact and/or remediation using process flow maps. This information included transaction-based IS and process-based KPIs. However, these programs were managed by the individual groups and often failed to consider the needs of the wider-organisation. In terms of the socio components, the OCM program identified stakeholders for the purpose of coordinating commitment and ownership of

potential business change. A Stakeholder Management Framework (SMF) systematically classified stakeholders identifying their roles as decision-makers, change sponsors, change agents, and change targets. The roles determined the level of stakeholder engagement and expected extent of commitment, which was monitored and measured over the life of the project. The SMF framework was based on the work of Kurt Lewin (1951) (Company Training Manual 05, 2003).

The extent of the Company's system-to-system interdependencies and, more importantly, related project dependencies, were not recognised until the middle of the decade. It was during the redevelopment of the Company's supply-systems that the anomalies became apparent. The dependencies were successfully managed through group related integrated project team (IPT) arrangements. However, the depth and breadth of the system-to-system interdependencies were not identified until ICT changes affected multiple group operations. For instance, the finance group authorised modifications to the Company's core finance system, which triggered anomalies in the supply-system. These anomalies were overlooked and the degree of overlap was not apparent until the finance system redevelopment was well underway, an oversight that cost the Company dearly. The Company was at times overwhelmed by the depth and breadth of change, mostly because the change triggers were externally driven. Often the changes involved modifying its ICT environment. This was a major challenge because the Company's ICT was foremost managed by a number of individual groups who frequently neglected to consult others on matters relating to system, policy or process interdependencies. Another overwhelming factor was the impact of these changes on system users where, in some instances, they were unable to perform their duties.

The Company had, to some extent, attempted to embrace the socio-technical elements of organisation change through its change programs and IS project initiatives. However, not all components implicated in the change process were considered, which exposed the Company to substantial financial expense and performance degradation.

#### **4.4 Problem Context**

As noted, the wider literature acknowledged that, organisations were increasingly more susceptible to change and, as a result, were unable to readily adapt. This often resulted in performance inefficiencies, which was a consequence of misaligned policies and processes, and organisation behaviour (Becht, Bolton & Roell 2002; Chuter 2000; Drucker 1999; Earle 1940; Levin & Gottlieb 2009; Roark & Freemyer 2010; Ryden 2003; Searle 2006; Spector, Lane & Shaughnessy 2009; Wolf 2011). The Company's predicament was similar whereby it was governed by a plethora of multifaceted, duplicated and conflicting controls. These controls were overseen by a mix of internal and external parties. Consequently, the Company was beleaguered and unable to respond readily to change leaving it in a state of disarray. The literature stated that, organisations had become increasingly more complex (Drucker 1999; Simon 1962). As noted, management theorists had responded with a proliferation of sophisticated DSS, management frameworks and tools, and organisation designs, to simplify and manage organisation complexity (Drucker 1999). The Company had responded to change in the same way, investing heavily in a mix of common frameworks and tools, and experimented with various organisation designs. The intent was to integrate and manage its complex and diverse environment. The Company's history revealed that these methods were ineffective, for the same reasons stated by Buchanan et al. (2005) and Fredendall and Hill (2001), as discussed in section 3.5. Despite the Company's attempts to integrate its environment, it remained a culturally diverse and fragmented organisation.

As noted, technology innovation and integration was a defining ingredient of the modern organisation with an array of solutions available to effect ICT modernisation and interoperability (Chang, Makatsoris & Richards 2004; Fredendall & Hill 2001). Change management was a key practice introduced as a means of coercing business efficiencies and technology innovations, among other similar programs. Like most organisations, the Company embraced technology innovation and integration programs to improve and streamline its business practices. Nonetheless, its history revealed that, over the decades, attempts to integrate its administrative and operational ICT

environments were less than successful. The Company also adopted, to a lesser degree, change management practices to control the shifting organisation. These methods mostly targeted stakeholder management rather than the key change issues of decision-making, authority and responsibility arrangements, and knowledge management.

The Company's change programs were, foremost, based on reactive responses to external triggers and controls. According to Meryl Lewis (1983) (in Shafritz & Ott 1987), change environments of this type reduced the level of proactive behaviour and ignited a reactive culture instead. This was effectively the Company's situation. The literature also stated that change communication programs assisted organisations to more efficiently manage change. Change communication formed part of the Company's change program; however, it was adopted for the purpose of communicating stakeholder roles and their responsibilities rather than to promulgate the overall change process. Noteworthy was the general consensus that, change management programs and associated technology frameworks often failed to deliver the desired or expected results (Cao & McHugh 2005; Coulson-Thomas 2008; Lang & Zangl 2008). As discussed, the Company had a history of failed change and technology programs despite having implemented a multiplicity of common change frameworks and tools.

#### **4.5 Case Problem**

As discussed, the Company was unable to respond readily to change for a number of reasons, leaving it in a state of flux, which was a position it had endured for decades. The change was predominantly externally driven and, inadvertently, directed at the coal-face of the Company's supply-chain activities. The Company's documents revealed a succession of anomalies within its supply-chain environment, which became stressed when exposed to change. The documents revealed that, as the Company expanded, its supply-chain became increasingly fragmented and its control (governance) frameworks skewed. A number of authority and responsibility demarcations were implemented to remediate these issues. In some instances these

arrangements added to the existing supply-chain anomalies and further undermined the Company's performance and efficiency levels.

Function	Process	Sub-Process	Procedure	Activity	Task
Logistic Management	Supply Stores & Inventory Management	Cataloguing			
		Supply Management	Inventory Management		
			Stores Accounting		
			Stocktaking & Reporting		
			Disposal		
			Supply-Chain Purchasing		
		Purchasing	Determine Method of Procurement	Determine Mandatory Requirements	Choose Efficient, Effective & Ethical Use of Resources
					Use Company Standing Offers
					Use Stated Contracts
					Comply with Engineering Requirements
					Choose Proposal Approver
					Seek Delegate Approval
					Ensure Delegates Meet Competency Requirements
				Select Method of Procurement	Determine Procurement Complexity
					Determine Supply History
					Establish Market Knowledge
					Determine Urgency of Need
				Review Purchase History	Consider QA Factors
					Ascertain Current Supplier
					Determine Standing Offer Status
				Review Engineering Requirements	Exercise Market Testing Discretion
					Obtain Prior Authorisation
				Review Methods of Procurement	Assess Direct Purchase Options
					Assess Standing Offers
					Solicit Quotations
				Determine Sourcing Options	Assess International Option
					Assess Market Knowledge
				Approve Method of Procurement	Assess Other Options
					Purchase Through Standing Offer
					Purchase Internationally
					Purchase Directly
			Commercial Purchasing		
			International Sales		
			Manual Purchasing Methods		
		Item Repairs Management			
		Equipment Maintenance			
		Warehouse & Distribution			
	Logistics Performance Management				
	Logistics IS Capability Management				
	International Logistics				

**Table 4: Logistics Management Process Hierarchy**

A major concern was that the Company's strategic decisions were executed without cognisance of its core business, supply-chain activities. This irregularity was recognised by stakeholders at the coal-face of the supply-chain but disregarded at the executive level where the majority of the strategic decisions were shaped, then delegated to the appropriate authority for action. The Company's high-end managers disregarded their obligation to communicate impending changes to supply-chain stakeholders. Consequently, there were notable communication deficiencies between the decision-makers, authority and responsibility delegates, and supply-chain stakeholders. There were many incidents where the inability to identify and manage supply-chain interdependencies set in play a domino effect of dysfunctional activities. When problems were identified there were no mechanisms in place to invalidate or remediate the decision.

The Company's core business comprised supply-chain (or logistics) activities. These activities engaged multiple functions, processes, organisation groups, systems, policies and roles and responsibilities, for example. This research investigated a single function (or high-level process), and its associated sub-processes, tasks and activities, impacted by a change process. The related function (or process) hierarchy is illustrated at Table 4. Although there were many anomalies present throughout the supply-chain, investigating all activities implicated in a change process was beyond the scope of this study. 'Logistics Management' was the high-level supply-chain process (or function) chosen for this investigation, specifically, the sub-process 'procurement'. Most of the Company's operational groups performed procurement activities in support of their operations, which included capital equipment and related supply item purchases. The administrative groups' purchases were largely consumables: corporate equipment; stationery; and ICT peripherals, to name but some. These items were non-capital equipment but nonetheless, they were considered essential to the day-to-day running of the organisation. Importantly, all capital equipment purchases were transacted using the Company's supply-system. Consumables were transacted using the corporate credit card or purchase orders. These procurement methods were governed by the same

financial and procurement policies, and authority and responsibility arrangements.

In addition, capital equipment purchases were governed by a series of mandatory requirements over and above the Company's procurement policies and authority and responsibility arrangements. These requirements covered item identification, supply-system purchases, purchase pre-requisites, and purchasing levels. Capital equipment purchases were more convoluted than non-capital items, having an additional eight procurement stages, and fourteen equipment specific and supply-system guidelines. Moreover, the operational groups were governed by unique (operation-specific) policies and processes, which were essential to sustain their diverse operations. Further, each operational group head was assigned the role of business owner with each responsible for their respective operations. Synchronising the operational groups' procurement processes was a far from trivial task, given they managed different equipment and, justifiably, had unique acquisition (procurement) and support requirements. In some instances, the groups informally tailored the Company's procurement policies to better serve their respective needs.

The finance systems configuration management, and authority and responsibility arrangements were similarly confusing with activities delegated across three separate administrative groups. For instance, the finance group head was the finance authority and finance system owner. There were, effectively, three purchasing systems; the supply-system's finance module, the core finance system, and one legacy system. CSD was responsible for all major technical changes, and some minor amendments, while the support group was tasked with on-site network configurations and installations. The finance group, as the business owner, managed all system related process changes. Even more challenging was the relationship between the procurement authority, who was head of the finance group, and the procurement business owner, who was head of the corporate group. A matrix defining the authority and responsibility arrangements for the Company's supply-system is shown at Table 5.

		FUNCTION (High-level Process)				
		Finance	Procurement	Supply (Logistics)	ICT Management	Facilities Management
GROUP	Finance	BO, PA, SO, TA	PA, SO			
	Corporate		BO, TA	TA		
	CSD	TA	TA	TA	BO, PA, SO, TA	TA
	Support	TA	TA	TA	TA	BO, PA, SO
	OPS1			BO, PA, SO		

*Authority Responsibilities*

*BO - Business Owner; PA - Process Authority; SO – System Owner; TA – Technical Authority*

**Table 5: Supply-System Authority and Responsibility Arrangements**

The research problem was based on the Company's administration of the Australian Government's 2008 revised Commonwealth Procurement Guidelines (CPG), which were introduced to standardise finance and procurement processes across all Commonwealth agencies. All agencies governed by the FMA Act (1997) and the Commonwealth Authorities and Companies (CAC) Act (1997), were governed by the CPG, and other associated materials. The revised CPG were a Commonwealth Government initiative introduced, in part, to support the Australia-United States Free Trade Agreement procurement arrangements. The initial arrangements, which came into effect 1 January 2005, governed a range of activities, which included:

- procurement activity and its management;
- tendering processes; and
- contract management.

The most recent CPG amendments were introduced on 1 December 2008, and mandated changes to the following practices:

- value for money;
- competition;
- efficient, effective and ethical use of resources; and



- accountability and transparency.

The respective Government agencies were responsible for implementing the revised CPG by amending all related procurement components, which included; policies, processes, training programs, and support systems. The majority of these changes were transaction-based and, consequently, impacted the lower-levels of the procurement process. These transactions were the intersecting activities that transpired at the organisation coal-face.

Implementing the 2005 CPG revisions was a major challenge for the Company and extensively impacted its operations. The 2008 CPG revisions created even greater turmoil. The 2005 changes brought in a series of Commonwealth Government mandated finance and procurement changes. The Company had struggled to implement these changes in a timely manner and its supply-chain performance and effectiveness had suffered as a result. These changes had a flow-on affect with the Company struggling to administer and resource the 2008 CPG requirements. A major disappointment for the Commonwealth agencies was the Government's refusal to compensate them for the cost of implementing these changes. In the Company's case, the out-of-pocket costs amounted to hundreds of millions of dollars. The activities (and impacts) associated with the 2008 CPG implementation process are outlined at Figure 31 and 32 and detailed at Appendix 1. The implications of these activities are discussed in Chapter 6.

#### **4.5.1 Problem Approach**

The literature acknowledged the limitations and inadequacies of the theories, frameworks and tools concerned explicitly with the systemic nature of change and its impact on the organisation. This research has addressed these gaps, using the case problem to explore and understand change complexity. The literature also recognised that, automated change tools provided a more comprehensive and capable solution for predetermining and communicating potential change impacts. Chapter 3 described and validated the modelling methods and formalisms used to capture and identify the key organisation change entities, their dynamics and interdependencies, implicated in a change process. The Company's implementation of the revised 2008 CPG was the

process used to explore the key change components. The CPG process was mapped using a range of high-level and low-level models, which were translated to a physical database. The end product was an effective, automated change tool (ACT). Chapter 5 presents the methodology used to develop, test and evaluate the ACT. Chapter 6 demonstrates the ACT development process and discusses its effectiveness to capture, analyse and assess change impacts, within the context of the case problem. Consequently, the research analysis findings are discussed in Chapter 6.

#### **4.6 Chapter Summary**

This chapter provided a chronology of the Company's past and present stature, revealing its evolutionary process as a continual change cycle. The rationale behind the decades of change initiatives was explained and the impacts discussed. The Company evolved from a series of independent organisations to a diarchy arrangement. While this arrangement was seen as an improvement on past designs the Company's ability to truly integrate its components remained a concern. A review of the Company's documents showed it was governed by a number of external controls, which had repeatedly initiated both intended and inadvertent change. This trend had desecrated the Company's performance and fragmented its environment. The Company's size, complexity and diversity had restricted its ability to readily adapt to change. Similarly, the literature acknowledged the difficulties large, complex organisations faced managing change. There was also the issue of managing soft factors, which the literature considered was important, but it was a practice the Company had not managed well.

The Company foremost had been managed from an outcome and performance perspective. The expected outcomes had changed from time-to-time to reflect the mandate and political focus of the Government of the day. Consequently, new policies and supporting management practices were introduced to sustain the new arrangements or a particular focus. Over the decades the Company had invested heavily in various management frameworks and tools, and undertaken numerous projects in order to implement and sustain the required changes. These products were supposed to assist organisations to more

effectively manage administrative and operational activities. In theory, these products should have enabled the Company to better manage its environment. However, as demonstrated in this chapter, and throughout the literature, these products often failed to deliver the expected or desired results.

This chapter has demonstrated, through the Company's documents, that any number of change events can significantly impact the organisational environment. The case problem revealed that change could be systemic and impact a number of components at varying levels within the organisation. Often these changes were unintentional with change components linked via complex and dynamic interdependencies. For example, policies were linked to processes, procedures and tasks etc, which in turn, were supported by data from multiple IS that serviced a number of users with various responsibilities. In addition, these organisation components were governed by an assortment of authority and responsibility arrangements, which were often convoluted and misaligned. The Company's environment comprised an extremely complicated arrangement of entities and interdependencies. Consequently, the task of capturing and assessing these interfaces was a far from trivial exercise. This chapter has shown that failure to undertake a comprehensive change impact assessment can lead to procedural anomalies, inconsistencies and, in extreme cases, chaos. This scenario was presented through the case problem where a number of unplanned changes severely compromised its supply-chain operations.

This chapter has justified the case participant selection whereby the Company, as a large, complex organisation, has provided the depth and information richness required to fully explore the complexity of organisation change. A small business enterprise (SME) would not have provided the level of complexity or degree of component interrelationships needed to compile a comprehensive view of the intricacies of organisation change. The chapter has also exposed the ineffectiveness of common ICT innovations and organisation frameworks and tools to effectively manage organisation change. This phenomenon was also shown to be supported by several literature works. In addition, this chapter addressed the merits of adopting an automated change

tool (specifically the ACT) to manage organisation change and organisation complexity. The ACT is further discussed in Chapter 6. The following Chapter presents the research design, which includes the methodology used to develop, test and validate the ACT.

## **Chapter 5**

### **Research Design**

#### **5.1 Introduction**

This chapter presents and justifies the research method chosen to investigate a key change event within a complex socio-technical environment. The purpose of the study was to explore the key entities, dynamics and interdependencies implicated in a socio-technical change process. The aim was to develop a change tool that would provide a comprehensive change management solution. Given the case participant's (the Company's) size, its supply-chain complexity and diversity, an in-depth, single case study was deemed appropriate to explore these elements. Explorative studies were synonymous with qualitative methods (specifically case studies) and where the variables or identifiable units were unknown. Case studies were also synonymous with investigations concerned with organisation change. Taking an exploratory research approach meant that participants could share their experiences and perceptions in their capacity as supply-chain stakeholders and change targets. Through their perceptions, this study detailed critical issues stakeholders encountered in the course of specific change events, the Government's commonwealth procurement guidelines (CPG), for example.

The Company's supply-chain procurement activities were most vulnerable to change and the stakeholders' paramount concern was mitigating and controlling the effect of these changes. Therefore, an integral part of this research was the collection and analysis of data commensurate with developing an automated change solution (or system) capable of predetermining and reporting key (change) entity interdependencies. To that end, qualitative information systems development (ISD), specifically systems analysis and design (SA&D), methods was used to ratify the data in terms of stakeholder requirements. The method was also used to develop, evaluate, and test the automated change tool (ACT) against its ability to support real-time model-based scenario building and sensitivity analysis.

The chapter is organised as follows. A brief overview of established research methods is presented with qualitative methods discussed in greater detail to justify their suitability to the research problem. Next, the research strategy is explained and framed within the context of this study and is followed by the case study research process. The research analysis and findings are presented in Chapter 6.

## **5.2 Research Methods**

A number of definitions have been used to define research. Most academics agreed that research was a disciplined line of 'inquiry' (Williamson 2000b) with research methodologies the backbone of all formal lines of inquiry (Leedy 1997; Marshall & Rossman 1999). The three common research methods were defined as; qualitative, quantitative, and mixed methods, with each comprising different research approaches or frameworks (Creswell 2009; Mingers 2001; Myers 2006; Williamson 2000b; Yin 2009). All research methods were concerned with collecting and analysing empirical data in their own different way (Yin 2009). The applicability of a specific research method was dependent upon the nature of the research problem, and the research framework needed to add credibility to the research process (Leedy 1997; Marshall & Rossman 1999; Thomas & Brubaker 2000; Yin 2009).

Quantitative research was defined as the identification and analysis of measurable objects and their relationship within a pre-determined environment (Creswell 2009; Leedy 1997). This method was associated with positivism (or experimental research styles) and deductive logic (Creswell 2009; Leedy 1997; Thomas & Brubaker 2000). Quantitative studies were largely reliant on experimental and/or survey instruments, and mostly used statistical data analysis (Creswell 2009; Leedy 1997; Thomas & Brubaker 2000). This research style was often referred to as traditional or scientific and applied research, and included hypothesis and theory testing as core criteria (Creswell 2009; Thomas & Brubaker 2000; Williamson 2000a). Qualitative research originated from the social sciences and was traditionally associated with studies concerned with human social interactions or real-life phenomena (Creswell 2009; Marshall & Rossman 1999; Yin 2009). This method was

described as a constructivist approach, grounded by exploratory or participatory research styles, and inductive reasoning (Creswell 2009; Marshall & Rossman 1999; Yin 2009). Qualitative research draws from a large selection of approaches, data instruments and analyses (Creswell 2009; Marshall & Rossman 1999; Yin 2009). Qualitative studies were generally undertaken in uncontrolled environments with any number of unknown variables (Yin 2009). Mixed methods research has grown in popularity and stature over the last decade. This method combines both quantitative and qualitative approaches and was considered appropriate for investigating specific, complex social environments. Mixed method research applies the richness of these two approaches in a single study (Creswell 2009; Yin 2009).

The acceptance of information systems (IS) research has increased significantly since the 1970s and 1980s when these types of studies were predominantly user-centric (Trauth 2001). In the late 1990s IS research shifted to embrace (to a limited extent) a more holistic design approach, focusing on business processes, the organisation in general, and the ISD framework itself (Lee, A 2001; Trauth 2001). Mumford (2003) described IS research as socio-technical oriented because of its 'participative' nature and the fact that IS decision-making was influenced by the parties most affected by the decision. From the late 1990s onwards, IS research engaged the core methodologies; quantitative, qualitative and mixed methods, respectively (Sawyer 2001; Trauth 2001; Wynn 2001). Burstein (2000), Nunamaker, Chen and Purdin (1990), and Hasan (2003) advocated the legitimacy of ISD as a valid research activity. Burstein (2000) noted that, ISD had been omitted from mainstream IS research methods largely because of its association with the social sciences. She viewed this oversight as an indictment against ISD technical attributes and its engineering and applied science origins. Burstein (2000, p 130) provided philosophical and practical evidence to support ISD as a recognised and established research paradigm. Her findings were based on the works of notable IS academics.

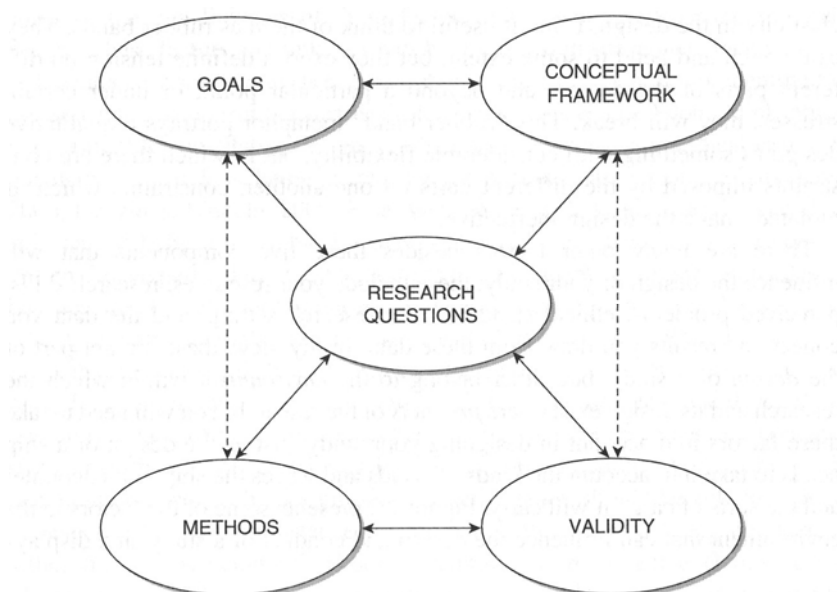
### **5.3 Research Strategy**

As noted, the purpose of this study was to explore the key entities, dynamics and interdependencies implicated in a socio-technical change process. The investigation focused on the Company's supply-chain procurement activities, which were subjected to a number of change events (or triggers). The research aim was to identify and capture the key entities involved in a specific change process, and develop a tool capable of readily identifying change targets for the purpose of providing a comprehensive change management solution. The approach taken was based on the premise that any attempt to manage or understand change, in a complex socio-technical environment, must be underpinned by an automated predictive tool. The literature revealed a knowledge gap whereby no explicit prior research had identified and/or tested variables or formulated any hypotheses pertinent to this research problem, or research environment.

Quantitative methods were considered inappropriate given the research problem and in the absence of any explicitly defined variables. Further, quantitative methods would not have provided the flexibility needed to disentangle a complex and dynamic environment or provide the depth and detail required for this investigation. A mixed methods approach was also considered inappropriate because, as noted, there were no applied data or hypotheses testing. In addition, data comparisons and statistical analysis were deemed impractical for a single case study (Yin 2009). Alternatively, qualitative methods provided an 'openness and flexibility' that enabled the research design to be modified as required to focus on 'new discoveries' and 'relationships' (Maxwell 2005, p 22). According to Mumford (2003), there was a genuine need to clarify and describe perceived knowledge gaps in relation to an event or problem. Mumford (2003) emphasised the importance of understanding a problem before attempting to solve it: taking a holistic approach to problem solving. She believed problem solving was associated with understanding the dynamics of the problem. Designing a problem solving program or strategy that incorporated a series of practical operations would achieve the desired result (Mumford 2003).



Qualitative methods offered an interpretative lens to explore the existence of a problem and provided the ‘mechanics’ to reach a solution (Trauth 2001). In addition, qualitative methods had the ability to explain complex themes and consider a range of interrelationships over multiple domains (Trauth 2001). In light of the research problem’s explorative nature, a qualitative research method was deemed appropriate for this study. Figure 22 outlines the qualitative research concept.



**Figure 22: An Interactive Model of Research Design (Maxwell 2005, p 5)**

Burstein (2000), Hasan (2003), and Nunamaker, Chen and Purdin (1990) considered ISD a legitimate research method. As noted, a number of ISD frameworks were underpinned by quantitative and qualitative research methods. Most ISD frameworks were considered quantitative, having an engineering or applied science influence (Burstein 2000; Hasan 2003), while others had a general system theory (GST) grounding (Lui & Piccoli 2007; Nilsson, A 2005). For example, a prototype (quantitative) system was aligned with, or illustrated, a specific ‘theoretical framework’ and was developed using fixed ISD practices to demonstrate a specific outcome (Burstein 2000; Hasan 2003). Alternately, qualitative ISD frameworks were social science-based with a socio-technical design approach whereby stakeholders participated in the design and decision-making process (Burch 1992; Burstein 2000; Hasan

2003). In the latter instance, the frameworks were less contrived with the outcome collaborative and exploratory focused (Burstein 2000).

Mumford (2003) viewed participatory development as a problem prevention strategy, based on the premise that stakeholders involved in the ISD process would be least resistant to change and workplace alienation. The inclusion of stakeholders in ISD problem solving was a collaborative practice introduced by von Neumann during the Electronic Discrete Variable Automatic Computer (EDVAC) design, and other computer applications of the same period (see section 2.6.). The ISD socio-technical considerations enveloped the technical aspects of information communication technology (ICT), together with the human interface between organisation information and processes (Alter & Browne 2005; Hasan 2003). In light of the research problem complexity, and the context of the research aims, a socio-technical (qualitative) ISD approach was considered the method best suited to develop the ACT.

### **5.3.1 Qualitative Methods**

Qualitative research embraces multiple strategies of inquiry, data collection, analysis, and research reporting procedures (Creswell 2009; Leedy 1997). Key qualitative approaches included:

- case studies;
- ethnography;
- grounded theory;
- phenomenological research; and
- action research (Marshall & Rossman 1999; Williamson 2000a; Yin 1989).

Case studies are described as empirical inquiries of a socio-technical and holistic-centric nature, and are considered synonymous with understanding complex social phenomena (Darke & Shanks 2000; Yin 2009). Case studies are 'exploratory', 'explanatory', or 'descriptive' focused whereupon the research problem determines the appropriate approach (Yin 2009). The case study inquiry was highly appropriate when dealing with multiple and unknown variable types where it was used for hypothesis generation, theory development and theory testing (Creswell 2009; Darke & Shanks 2000;

Williamson 2000a; Yin 2009). The case study approach was most suited to ISD research where objects and their interdependencies were explored from a socio-technical perspective (Burstein 2000; Hasan 2003; Myers 2006).

Ethnographic research studies the behaviour of an object within a cultural and social context (Creswell 2009; Leedy 1997; Myers 2006). This approach differed to case studies in that the research findings were not usually generalisable because they were representative of a specific sample group (Leedy 1997; Williamson 2000b). Ethnography studies primarily focused on discovering the social patterns in human behaviour and were synonymous with field work or observation research (Creswell 2009; Leedy 1997; Maxwell 2005; Williamson 2000b). Grounded theory is a line of inductive inquiry developed through one or more studies where theory is derived from the data source(s) (Maxwell 2005). It is a method that identifies relationships between multiple data sources for the purpose of establishing theory (Marshall & Rossman 1999; Williamson 2000b). Grounded theory was not considered to be an appropriate research method because of the key role that the literature played in development of the models that were a major outcome of the study. That is, in grounded theory, a theory is 'grounded' in the sense that it is 'developed from the data, as opposed to being suggested by the literature' (Leedy 1997, p 163). In this study, the literature was the major source for the development of the early versions of the formal (i.e. specified using rigorous IS conceptual modelling techniques) models of the IS change management domain that were, in turn, used to drive the development of the automated, structured, impact prediction tool.

Phenomenological research was identified as understanding and presenting human experiences and views of social realities from the participants' perspective (Creswell 2009; Leedy 1997). Similar to ethnographic research, phenomenological studies were also human-centric (Leedy 1997; Williamson 2000b). Action research was concerned with the 'study of human practice and social actions' (Oosthuizen 2000, p 141). It differed from other approaches with the researcher required to participate in the inquiry and contribute to a practical outcome (Coghlan & Brannick 2001; Oosthuizen 2000). Action research

focused on single situations with the line of investigation generally field-based, reflective, cyclical, and collaborative (Oosthuizen 2000).

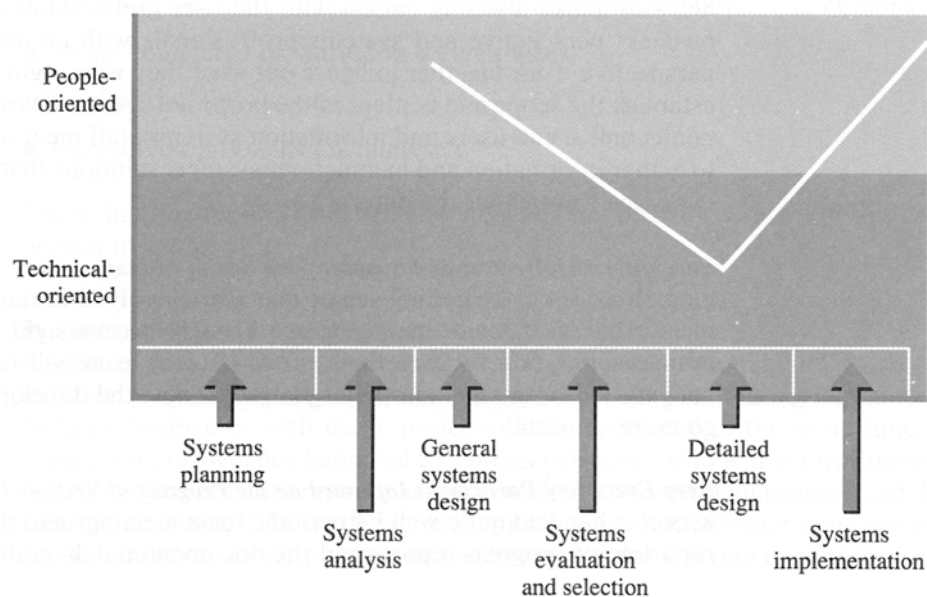
The purpose of this study was to explore and capture undefined key entities and their interdependencies in a complex socio-technical environment. Therefore, the case study was considered the appropriate research approach. Case studies were also synonymous with IS research (Burstein 2000) and, in light of the study's ISD component, this approach best served the research problem. In addition, case studies were commonly used in organisations as a collaborative approach to implement change programs; therefore, they were better suited to exploring organisational change issues (Coghlan & Brannick 2001; Schmuck 2006; Somekh 2006). Given the research focus was to explore the implications of change in a socio-technical environment, the case study provided a sound research framework. Accordingly, an ethnographic or phenomenological study was deemed inappropriate, while action research was not suited to an explorative study. Finally, grounded theory as a multiple, data-centric method would not have provided the depth of inquiry needed for this study.

#### 5.3.1.1 Qualitative Information Systems Development (ISD) Methods

As noted, qualitative ISD methods were social science-based with a socio-technical and participatory approach to analysis, design and implementation of ICT artefacts (Burch 1992; Burstein 2000; Hasan 2003). Qualitative ISD methods included; Systems Development Life Cycle (SDLC), Joint Application Development (JAD), Rapid Application Development (RAD) (Burch 1992; Lui & Piccoli 2007), and SA&D (Alter & Browne 2005). Qualitative ISD frameworks were less contrived because they were collaborative and exploratory focused (Burstein 2000). For example, qualitative ISD frameworks adopted qualitative interview techniques to elicit stakeholder requirements (Burch 1992). Consequently, users were involved in the ISD process and foremost guided its development. An example of a high-level socio-technical ISD framework where users were directly involved in the ISD process is shown at Figure 23.

SA&D as a qualitative socio-technical ISD framework (Lui & Piccoli 2007), was frequently used to manage systems-oriented organisation change (Alter &

Browne 2005). Alter and Browne's (2005) 'Range and Scope of SA&D Contexts' shown at Figure 4, and discussed in section 2.7.2, provided an excellent example of the role of SA&D in a socio-technical environment. In light of the research problem and research aims a socio-technical (qualitative) approach was considered more suited to developing the ACT. SA&D was chosen as the qualitative ISD framework because of its standing as a systems-oriented organisation change framework. In addition, the researcher was a competent user of the SA&D framework.



**Figure 23: People-Oriented and Technical-Oriented Phases of ISD (Burch 1992, p 81)**

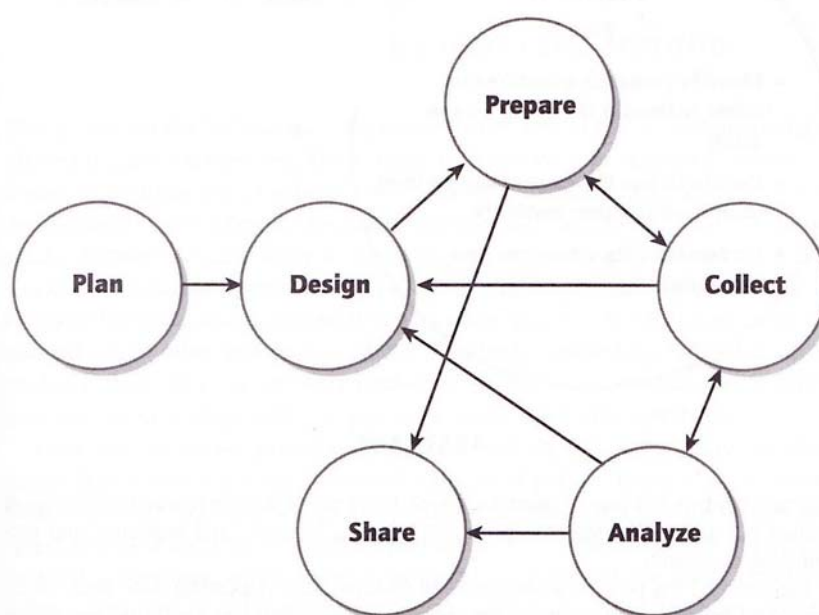
### 5.3.2 The Case Study Approach

According to Darke and Shanks (2000), Leedy (1997) and Yin (2009), case studies were categorised as follows:

- a single case (or single unit of analysis) which may be an explorative in-depth study of a phenomena that provides a rich understanding of a situation or event; and
- multiple cases where more than one case (or multiple units of analysis) were studied mostly for the purpose of comparing 'cross-case' findings.

A single case study was considered more appropriate for this research because the approach provided the depth and richness of analysis needed to explore the phenomenon of organisation change in a complex, dynamic

environment. Creswell (2009) and Yin (2009) noted that, it was inappropriate to make generalisations from a single case study because the information gleaned from one study might not be relevant to other cases. However, both agree that single case findings may be used to generate hypotheses, or propositions for generalisations, especially where a case has been framed by a theoretical lens, and followed a valid research method. Figure 24 shows the case study as a collaborative, iterative and valid research process.

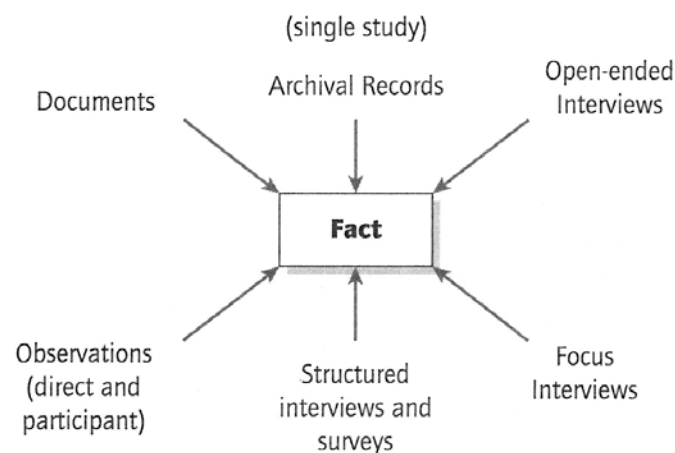


**Figure 24: Doing Case Study Research: a linear but iterative process (Yin 2009, p 1)**

This study focused on one organisation and one environment, the Company's supply-chain (logistics) activities, with the research framed using a mix of theoretical perspectives. The study was validated in accordance with case study research procedures (Creswell 2009; Leedy 1997; Yin 2009) and the SA&D frameworks (Alter & Browne 2005; Burch 1992), to ensure robustness of the findings and research process. A single study should also focus on selecting the appropriate subjects, location, or groups to be interviewed or observed to provide an accurate and reliable overview of events within a given environment (Creswell 2009; Miles & Huberman 1994; Mumford 2003; Yin 2009). The case study research process is detailed in section 5.4.

### 5.3.3 Data Collection Techniques

Case studies rely on in-depth multiple data sources and collection techniques to provide an information rich analysis platform (Creswell 2009; Darke & Shanks 2000; Yin 2009). Multiple data sources include; documents, archival records, interviews, observations, and physical artefacts (computer software, systems, for example) (Creswell 2009; Leedy 1997Yin 2009). ‘The rationale for using multiple sources of evidence was triangulation’ (Yin 2009, p 114). Triangulation involves cross-referencing all data sources to validate the research design in terms of data objectivity, accuracy, and suitability to the research aims (Creswell 2009; Maxwell 2005; Williamson 2000b; Yin 2009). Figure 25 illustrates the single case study triangulation process.



**Figure 25: Convergence of Evidence (Yin 2009, p 117)**

Documents and archival materials include; letters, e-mails, minutes of meetings, written reports, administrative documents (proposals, business cases etc), formal studies or evaluations, and media articles (Creswell 2009; Yin 2009). Documents were typically used to corroborate information from other sources and to make informed inferences (Yin 2009). Interview structures include; one-on-one, face-to-face, focus groups, telephone or internet-based (Creswell 2009), open-ended (incorporating first and second-level questions), in-depth (where facts and opinions were sought), and focused (where specific or corroborative inquiry was needed) (Yin 2009). Physical artefacts include; art objects, computer software, ICT devices, and film and video material (Creswell 2009; Yin 2009).

Open-ended interviews are often used in case studies to elicit information and to avoid any researcher inherent biases or preconceptions (Creswell 2009; Darke & Shanks 2000; Yin 2009). Focused interviews assist to validate interview material and are used to frame additional 'lines of inquiry' (Yin 2009). In-depth interviews are common in situations where the participant's experiences and opinions are sought (Yin 2009). As noted, documents provided a rich source of data embracing a variety of historical and current materials (Leedy 1997). The inclusion of artefacts, specifically ICT, as a data source enabled the researcher to experience the Company's actual software functionality (Yin 2009). As raised earlier, qualitative ISD frameworks used interviews to elicit or confirm stakeholder requirements (Burch 1992; Yourdon 1989). This study relied on in-depth, and both open-ended and focused interviews, together with public and Company documents and artefacts, to provide an accurate and reliable account of an organisation change event. A structured interview format would not have provided the level of detail or reflected the intensity that surfaced during the interviews. These data collection materials were used to specify the ACT design.

#### **5.3.4 Data Analysis Techniques**

Case study data analysis involves analysing the data for themes or issues (Creswell 2009; Maxwell 2005; Williamson 2000b). For example, documents are analysed in accordance with predetermined themes (those derived from the literature or existing theories), or are analysed using themes or issues that emerge during the analysis process (Creswell 2009; Williamson 2000b). The identification of themes from multiple data sources was referred to as triangulation (see section 5.3.3 and 5.3.5) (Creswell 2009; Williamson 2000b). Of particular interest to this study was Creswell's (2009, p 189) method of using themes to 'build additional layers of complexity' for the purpose of developing theoretical models. This form of analysis extends 'theme identification' into 'complex theme connections' (Creswell 2009, p 189), or data relationships (Maxwell 2005; Williamson 2000b). Likewise, the SA&D framework applies a similar form of data analysis to identify system components (and data) interdependencies (see section 3.6.1).



This study adopted multiple data sources to explore and interpret the impact of organisation change. These materials included:

- interviews;
- Company materials; and
- the wider literature (incorporating organisation theory, and the sub-theories decision theory, socio-technical theory, change theory, together with GST and technology theory).

These data sources were analysed using triangulation in accordance with existing themes (or key issues) and pattern identification, and included issues that emerged from the analysis process.

### **5.3.5 Research Validation and Reliability**

Yin (2009) proposed a formula for judging the quality of [qualitative] research designs. His philosophy focused on a series of common criteria used to test the validity and reliability of the overall research design through data collection and data analysis techniques. The formula Yin (2009) used is illustrated at Figure 26. Case study construct validity was supported by a series of measures used to ensure the concepts studied were objective, accurate, and appropriate to the research aims (Creswell 2009; Darke & Shanks 2000; Yin 2009). Common validity (or data validation) procedures widely used were triangulation and member checking. The triangulation method was explained in section 5.3.3 where it was shown to be a powerful multiple data source collection technique. Triangulation exposes the researcher to a 'broad range of issues' that are rich in depth and substantiated through saturation (Maxwell 2005; Yin 2009), or recurring issues (Creswell 2009). Consequently, triangulation was considered a more convincing and accurate data interpretation technique (Maxwell 2005; Williamson 2000b; Yin 2009).

Member checking (or respondent validation) involves returning the data analyses findings (as opposed to the interview transcribes) to the participant for verification of content (Creswell 2009; Leedy 1997; Maxwell 2005; Yin 2009). This approach was considered a valuable exercise in situations where themes had been identified (Maxwell 2005; Yin 2009). Member checking was

also performed during the data collection and data analysis phases. According to Maxwell (2005), adopting these techniques to validate the research process will exonerate the researcher from any inherent bias.

TESTS	Case Study Tactic	Phase of research in which tactic occurs
Construct validity	<ul style="list-style-type: none"> <li>◆ use multiple sources of evidence</li> <li>◆ establish chain of evidence</li> <li>◆ have key informants review draft case study report</li> </ul>	data collection data collection composition
Internal validity	<ul style="list-style-type: none"> <li>◆ do pattern matching</li> <li>◆ do explanation building</li> <li>◆ address rival explanations</li> <li>◆ use logic models</li> </ul>	data analysis data analysis data analysis data analysis
External validity	<ul style="list-style-type: none"> <li>◆ use theory in single-case studies</li> <li>◆ use replication logic in multiple-case studies</li> </ul>	research design research design
Reliability	<ul style="list-style-type: none"> <li>◆ use case study protocol</li> <li>◆ develop case study database</li> </ul>	data collection data collection

**Figure 26: Case Study Tactics for Four Design Tests (Yin 2009, p 41)**

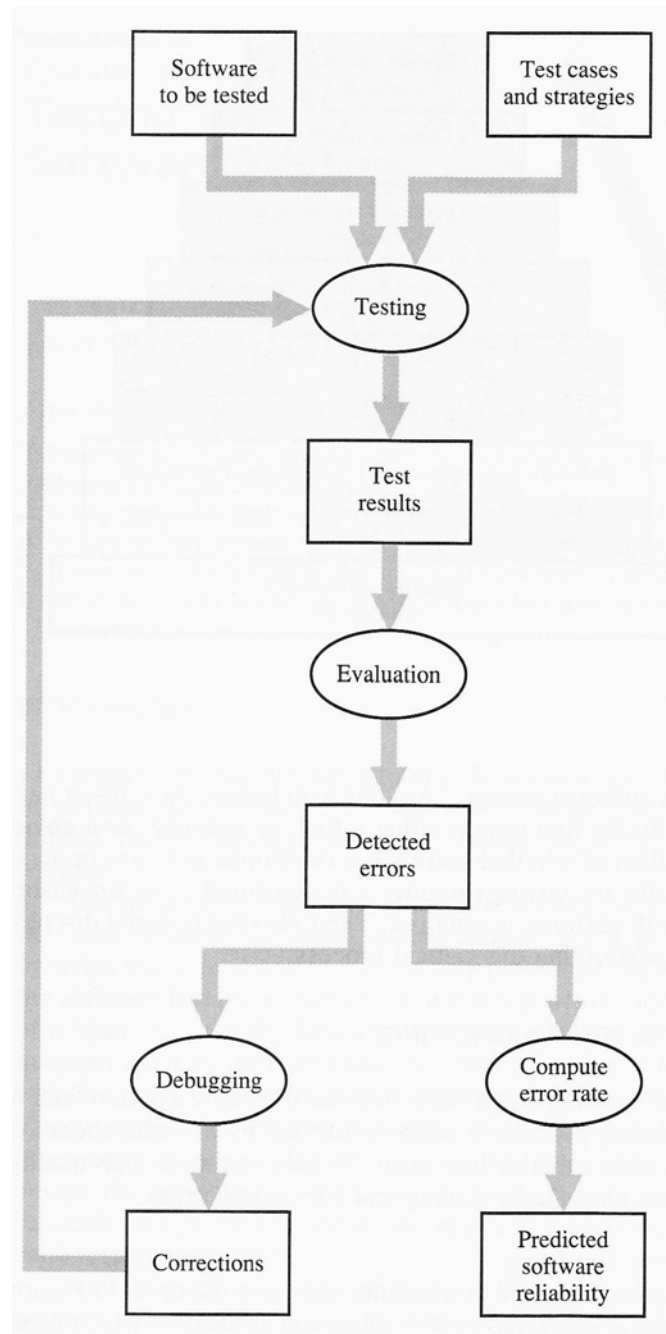
Internal validity was a procedure considered inappropriate for exploratory studies (Yin 2009) and, therefore, was not incorporated in the research design. External validity is a test used to determine whether the research findings are generalised outside of the case study findings (Creswell 2009; Maxwell 2005; Yin 2009). Single case findings are generalised by extending or developing a theory that can be applied to other cases (situations or domains) (Creswell 2009; Maxwell 2005; Yin 2009). Of importance to this study was Maxwell's (2005, p 116) view that, generalisations could be stated when there was 'universality of the phenomenon'. Put simply, universality of the phenomenon means that similarities can be drawn between other cases or situations, or events can be corroborated through other studies. The propositions that emerged from this study were applied to extend organisation change theory. Therefore, the researcher argues that the case findings are generalised under the universality of the phenomenon criteria. This concept is discussed in Chapter 7.

Reliability is a process used to ensure the research design protocol is followed to the extent that other researchers are able to repeat the study using the

same approach, and return the same results (Creswell 2009; Williamson 2000b; Yin 2009). Reliability is achieved by methodically documenting the research process, eliminating researcher bias, and double-checking research materials, analyses and findings (Creswell 2009; Maxwell 2005; Yin 2009).

#### 5.3.5.1 SA&D Test, Evaluation and Reliability Procedures

SA&D system testing methods were underpinned by set criteria designed to find and eliminate system errors for the purpose of determining the system's level of reliability (Burch 1992). System reliability was determined by error rate, which was expressed through the system terminating abnormally (crashing), the system not performing logically (logic) and, the system looping (hanging) (Burch 1992). System testing provided a framework to ensure the program (or system) performed as required (Burch 1992; p. 708). For example, test data was used to assess the systems' capacity to store and return the required information (O'Brien 1999). The SA&D test procedures are illustrated at Figure 27. Burch (1992) discussed two types of system testing, white box and black box. White box testing was concerned with the logical structure of the software, while black box testing focused on testing the systems functional requirements (Burch 1992). 'Test cases' were a series of formal procedures developed to evaluate (accept, modify or reject) system functionality against user requirements (Burch 1992; Yourdon 1989). The functions evaluated typically covered; field, record, file, data entry, controls, and program flow (Burch 1992). Test case strategies were complexity dependent and, hence, varied from system-to-system (Burch 1992; Yourdon 1989).



**Figure 27: Structured Software Testing Scenario (Burch 1992, p 710)**

Acceptance testing (or test walkthroughs) (Yourdon 1989) was a strategy applied to measure a system's capacity to satisfy user requirements within an operational environment (Burch 1992). Acceptance testing incorporated Alpha and Beta testing, with the former conducted in the users' natural settings in the presence of 'system professionals' and the latter performed in a laboratory in the absence of system professionals (Burch 1992). A user test group consisted of stakeholders who used the system in their day-to-day work activities (Burch 1992). Consequently, aside from validating the system's

functional requirements, an important component of system testing was its perceived usability (Burch 1992). An example of a usability test case is shown at Figure 28.

USABILITY FACTORS					
	1 = low to 5 = high				
A. Ease of use	1	2	3	4	5
B. User friendliness	1	2	3	4	5
C. Understandability	1	2	3	4	5
D. Level of confidence	1	2	3	4	5
E. Conformance to requirements	1	2	3	4	5
F. Conformance to response time	1	2	3	4	5
G. Comfort level	1	2	3	4	5

Please circle the number applicable to each quality factor.

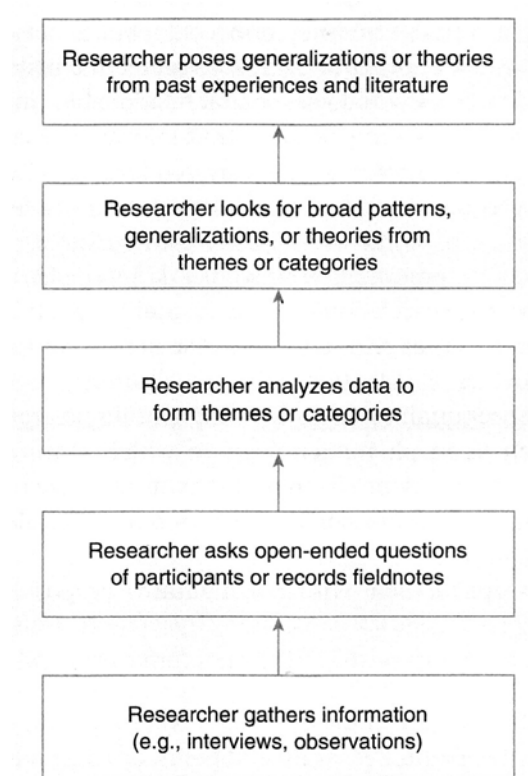
**Figure 28: Software Usability Factors Worksheet, (Burch 1992, p 728)**

### 5.3.6 Findings Interpretation and Reporting

Creswell (2009) and Williamson (2000b) viewed data ‘interpretation’ as making sense of, or deriving meaning from, data. For example, meaning was drawn by comparing the case findings with the information assembled from the literature or the theoretical lens used to frame the study (Creswell 2009). Further, Creswell (2009) stated that, the process of developing generalised themes and models from data, and comparing these findings with the existing literature (or theoretical perspectives) involved theory building. Theory building was essentially the process of interpreting the research findings as generalised propositions (Creswell 2009; Yin 2009). The theory building interpretative process is shown at Figure 29. This study applied a similar philosophy, adopting the literature (theoretical lens) to frame the research strategy. In addition, primary data (interviews) and Company materials were assembled into themes (or key issues) and used to determine gaps or inconsistencies in the applied framework (literature or theoretical lens). The case findings and literature comparison resulted in a number of research propositions, which are addressed in Chapter 7.

The research findings communication style was dependent on the nature of the data and the chosen research design (Creswell 2009; Yin 2009). Single case

findings were mostly presented using narrative or a mix of narrative and qualitative models, which included; tables, matrices, and process models (Creswell 2009; Darke & Shanks 2000; Leedy 1997; Yin 2009). The research findings herein have been presented in narrative form and include a mix of data display formats that are commensurate with SA&D practices. Given a large component of this research comprised the analysis, design and development of the ACT, a graphical presentation style was considered more suitable. Yin (2009) described theory-building as a research findings communication style. For example, where report chapters or sections followed theory-building logic, research hypotheses or propositions were considered more credible (Yin 2009). In that light, this study adopted theory-building logic to present the research findings and communicate and substantiate the research propositions.



**Figure 29: The Inductive Logic of Research in a Qualitative Study (Creswell 2009, p 63)**

## **5.4 The Case Study Research Process**

### **5.4.1 Research Focus**

As discussed, the Company was chosen as the case participant for a number of reasons. First, it was Australian owned and based, and therefore readily accessible. Second, the researcher was a Company employee with first-hand knowledge of the supply-chain environment, in addition to having access to a range of Company documents, artefacts, and subject matter experts (SMEs). Thirdly, the Company was a large complex organisation with diverse business characteristics. These features were important from the perspective of exploring the impact of change within a large, diverse socio-technical organisation. The Company's supply-chain procurement activities were the object of investigation because, as noted, they were most vulnerable to change and provided an opportunity to gauge the systemic and chaotic nature of change. This was a qualitative explorative study that posed the following questions:

1. What components are implicated in an (organisation) change process?
2. To what extent can a model or schema be used to effectively capture and illustrate these components?
3. Can the resultant schema be translated into a practical and responsive automated change tool?

Therefore, the research objectives were to:

1. Systematically capture, identify and simulate the entities and interdependencies involved in an organisation change process.
2. Translate the outputs from '1.' above into a responsive and effective automated change tool.

The focus of the investigation was the Company's implementation of the 2008 revised CPG. The complexity of the Company's procurement environment and the scope and impact of the CPG changes were detailed in section 4.5. As noted, the purpose of the study was to explore the key entities and interdependencies implicated in a complex socio-technical change process. To that end, the study comprised three core data collection phases, which are described in the following sections.

## **5.4.2 Data Collection**

### **5.4.2.1 Literature (Theoretical Lens)**

The initial data collection phase involved a detailed review of the literature surrounding organisation theory and the sub-theories, decision theory, social-technical theory and change theory, together with GST and technology theory. These paradigms were deemed pertinent to the research aims and research objectives. Organisation theory was the core theoretical perspective chosen for the study because the object of investigation was an organisation, and the research problem was organisation behaviour-focused. As discussed in section 3.4, the literature indicated that, organisation-based studies required a multiple theoretical approach to comprehend the complexities and dynamics of the organisational unit. Consequently, the review was extended to include other theoretical perspectives; change theory, decision theory, socio-technical theory, GST, and technology theory, for example. These paradigms were classified as organisation theory sub-theories, even though GST was essentially a science-based perspective and technology theory was a derivative of engineering theory and the sciences.

Change theory was considered relevant because the study was exploring the impact of organisation change. Similarly, decision theory and technology theory were deemed critical organisation change components in terms of their capacity to contribute to an automated change solution. Automated tools were essentially decision support systems (DSS) and their effectiveness was dependent on choosing the appropriate ISD and decision framework, as discussed in section 2.4.2 and 3.4 respectively. Therefore, technology theory and decision theory were explored from a practical and theoretical perspective.

Socio-technical theory was considered a derivative of GST and an organisation theory sub-theory. As noted, socio-technical theory was adopted by post-modern theorists to explore and understand the organisation as a human-centric system of interrelated components. Socio-technical theory was pertinent to this research because it consolidated, in part, the organisation human and mechanistic components into a single framework. For example, people, skills, processes, technology, and authority lines were fundamental



considerations in organisation-based research. Finally, GST was significant in revealing the complexity and dynamics of the interrelated organisation components, but foremost, it defined the organisation as an open-system exposed to constant change. The theoretical lens used to frame the study provided a platform from which to explore and validate a range of constructs, frameworks and themes (Maxwell 2005; Yin 2009). The literature review commenced from the beginning of the study and concluded on its completion.

#### 5.4.2.2 Company Materials

The second research phase comprised an in-depth study of the Company from a historical and present day perspective and involved collecting data from various Company sources. This phase commenced from the beginning of the study and concluded on its completion. The Company's historical data was drawn from the period 1901 onwards. The objective was to explore the Company through its background to understand its behaviour characteristics, and explore the Company through its current state to capture the socio-technical components. The Company's policies, processes, systems, management frameworks (change management, and governance for example), and decision-making practices, were of particular interest because these, in part, determined its socio-technical components and its behaviour characteristics. The researcher had access to a range of Company documents and artefacts that were retrospective, current and visionary in nature, and included:

- general information obtained from the Company website;
- annual and financial reports;
- historical documents and reports;
- various Government and Company initiated performance audit reports;
- Company profiles and organisation charts;
- policy, processes and responsibility hierarchies;
- operational procedures and training manuals;
- magazine and industry specific journal articles;
- systems project documentation; and
- ICT reports, system profiles and related documentation.

The results of the in-depth Company review were presented in Chapter 4.

#### 5.4.2.3 Interviews

The third data collection phase comprised twelve in-depth, open-ended interviews, one of which was a telephone interview. Interview participants were chosen on their ability to provide an accurate and reliable overview of events within their environment (Creswell 2009, Leedy 1997; Williamson 2000b; Yin 2009). Most interviewees were chosen from a pool of previously identified logistics (supply-chain) SMEs from logistics projects, [logistics] policy and procedures, and [logistics] ICT. Other SMEs were drawn from various Company groups and were readily assessable because of their previous logistics project affiliations. These groups were identified in accordance with the topical issues that emerged from the wider literature, and the Company materials. All participants were consenting volunteers and their affiliations and responsibilities ranged from various governance and change programs, to IS and equipment acquisitions and sustainment.

The SMEs comprised a mix of logistics practitioners, project managers, and business managers with lower, middle, and high-end responsibility ranking. The logistics practitioners provided expertise on operational matters while the project managers responded to issues concerning logistics (supply-chain) ICT projects. The business managers input centred on the Company's internal and external business interactions and strategic decision-making practices. Two interviewees were not Company employees. One was approached on the basis of his previous relationship with the Company as an ICT project consultant and his experience as a consultant to a range of industry types. The second interviewee was approached in his capacity as Chief Executive Officer (CEO) of a large Queensland Government agency at the centre of a change program. He provided valuable information from an organisational change perspective and drew from his experience dealing with change issues. Most interviews were conducted at the Company's premises in Melbourne, Australia with the exception of the two non-Company employees. These interviews were conducted at a private residence and international conference venue in

Brisbane, Australia, respectively. The telephone interview was conducted with an interstate participant.

The study adopted an iterative approach, where the researcher was guided by developments as to how many interviews should be conducted and who should be interviewed (Creswell 2009; Yin 2009). For example, where there was a perceived gap in the information provided, or where an issue or event needed clarification, further interviews were conducted with additional subjects. This approach provided a flexible research platform (Creswell 2009; Yin 2009). The end result was a broad interview base that was rich in Company knowledge, which ensured a range of issues were explored. Open interview schedules were used during the interviews to ensure the interviewee and interviewer maintained focus on the key areas of interest (Creswell 2009; Yin 2009). The schedules were loosely framed around the data derived from the literature, Company materials, and, in some instances, data that emerged from the interviews. Each participant was provided with an interview schedule beforehand outlining the interview questions. For some participants the interview schedules were partially customised to enable the elicitation of data specific to a particular group or work-flow.

The interview duration averaged between one to two hours. The telephone interview was conducted using the same open-ended format. Each participant was asked to describe their work environment and core responsibilities from an operational (work-flow) and business (organisational) perspective. They were invited to comment on their exposure to change programs and related decision-making processes. In addition, they were also asked to reflect on any Company initiated modelling-based change approach. Where applicable, subjects were asked to describe and comment on the revised CPG implementation process and share their experiences and perceptions. Where participants expressed concerns regarding the CPG process, the researcher used additional 'lines of inquiry' and 'conversational questioning' (Yin 2009, p 106) to clarify issues and elicit further information.

With the exception of the one telephone interview, all interviews were digitally recorded, transcribed and returned to the participant for verification, and

amendment where required (Creswell 2009; Williamson 2000b; Yin 2009). Hand-written notes were taken during each interview to follow up issues not clarified during the interview process (Creswell 2009; Yin 2009). Overall, the Company's key group participants, and non-Company employees, were able to express their views and share their experiences and perceptions, and validate the information they provided. The participants were also asked to validate interview data for the purpose of developing the ACT logical schemas and physical meta-schemas, and to scope the ACT stakeholder requirements. The interview and validation phase commenced in December 2007 and concluded June 2009.

### **5.4.3 Data Analysis**

As noted, multiple data sources were used to collect the data, which were analysed in accordance with emerging themes (or key issues) (Creswell 2009; Maxwell 2005; Williamson 2000b). Triangulation was used to ratify the key issues, which were categorised using identification by recurring issues (or saturation) (Creswell 2009; Williamson 2000b). The information gleaned from the data sources was substantial and indicated that, apart from the issues derived from the literature and Company materials, other significant elements had to be considered in an organisation change process. The analysis process used a variety of data displays to illustrate this phenomenon. For example, a cross-function process diagram (CFPD) and a cross-function decision model (CFDM) was used to modularise the entities, information flows, and decision points involved in the CPG change process. As discussed in section 3.6.1, process models were limited in their scope to capture and illustrate interdependencies at the lowest entity denomination (or sub-system) level.

A selection of high-level qualitative formalisms (described in section 3.6.1), enabled the key organisation change issues (entities) that emerged from the data, and the CPG change process, to be compiled into complex theme connections and relationships (Creswell 2009; Maxwell 2005; Williamson 2000b). As noted, high-level formalisms were incapable of capturing unique data instances and dynamic interdependencies. Consequently, an entity relationship diagram (ERD) (or low-level modelling formalism) was used to

map the key change entity dynamics and interdependencies to their lowest denomination (or single record instances). Taking a data modelling analysis approach allowed the ACT low-level schema to be translated into a physical database (ACT). The translation process is explained and illustrated in detail in the next Chapter.

A considerable component of the data analysis was geared toward development of the ACT. The data analyses formalisms used to scope and develop the ACT were selected because they were commensurate with SA&D practices (see section 3.6.2). Consequently, data could be ratified in terms of stakeholder requirements and the Company's business needs. The choice of formalisms was critical given the data had to be interpreted and presented using a process that would readily translate into a working system (or tool). A range of formalisms were utilised to achieve the required result, which was an automated change tool capable of supporting real-time model-based scenario building and sensitivity analysis.

#### **5.4.4 Case Study Validation and Reliability**

This study implemented triangulation and member checking validity tests to ensure the interpretation of the analysis findings was accurate, objective and appropriate to the research aims. Accordingly, the diversity and depth of the interviews, the range of Company materials, and the theoretical lens provided the data richness and multiplicity required to guarantee the validity of the data (Creswell 2009; Williamson 2000b; Yin 2009). In addition, the themes that emerged from the study were substantiated by their repetitiveness (or reoccurrence) throughout the data sources (Creswell 2009; Maxwell 2005; Yin 2009). These factors combined served to eliminate the prospect of any researcher bias (Maxwell 2005; Yin 2009).

Moreover, SMEs were continuously solicited for feedback concerning the validity and appropriateness of the data to the research aims. The SMEs were also asked to validate the researcher's interpretation of the data, which were reflected in the data displays (or formalisms). Using a theoretical lens to frame the study provided an additional validation test. For instance, the findings were deemed generalisable because the research propositions confirmed their

significance to extend an existing theory (organisation change theory). Moreover, the researcher argues that the propositions may unequivocally be extended to other industries or cases, adding to the eternal validity of the research findings (Creswell 2009; Maxwell 2005; Yin 2009). This aspect is particularly relevant to those organisations that have experienced difficulties in relation to organisation change, as identified in the literature and discussed in section 7.2.

Research design reliability was guaranteed by the researcher following protocol to the extent the study may be repeated with the same results (Creswell 2009; Williamson 2000b; Yin 2009). This study maintained a steady and robust passage through the research process. The researcher adhered to the case study protocols with all evidence, data sources, analysis and findings, cross-checked and documented to ensure their reliability. Moreover, scrutinising the research process guaranteed the research could be repeated with the same outcomes. In addition, research design authenticity was achieved by adhering to the SA&D standards throughout the ACT schema and database development processes. This facet is addressed in the following section and discussed in detail in the next chapter.

#### 5.4.4.1 ACT Test, Evaluation and Reliability

As noted, the analysis, design and development phases of the ACT were continuously validated during the research process. For example, the underlying structure of the ACT comprised the data analysis findings, including the formalisms that emanated from the case study research process. As discussed, there was significant rigour in the research process, and the SA&D procedures added another layer of validity and reliability. SA&D system testing was the method used to determine the level of reliability (Burch 1992; Yourdon 1989). Specifically, the black box method (see section 5.3.5.1) was used to trial the ACT to eliminate errors and maximise its reliability. The system testing was twofold. First, the ACT was performance tested against its capacity to satisfy stakeholder requirements (Burch 1992). These requirements were essentially a series of predicted data inputs and information outputs. The Company's

supply-chain procurement process, 'determine method of procurement', was used as the test case to assess the ACT performance.

To that end, the ACT was populated with related test case data to explicitly examine its functionality. The second system test was usability (or acceptance testing). In this instance, alpha acceptance testing (see section 5.3.5.1) was used to assess user satisfaction and to determine the ACT ease of use. Alpha testing mostly focused on the look and feel of a system, assessing the aesthetics of data input screens and report outputs. The SME interviewees formed the user test group and performed the black box and alpha testing. The tests were conducted in the SME work environment and in accordance with SA&D system test principles (see Figure 27 and 28).

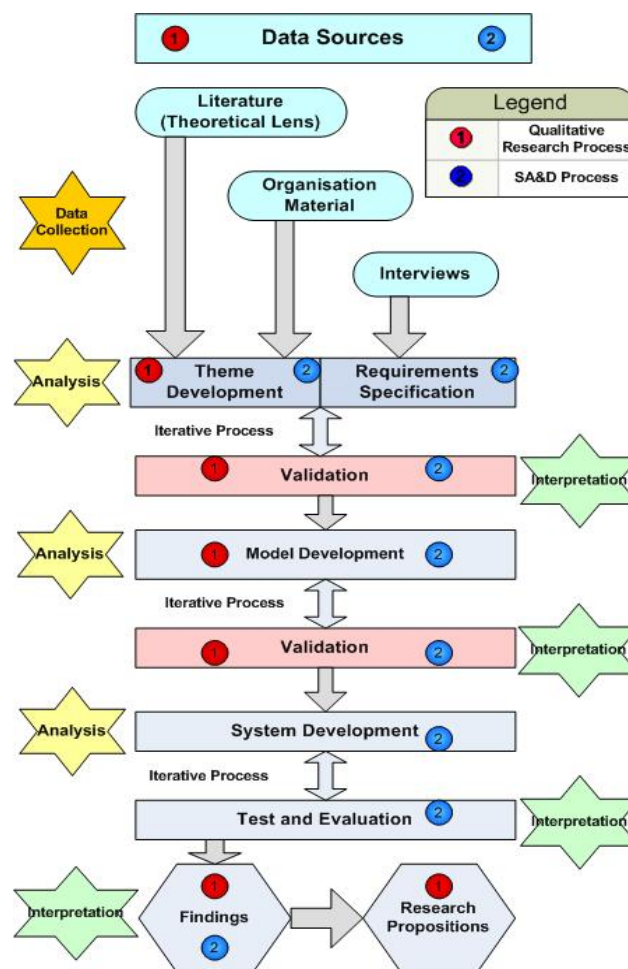
The objective of the tests was to ensure the ACT performed as intended in an operational environment and satisfied stakeholder requirements. Reliability of the SA&D process was guaranteed by documenting the ACT analysis, design and development procedures, together with the test case procedures and results. In addition, double-checking all materials, and adhering to system evaluation outcomes, ensured system credibility and reliability of the SA&D process. Moreover, the applied rigour of the SA&D system test procedures, which embraced stakeholder participation, eliminated the potential for researcher bias. The ACT analysis, design and development process, and test results are fully documented in the next chapter.

#### **5.4.5 Case Findings Interpretation and Reporting**

As noted in section 5.3.6, the case findings interpretation process involved comparing the case data (Company materials, and interview data) against the data assembled from the literature (theoretical lens) (Creswell 2009; Williamson 2000a). Moreover, meaning was drawn from the case data and used to determine gaps or inconsistencies in the literature. The findings were communicated using a mix of narrative and qualitative formalisms; tables, matrices, and high-level and low-level models. The models used to present the findings were commensurate with SA&D practices and reflected the data-centric nature of the ACT. Presenting the findings using a pure narrative approach would not have illustrated the complexity and dynamics of the

change process. Similarly, the meaning of the illustrations might have been lost in the diagram without any narrative to describe the complexities. The case study research process is shown at Figure 30.

This research was exploratory and framed with a theoretical lens; therefore, theory-building was considered a valid means of substantiating the research propositions. The format of the report followed theory-building logic, whereby each chapter contributed and added credibility to the research propositions (Yin 2009). The connection between theory-building and the research propositions is outlined in Chapter 7 where the propositions are clearly stated.



**Figure 30: Case Study Research Process**

## 5.5 Chapter Summary

In this chapter a summary of the key research methods was presented to illustrate the appropriateness of the chosen research approach in the context of the research problem and research aims. In choosing a qualitative (case)



study, the richness, diversity and quality of the data sources, provided an in-depth account of the complexities and dynamics of organisation change. The breadth of the data and the range of knowledge gleaned from the interview participants presented a solid base from which to explore the systemic nature of organisation change. A two-dimensional research approach (combining qualitative research methods with qualitative SA&D practices), increased the robustness of the data analysis and validation processes. Furthermore, the duality of these approaches added rigour to the reliability of the research process, which included the ACT development and testing phases.

This chapter also argued that the research findings were generalisable, from the perspective of extending existing theory, and the application of the findings to other industries or cases. The relationship between the findings and the research propositions were also addressed with theory-building discussed as a valid means of substantiating the research propositions. Finally, the chapter also raised the importance of structuring the research report in accordance with the chosen research design. The qualitative research approach provided some flexibility regarding the report format. The format chosen for this report was theory-building logic and the relevance and justification for its use has been addressed in this chapter. The case study analysis and findings are presented in the next chapter with the research propositions clearly stated in Chapter 7.

## **Chapter 6**

### **Case Study Analysis and Findings**

#### **6.1 Introduction**

This chapter presents the case study data analysis, and findings interpretation processes, with the analysis findings discussed in the context of the research problem, research aims, and research propositions. The results of the research validation and reliability tests - including the outcome of the automated change tool (ACT) evaluation and reliability tests - have been incorporated into this chapter to substantiate the research findings. The analysis process, essentially, comprised three core components. First, the data source materials were analysed to determine the key organisation themes (or change entities) most vulnerable to change. Second, process models were used to assess the impact of the Australian Government's 2008 revised Commonwealth Procurement Guidelines (CPG). The third phase comprised analysis of the key change entities to determine their dynamics and interdependencies. A variety of high-level and low-level models were used for this analysis, which incorporated the ACT development process. The models chosen to perform the analyses were commensurate with systems analysis and design (SA&D) practices, and the data analysis process complied with the single case study guidelines.

This chapter also substantiates the external validity of the research findings and introduces the research propositions, which are addressed in Chapter 7. As noted, qualitative case study data analysis and findings reporting methods were used to explore and validate the key change entities, their dynamics and interdependencies implicated in a complex socio-technical change process. The investigation focused on the Company's supply-chain (logistics) procurement activities, which were impacted by the revised CPG. The case analysis findings were interpreted using a series of tables and models and the significance of these findings are interleaved within the chapter. The case analysis findings summary is presented at section 6.8.

## **6.2 Data Analysis**

Analysis was performed on three data sources; the literature (or theoretical lens), Company materials, and interviews. Some interview outcomes expressed the participants' general observations concerning the Company's supply-chain environment. Other outcomes were a combination of general observations and the participants' experience and perceptions regarding the CPG implementation process. From these data sources the researcher was able to identify the key entities implicated in an organisation change process. While the findings interpretation process drew meaning from comparing the Company and interview findings against the literature findings, the data analysis process was more methodically structured. For example, the Company and literature data sources were initially analysed together to identify change entities and reconcile anomalies (identify gaps and interpret data inconsistencies). Next, the interview data was analysed against the Company and literature source findings using the same approach. This technique enabled the incremental analysis of entities involved in the change process and allowed the identification and comparison of anomalies between each data source. This was an important factor because there were a number of anomalies between the data sources, which otherwise would have remained opaque had an incremental analysis approach not been used.

### **6.2.1 Literature (Theoretical Lens) and Company Data**

The literature (theoretical lens) provided an overview of organisational entities (issues or themes), change management frameworks, and related change tools. The literature initially centred on organisation theory but was extended to cover other theories and sub-theories discussed in Chapters 2 and 3 respectively. As stated earlier, the theories and sub-theories identified in this study were explored in the context of the research problem and research aims. The literature analysis findings identified a number of organisation entities (or recurring themes). The results of the Company data analysis were more specific in identifying the Company's supply-chain key components, especially those involved in the procurement process. A list of the Company materials used in the analysis was provided in section 5.4.2.2. The objective of the data

analysis was, in part, to determine the key organisation change entities. It should be noted here that, from this point forward, the term 'entity' will be used as an interchangeable term for 'issue' or 'theme'.

The literature and Company key entities were compared to identify recurring data patterns and to draw out any additional entities. As noted, triangulation was the approach used to identify and ratify emerging and recurring entities from the data sources. The key entities were categorised using identification by saturation (or recurrence). For example, where an entity appeared across all or most of the data sources, the entity was categorised as a key component. The results of the literature and Company data comparison is illustrated at Table 6, where the recurring entities have been identified as the key organisation entities. The comparison revealed a number of data anomalies, which have been highlighted in red in the same table, with their meaning explained in the following section.

Key Entity	Literature	Company Material
Process ( <i>Function Hierarchy</i> )	x	x
Constraint ( <i>Policy Hierarchy</i> )	x	x
Strategies	x	x
People	x	
Role		x
Authority	x	x
Responsibility		x
Systems	x	x
Contracts		x
Projects	x	x
Costs		x
Competencies	x	x
Soft Factors	x	
Governance	x	x
Group ( <i>Hierarchy</i> )	x	x
Compliance	x	x
Training		x

**Table 6: Key Organisation Entities**

#### 6.2.1.1 Data (Entity) Comparison

*Process (Function Hierarchy)* - the 'process' hierarchy was identified as an irregularity because the literature described the entity 'process' in a number of different of ways. For example, function, procedure and activity were used as

interchangeable terms to describe a [business] process. Conversely, the Company's operations were underpinned by a complex process hierarchy. As noted, the process hierarchy covered multiple functions, processes, sub-processes, procedures, activities and tasks. The hierarchy had been in place for some time owing to the many supply-chain projects that had scrutinised and process-mapped its operations. An example of the Company's process hierarchy is illustrated at Table 4, Chapter 4.

*Constraint (Policy Hierarchy)* - the literature considered the entity 'constraint' an interchangeable term for 'policy', 'rule', 'standard', 'regulation' or 'law', to name but some. In contrast, the Company had an established constraint (or policy) hierarchy, which included; Commonwealth Government legislation, State and local government by-laws, policies, rules, regulations, standards, various document controls, and related clauses. Therefore, the entity 'constraint' was considered an anomaly.

*People, Role, Authority and Responsibility* - these entities were identified as anomalies because the literature mostly referred to people (or employees) as an object against which data was stored. Further, the term 'people' was often used as a collective term to describe an organisational component. Alternatively, the Company data did not reference the entity 'people' as a single object but viewed people in terms of their roles (position title), and their authority and responsibilities (secondary roles). While the literature referred to 'authority' as a core entity, it was not defined as a responsibility, but used interchangeably with the entity 'people'. The Company's artefacts (systems) revealed that, for administrative purposes (the need to recognise a single data instance), the entities 'role' and 'responsibility' were mapped to a 'position\_id' (see section 3.6.3 for an explanation on unique identifiers for data storage and retrieval). The entity 'position' was not prevalent in the Company materials, partially because the area of investigation was the logistics (supply-chain) environment. Had the researcher explored the Company's human resource processes then perhaps the entity 'position' would have emerged as a key organisation component.

*Contracts and Costs* – the literature failed to identify ‘contracts and ‘costs’ as core entities. However, the Company materials repeatedly referenced these entities as critical organisation components; therefore, they were categorised as anomalies.

*Soft Factors* - the literature referenced ‘soft factors’ as a core entity, especially in decision and change theory, but the entity was absent from the Company materials.

*Group (Hierarchy)* – ‘group’ (or organisation) was another irregularity where the literature identified organisation as an interchangeable term to describe a division, department etc. The Company’s group hierarchy identified the ‘executive’, ‘group’, ‘division’, ‘branch’, ‘directorate’ and ‘unit’ or ‘SPO’ levels, as organisation components.

*Training* – the entity ‘training’ was omitted from the literature but widely promulgated throughout the Company materials as a key organisation component. This may have been attributed to the Company’s reliance on supply-chain training programs to support its operations.

### **6.2.2 Interview Data**

As noted, the interview schedules were shaped using the literature and Company data analysis findings. The objective of the interviews was to corroborate the literature and Company entity findings and identify any emerging entities. The interview data was drawn from the participants’ organisation change experience generally, and in some instances, captured their experiences in relation to the CPG implementation process. As discussed, the triangulation method was used to corroborate the entities derived from the literature, Company, and interview materials, and to identify and reconcile entity anomalies. The interview data identified a number of critical issues that emerged as a consequence of the CPG changes and the Company’s change programs generally. A comparison of the literature, Company and interview findings is presented at Table 7, with the derived entities identified as the key organisation change entities. The data anomaly remediation procedure is explained in the following section.

Key Entity	Literature	Company Material	Interview Data
Process ( <i>Function Hierarchy</i> )	x	x	x
Constraint ( <i>Policy Hierarchy</i> )	x	x	x
Strategies	x	x	x
People	x		
Role		x	x
Authority	x	x	x
Responsibility		x	x
Systems	x	x	x
Contracts		x	x
Projects	x	x	x
Costs		x	x
Competencies	x	x	x
Soft Factors	x		x
Governance	x	x	x
Group ( <i>Hierarchy</i> )	x	x	x
Compliance	x	x	x
Training		x	x

**Table 7: Key Organisation Change Entities**

#### 6.2.2.1 Data (Entity) Comparison Remediation

The literature, Company and interview data comparison resolved a number of data (entity) anomalies. These anomalies were remediated using the same process applied to the literature and Company data comparison, whereby entities were identified through their saturation (or recurrence) across the data. Therefore, the data anomalies were remediated as follows.

*Process (Function Hierarchy)* – the interview data confirmed the process hierarchy. Therefore, the term ‘process’ was considered the key entity and was representative of a number of related sub-entities; procedures, activities and tasks, for example.

*Constraint (Policy Hierarchy)* – similarly, the interview data supported the ‘constraint’ hierarchy; therefore, ‘constraint’ was deemed the key entity and was representative of the sub-entities; ‘policy’, ‘rule’, ‘standard’, ‘regulation’ or ‘law’, to name but some.

*People, Role, Authority and Responsibility* – the interview data indicated that the entity ‘people’ should be subsumed by the key entities; ‘role’ and ‘responsibility’ (see data normalisation section 3.6.3). In addition, the data revealed that the entity ‘authority’ was an attribute of the entity ‘responsibility’

rather than a key entity itself. Therefore, ‘authority’ was subsumed by the entity ‘responsibility’.

*Contracts and Costs* – the interview data confirmed these entities were critical organisation components.

*Soft Factors* - the interview data confirmed the entity ‘soft factors’ was a critical organisation component.

*Group (Hierarchy)* – the interview data defined ‘group’ as the key entity, which was representative of a number of related sub-entities; ‘executive’, ‘division’, ‘branch’, ‘directorate’ and ‘unit’ or ‘SPO’, for example.

*Training* – the interview data confirmed the entity ‘training’ was a key organisation component.

The refined key organisation change entities, which are the product of the literature, Company, and interview data comparisons, are presented in Table 8.

Key Entity	Literature	Company Data	Interview Data
Process ( <i>Hierarchy</i> )	x	x	x
Constraint ( <i>Hierarchy</i> )	x	x	x
Strategies	x	x	x
Role		x	x
Responsibility		x	x
Systems	x	x	x
Contracts		x	x
Projects	x	x	x
Costs		x	x
Competencies	x	x	x
Soft Factors	x		x
Governance	x	x	x
Group ( <i>Hierarchy</i> )	x	x	x
Compliance	x	x	x
Training		x	x

**Table 8: Refined Key Organisation Change Entities**

### 6.3 CPG Implementation Analysis

As noted, a variety of data displays (models) were used to illustrate the Company’s CPG implementation process and to substantiate the key organisation change entities identified from the analysis findings. Two high-



level process models were used to map the CPG implementation process. Those models included a cross-functional process model (CFPM), which was used to map the CPG activities, and a cross-functional decision model (CFDM), which mapped the related decision process.

The first objective was to modularise and identify the entities impacted by the CPG process. As stated in section 3.6.1 process models were used, in part, to modularise a system (or objects) into manageable parts (Burch 1992). Process models were also used to map complex designs where there was a need to simulate multiple organisation levels and functions (or events) within an environment (Bernus 2003a). In addition, process modelling had been used to reduce complexity and increase simplicity through the recognition of objects or parts, and information flows (Burch 1992). The CFPM is shown at Figure 31 with the CFDM illustrated at Figure 32. The details of each CPG implementation activity, describing the parties involved their roles and responsibilities, and the implications (or impact) of the activities - including related decision outcomes - is enclosed at Appendix 1. The CPG CFPM and CFDM implementation analysis findings are discussed at section 6.3.3.

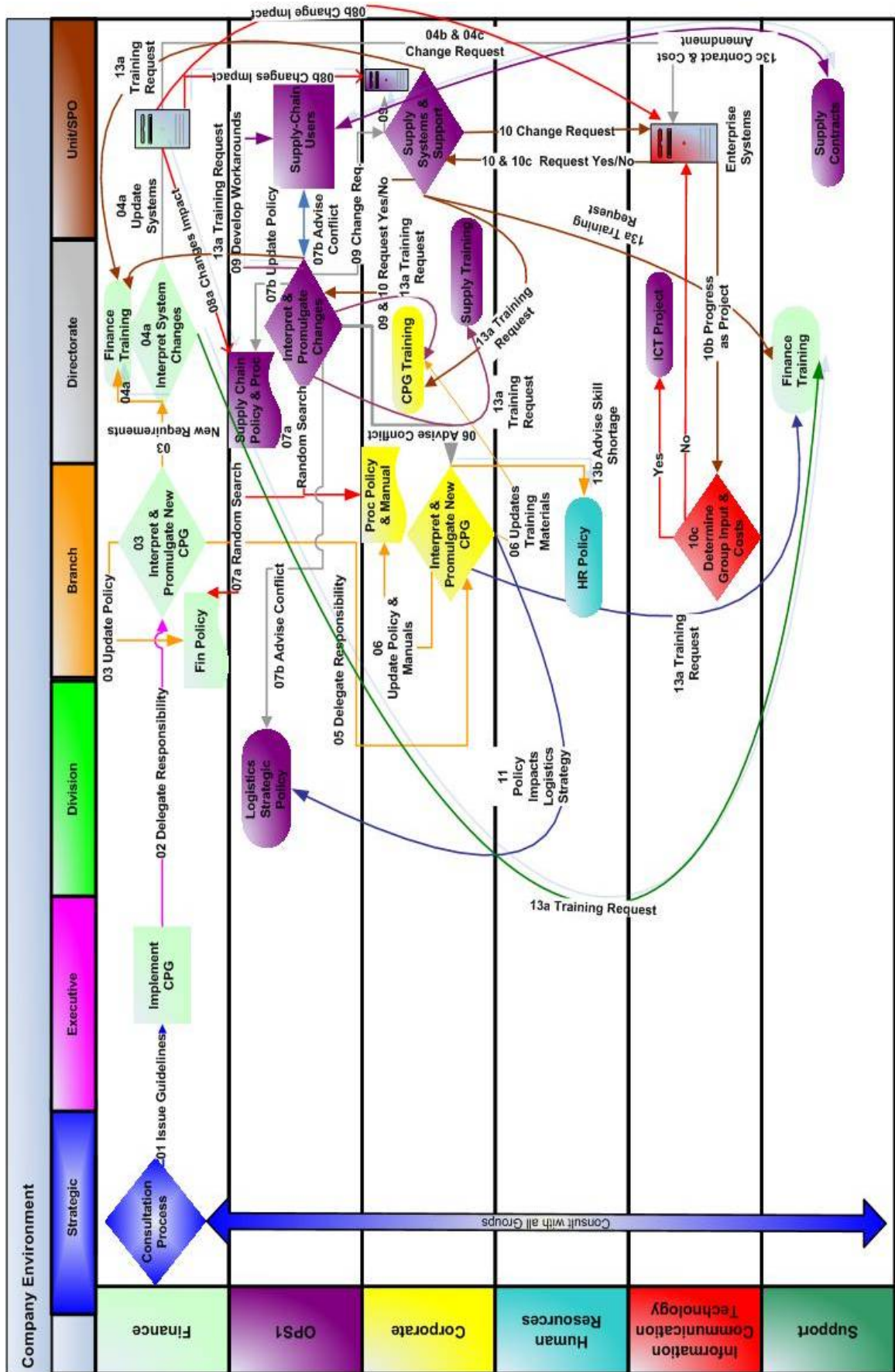


Figure 31: CPG CFPM

### **6.3.1 The CPG CFPM**

A CFPM was used to capture and map the Company's CPG implementation activities. The CFPM mappings revealed a number of these activities had severely impacted the following Company supply-chain entities; processes, policies, systems, roles and responsibilities, to name but some. What follows is a summary of the key issues taken from Figure 31, which are discussed in detail at Appendix 1:

- changes to existing contract and procurement processes translated to major supply-system changes, which needed to be managed as projects;
- supply-system changes were authorised (or not) without notifying supply-chain stakeholders leading to misalignment of policies, processes and system interfaces;
- conflict between existing supply-chain policy and processes, and new CPG requirements resulted in user confusion leading to productivity loss;
- revised training manuals and competency requirements were unavailable (or overlooked) making it impossible to execute the new CPG activities and tasks;
- contract change requests were needed to accommodate additional workflows, which incurred considerable costs;
- stakeholders were not consulted prior to the CPG subsequent policy development and implementation, which resulted in supply-chain workflow anomalies; and
- stakeholders were not notified of pending policy changes or new policies resulting in chaos.

### **6.3.2 The CPG CFDM**

A CFDM was used to map the CPG decision process to determine the related decision activities, and the implications of the decision-making process. The CFDM revealed a chain-reaction of related decision events had severely impacted the Company's supply-chain operations. The CFDM, illustrated at Figure 32, shows the Company's behavioural characteristics in terms of the

groups, roles and responsibilities involved in the CPG decision-making process. These characteristics are discussed in detail in Appendix 1, with a summary of the key issues described as follows:

- the group CEO (or group head) was the enterprise authority and systems owner with exceptions to this rule stated as required;
- the divisional (div) heads had responsibility for their respective divisional internal policy and the promulgation of all other policies;
- branch heads had responsibility for their respective policies (SOPs) and the interpretation and implementation of internal and external processes (exceptions to this rule have been identified as required);
- directors were tasked with implementing all processes and procedures, with users relying on procedures, and systems transactions to perform their activities;
- the double-ended light blue arrows on the left-hand column of the model shows there is collaboration and feedback within the group hierarchy, which may be formal or informal; and
- the single-ended red arrow on the left-hand column of the model demonstrates the absence of any collaboration or feedback within the group hierarchy, and indicates a push and control approach.

The Company's committee roles and responsibilities were not included in the CFDM because of the number involved in the decision process, and the limited timeframe available to map their activities. However, the role of the committees and their numbers were covered in Chapter 4. The CFDM is a high-level representation of the Company's groups and their activities. Chapter 4 provided a detailed account of the Company's design and its components.



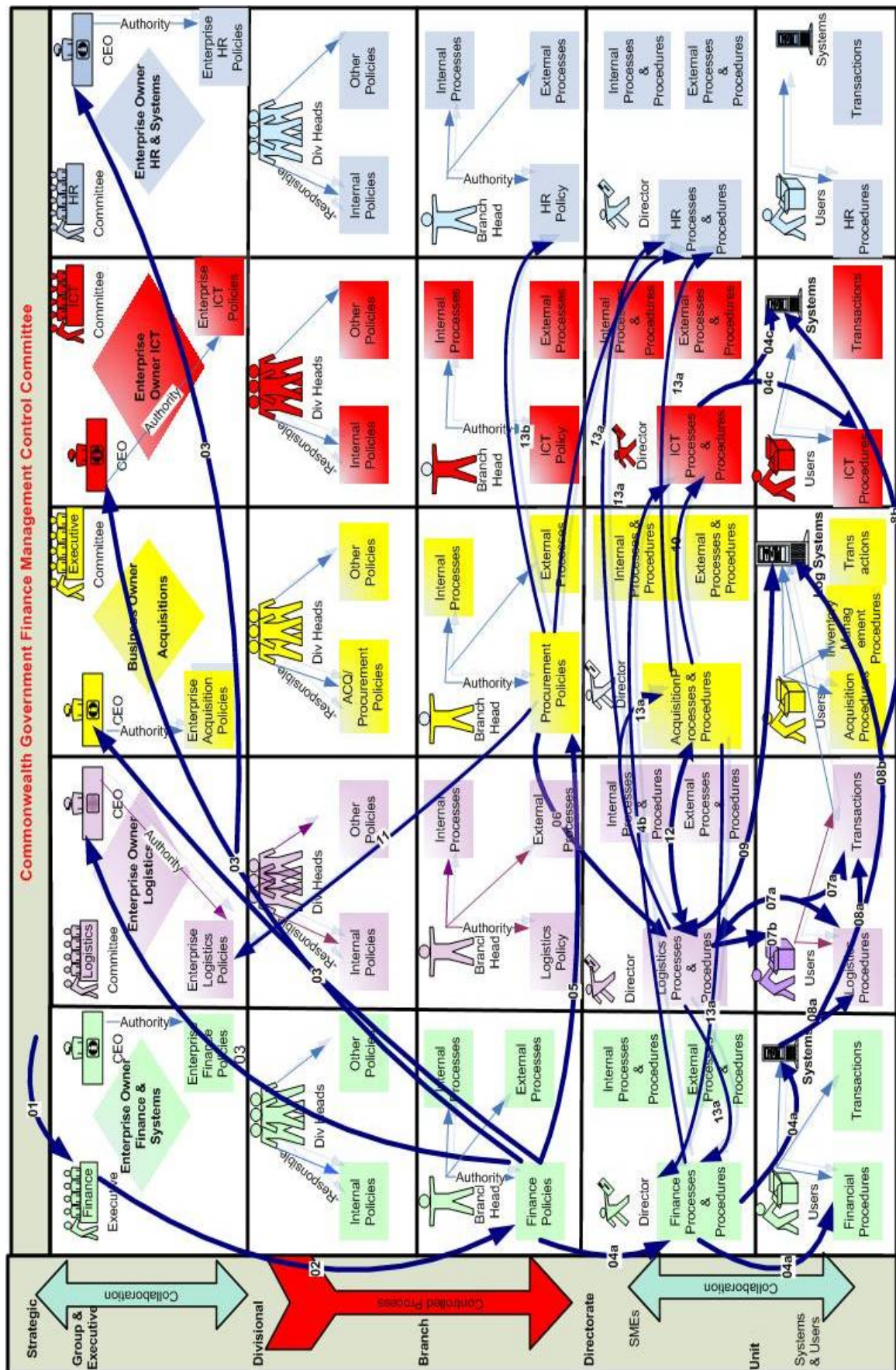


Figure 32: CPG CFDM

### **6.3.3 CPG Implementation Analysis Findings**

The CFPM and CFDM analysis findings confirmed that most of the activities originating from the 2008 CPG implementation process were concentrated at the Company's operational levels. These were the activities performed at the branch level and below. The ensuing organisation changes affected various activities across the Company's supply-chain. Notable was the fact that formal organisational consultation and feedback regarding the CPG implementation process occurred at the strategic level only. At this level high-level decisions were formulated then delegated to the group(s) for execution as policy. At the operational level, where policies become processes, consultation was ad hoc and generally occurred as a consequence of a change reaction. Overall, there was a distinct lack of formal feedback loops within the operational levels, and between the strategic and operations levels. Inadvertently there were various groups within the Company making decisions or taking actions that ultimately affected the supply-chain environment and often with insurmountable outcomes.

For example, 'Activity 03', shown at Figures 31 and 32, illustrates the Financial Controls Framework Branch (FCFB) role in interpreting the revised CPG, where they formulated and promulgated Company-wide procurement-related financial policy changes. Next, the Finance Systems Directorate (FSD) (shown at 'Activity 04a' and labelled 'Interpret System Changes') considered the policy changes and actioned a systems change request. The change request was forwarded to the Finance Processes and Procedures Directorate (FP&PD) (also shown as 'Activity 04a') who performed the required procedural and system transaction changes. In addition, the FP&PD forwarded a change request to the information communication technology (ICT) Processes and Procedure Branch (P&PB) (shown at activity '04b') to make the required system module changes.

However, an unforeseen consequence of these activities was that users of the supply-system were unable to raise invoices through the finance system and, hence, could not complete their orders. As noted, while workarounds were found to overcome these changes, these were temporary solutions and usually

resulted in users having to rely on a manual upload of data between the enterprise systems. Some of the workarounds had been in place for two years or more, which had raised the workloads of supply-system users and lowered work-rate efficiencies. Further, users had to retain a paper trail for each transaction for audit purposes, causing an additional burden. In some instances, the finance system changes had triggered a major rebuild of the supply-system, which cost the Company millions of dollars.

The most intriguing aspect of the CPG implementation findings was the involvement of various groups in the Company's logistics (supply) activities. The complexity of these arrangements were addressed in section 4.5 and illustrated at Table 5. The diversity of these arrangements presented a major challenge for the Company, with the situation further exasperated under the CPG implementation process. Modelling the CPG process highlighted these issues, and foremost, identified those entities most affected by the change. The entities impacted were socio-technical components in that there were people, skills, authority, processes, and systems etc, involved in the change process. The CPG CFPM and CFDM models were constructive in providing a practical insight into the Company's character and mechanics, especially in a change environment. Triangulation analysis was used to draw the data from these models and compare the outcome with the literature, Company and interview findings. Through this process a number of gaps (or entity anomalies) emerged, which were remediated in accordance with the procedures identified at sections 6.2.1.1 and 6.2.2.1, through saturation (or reoccurrence) of the entities across the CPG models. The results of the literature, Company, interview and CPG data comparison is shown at Table 9 and discussed in the following section.

The CPG findings provide a valuable and reliable information source; moreover, the overall outcome has identified a number of shortfalls in organisation change theory. This aspect forms part of the research propositions and is discussed in Chapter 7. The models used in the CPG analysis process were validated in accordance with SA&D practices (see

section 3.6.1), and qualitative case study validation and reliability procedures discussed at section 5.3.5.

#### **6.3.4 CPG Data Comparison Remediation**

The results of the CFPM and CFDM analysis validated the literature, Company and interview analysis findings by authenticating the key organisation change entities. More important, the model analyses were based on a practical example of an organisation change process. The CPG implementation data analysis revealed additional data (entity) anomalies. For example, the entities 'soft factors', 'compliance' and 'governance' were noticeably absent from the CPG activities. As noted, the rationale for eliciting entities, from a SA&D viewpoint, was for the purpose of determining data recording and storage needs. While 'soft factors', 'compliance', and 'governance' were confirmed key organisation change issues, they were not considered data entities from an SA&D perspective. Consequently, the researcher made the decision to omit 'soft factors', 'compliance' and 'governance' as data candidates, electing instead to build these criteria into the ACT functionality. The benefits of this approach are discussed in section 6.4.2.1.

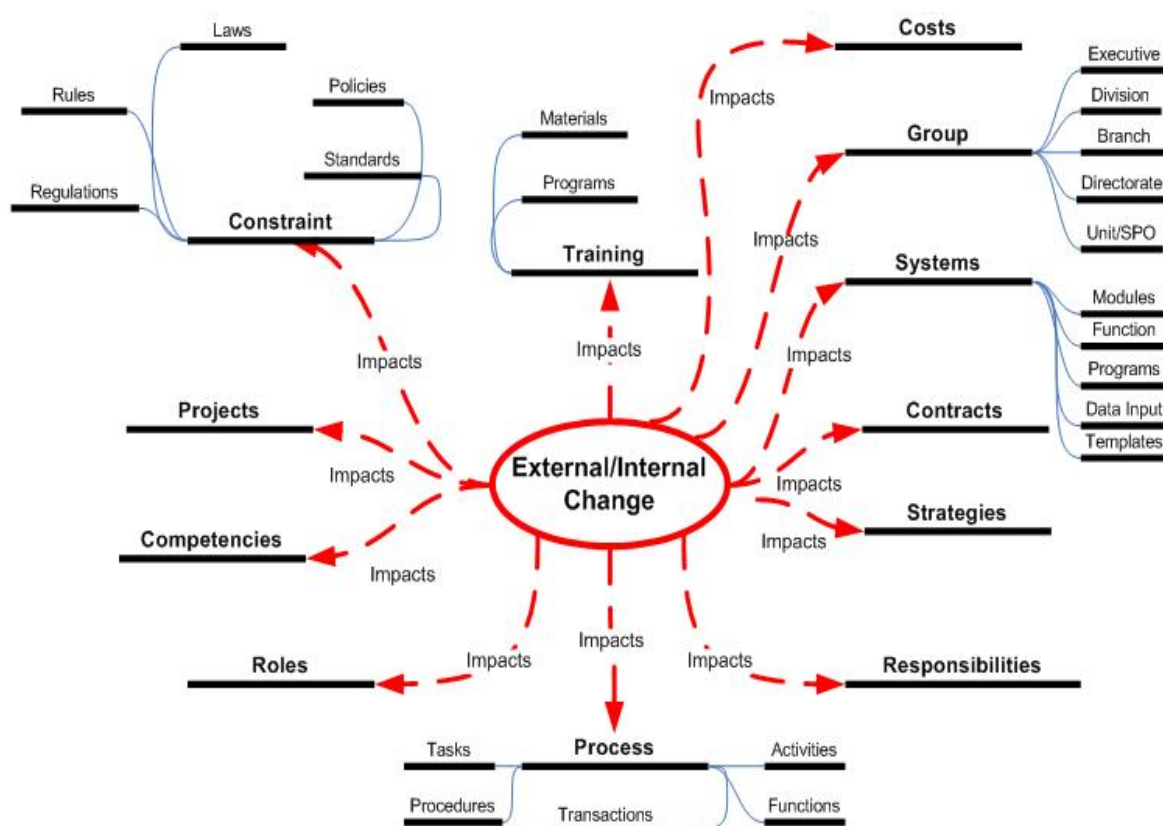
The entity 'training' was also identified as an anomaly because the CPG data revealed these changes impacted multiple training programs and materials. Therefore, 'training' was classified as an entity hierarchy incorporating training programs and materials as sub-entities. Similarly, the data showed the entity 'systems' was a hierarchical structure, comprising independent, but related, components; 'modules', 'programs', 'templates', for example. Therefore, these components were categorised as 'system' sub-entities. The key organisation change entities and sub-entities are shown at Table 9. The table title was amended to mirror the entity layers involved in the change process and to better reflect the context of the findings.



Key Entity	Literature	Company Data	Interview Data	CPG Data
Process (Hierarchy)	X	X	X	X
Constraint (Hierarchy)	X	X	X	X
Strategies	X	X	X	X
Role		X	X	X
Responsibility		X	X	X
Systems (Hierarchy)	X	X	X	X
Contracts		X	X	X
Projects	X	X	X	X
Costs		X	X	X
Competencies	X	X	X	X
Soft Factors	X		X	
Governance	X	X	X	
Group (Hierarchy)	X	X	X	X
Compliance	X	X	X	
Training (Hierarchy)		X	X	X

**Table 9: Key Organisation Change Entities and Sub-Entities**

An illustrative layered model shown at Figure 33 was used to reflect the key organisation change entities and sub-entities. These were the organisation components considered most vulnerable to change.



**Figure 33: Key Organisation Change Entities and Sub-Entities**

#### **6.4 Automated Change Tool (ACT) Analysis & Development Process**

As discussed, this research proposed that efficient and effective organisation change management practices required the support of an automated solution (or decision tool). Chapter 3 demonstrated the merits of modelling tools to illustrate organisation components and their interdependencies. The relevance of these formalisms as information systems (IS) development instruments was also justified. The rationale of the models used to design and develop the ACT was demonstrated in the example described in Chapter 3. This section describes the application of those models to the research problem, with reference to Chapter 3 used to qualify the purpose of the model.

The elicitation of user requirements was a core part of the ACT design and development process. For instance, the requirements were drawn from the data analysis findings, and were validated in accordance with the SA&D and qualitative case study methods. The user requirements were based on a series of stakeholder predetermined data inputs and information outputs, which are outlined as follows:

1. The system should provide a report listing policies (including) all relevant sections and related tasks that may be impacted by a change event (UR1).
2. The system should allow subject matter experts (SMEs) to update (delete, modify or add) information relating to organisation components (UR2).
3. The system should predict all system components (including user interfaces), affected by a change event, and list all related tasks and responsible parties (UR3).
4. The system should identify all organisation responsibility demarcations (UR4a, b & c).
5. The system should provide a report outlining all training programs and materials, and related tasks and responsibilities impacted by a change process (UR5).
6. The system should be automated and provide predictive reports on demand, as required (UR6).

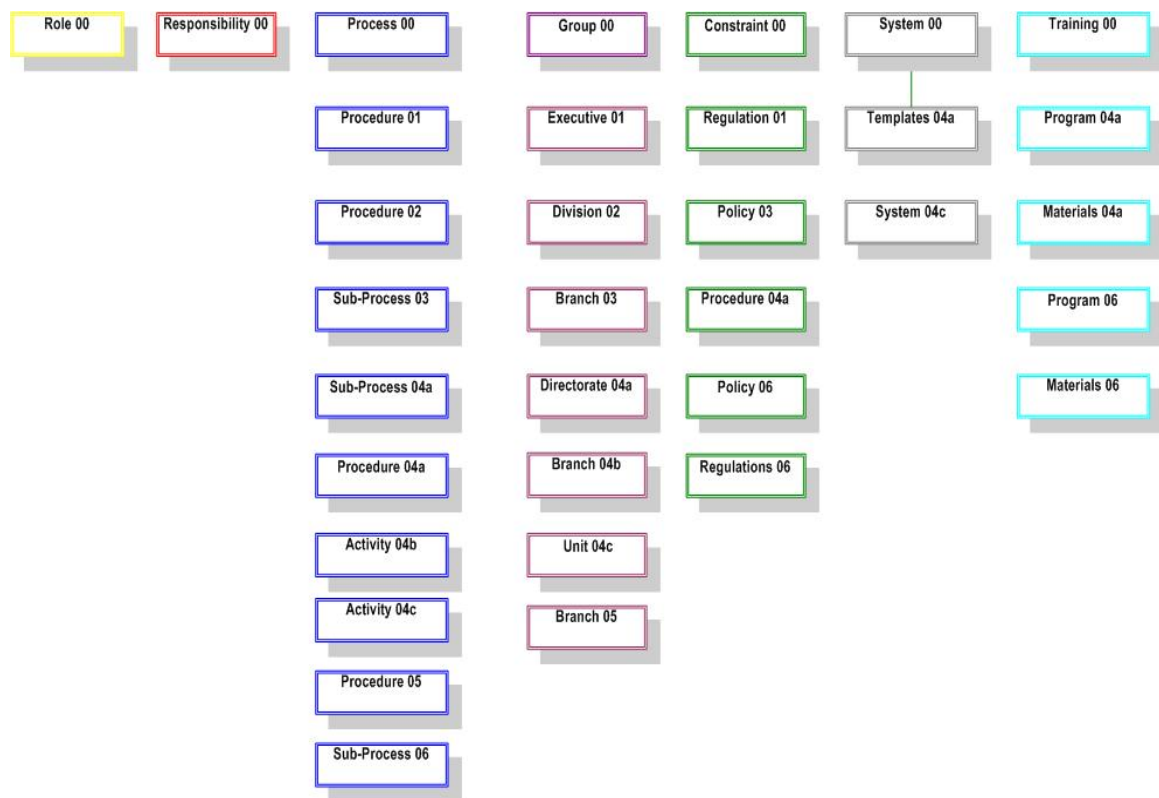
7. The system should be able to measure and predict the overall organisation change impact arising from a change event (UR7).

#### **6.4.1 ACT Hierarchical Model Analysis**

The key organisation change entities and sub-entities shown at Figure 33 underpinned the design and development of the ACT. Although the process model was considered a logical step in SA&D (Burch 1992; Yourdon 1989), it was limited in its ability to capture the organisation sub-entity (or sub-system) interdependencies.

##### **6.4.1.1 ACT Hierarchical Function Model**

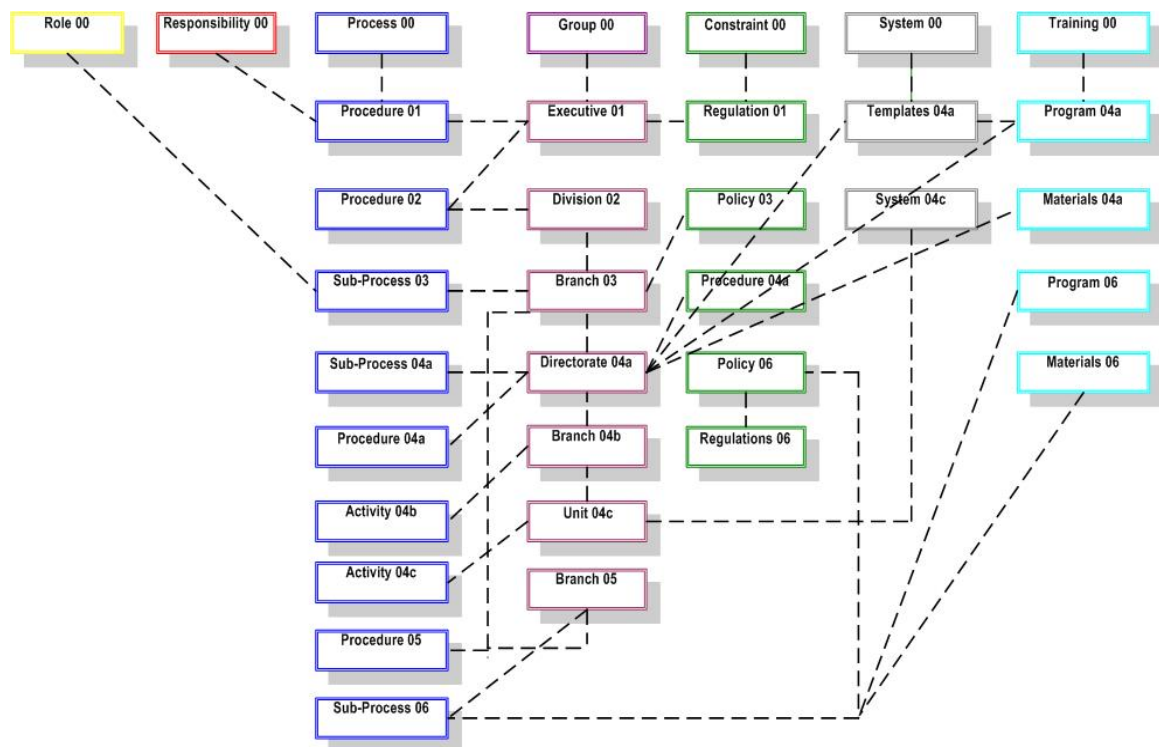
A high-level hierarchical function model illustrated at Figure 34 was used to group the key organisation change entities and sub-entities into their respective hierarchy relationships. Using an example taken from the CPG activities defined in Figures 31 and 32, this model illustrates the diversity of the key change entities involved in an organisation change process. The entities illustrated in the model are numbered in accordance with the sample CPG activities. A similar exercise was detailed in Chapter 3 to demonstrate the value of grouping the entities and sub-entities involved in an organisation process. However, given the number of entities and sub-entities involved in an activity i.e. process, procedure, activity, and systems, programs, modules and templates, for example, the entity interdependencies remained vague. A more complex formalism was needed to determine the key organisation change entity and sub-entity interdependencies.



**Figure 34: ACT Hierarchical Function Model**

#### 6.4.1.2 ACT Hierarchical Network Model

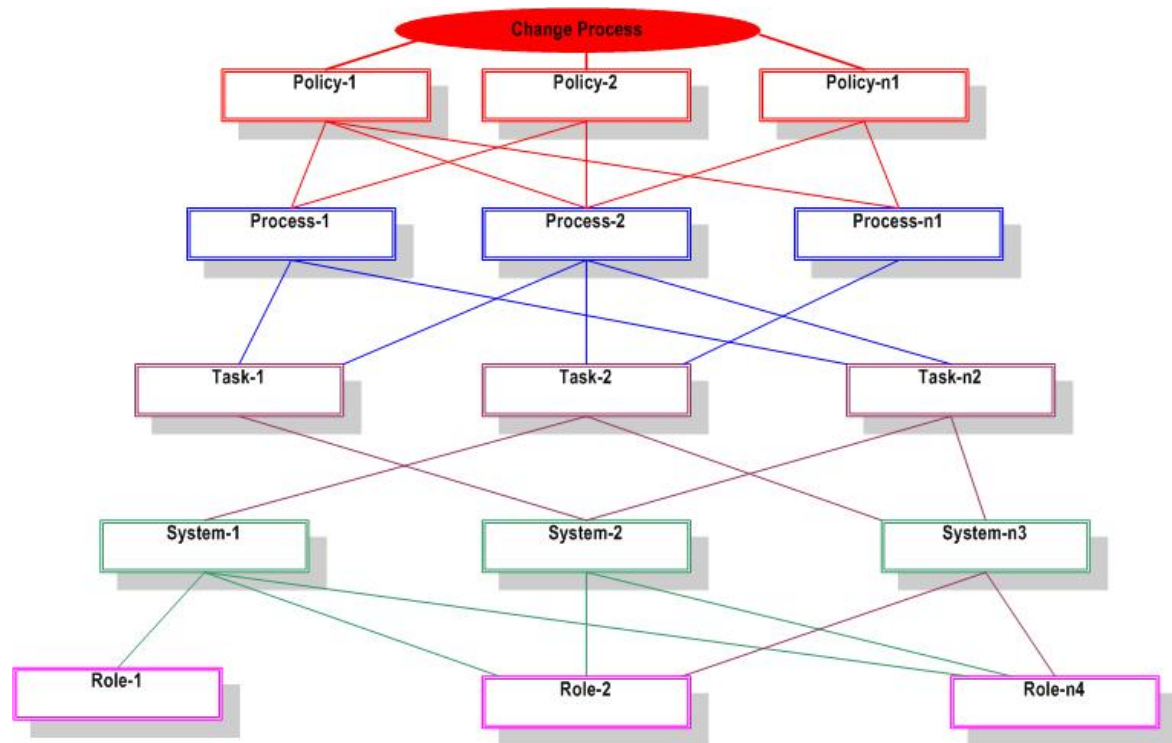
The hierarchical network model illustrated at Figure 35 was used to demonstrate the complexity of the ACT entity and sub-entity interdependencies. This model represents the entity interdependencies as multiple parties (entities) and sub-levels (sub-entities) involved in a change activity. A similar exercise was described in Chapter 3 to typify the phenomenon of multi-level intersecting entities. Although the activities used in the example are incomplete, the diversity and complexity of the interfaces have been demonstrated. As noted, the entity and sub-entity interdependency analysis must be repeated for each activity identified. The level of complexity and dynamics increases exponentially with the number of entity instances and sub-levels involved in an activity (or event). The CPG implementation process presented a solid example from which to examine the impact of organisation change and its complexity



**Figure 35: ACT Hierarchical Network Model**

#### 6.4.1.3 ACT Network Impact Analysis Model

Another method of examining the entity and sub-entity interdependencies was through a network impact analysis. This analysis was performed from a CPG implementation policy perspective. The CPG network impact analysis findings are shown at Figure 36 where the model provides a more intricate view of the systemic change impact. In this example, the CPG implementation process has impacted Policy-1, which in turn impacted Process-1, Process-2, and Process-n1. Similarly, Policy-2 impacted Process-1, and Process-2. Policy-n1 impacted on Process-2 and Process-n1. Process-1 comprises a number of tasks (Task-1 and Task-n2, as identified in Figure 36). Each entity and sub-entity has to be analysed to determine any policy change impact. Further, other derived changes, a process change for example, has to be analysed to the same level of detail. This analysis has to be repeated for each policy and, moreover, analysis must continue down through the system and role levels. Add the fact that there are also interactions at each level (e.g. a policy may impact on other policies, processes may impact on other processes etc), and level of complexity is clearly identifiable.



**Figure 36: ACT Network Impact Analysis**

A selection of high-level qualitative model formalisms enabled the key organisation change entities to be compiled into complex interdependencies. Although the formalisms described in this section defined and illustrated the interfaces between the multiple entities and entity sub-levels, they were limited in their capacity to capture the dynamics of the entity interdependencies. As discussed in section 3.6.2 the practice of identifying and illustrating dynamic interdependencies was better suited to low-level models, an entity relational (ER) model (or diagram) (ERD), for example.

#### **6.4.2 ACT Entity Relationship (ER) Model Analysis**

Chapter 3 discussed the value of ER models to identify the dynamics of the entity and sub-entity interdependencies. In addition, their ability to capture the lowest sub-entity intersecting point, or lowest measurable unit of change was also addressed. Entity relationships were described as interdependencies defined in terms of an organisation's business rules (or constraints) (Bagui & Earp 2003; Chen, P 1977; Mayer, Painter & Lingineni 1995; Yourdon 1989). ER modelling conventions were the techniques used to define relationship cardinality and enforce business rules (Bagui & Earp 2003; Chen, P 1983a; Khan, Kapurubandara & Chadha 2004; Simsion 2001). ER conventions were

mostly software dependent, and the modelling conventions chosen for this study were noted in section 3.6.3. The ERD was a low-level modelling instrument that abstracted, described, and logically portrayed data and data relationships, generally with a view of mapping to a physical database (Bagui & Earp 2003; Bernus 2003a; Chen, C, Song & Zhu 2007; Chen, P 1977, 1983a). Consequently, an ERD was used to map the key organisation change entities (and sub-entity) dynamic interdependencies illustrated at Figure 33.

Given the intent of the study was to translate the ERD into a physical database, and in light of the study's time restrictions, the key change entities were rationalised to reflect the stakeholders' most urgent requirements. Consideration was also given to the time already taken to source the data, and the period required to source additional data, to populate the database if all entities were included in the ACT design. The stakeholders unanimously agreed that the following entities would be omitted and reserved for future research:

- cost (deemed critical to assess the impact of change but the data required to fulfil the requirement was a project in itself);
- project (there was no data available mapping a project to a change instance);
- contract (this too was considered a vital issue but again, there was no explicit Company data available that specified which contracts had been affected by change); and
- strategies (this entity was omitted for the same reason – there was no Company data to support the policy-to-strategy hierarchy).

#### 6.4.2.1 ACT Logical Model (Schema) Analysis

The key organisation change entities (and sub-entities) were mapped using a low-level ERD, which was identified as the ACT logical model (or schema). The ACT logical schema was developed in accordance with the ERD method described in section 3.6.3, and represents the key organisation change entities and sub-entity dynamics and interdependencies involved in a change process. The ACT logical schema is shown at Figure 37. The ACT logical schema reflects the Company's business rules, and includes additional rules identified

from the data analysis findings, required for an effective change management solution. The core business rules were gleaned mostly from the Company, interview, and CPG implementation analysis findings, in addition to the user requirements specifications, and to some extent, the literature findings. An example of the business rules that have been incorporated into the ACT logical schema is illustrated at Figure 38. Their application and benefits are summarised at Table 10.

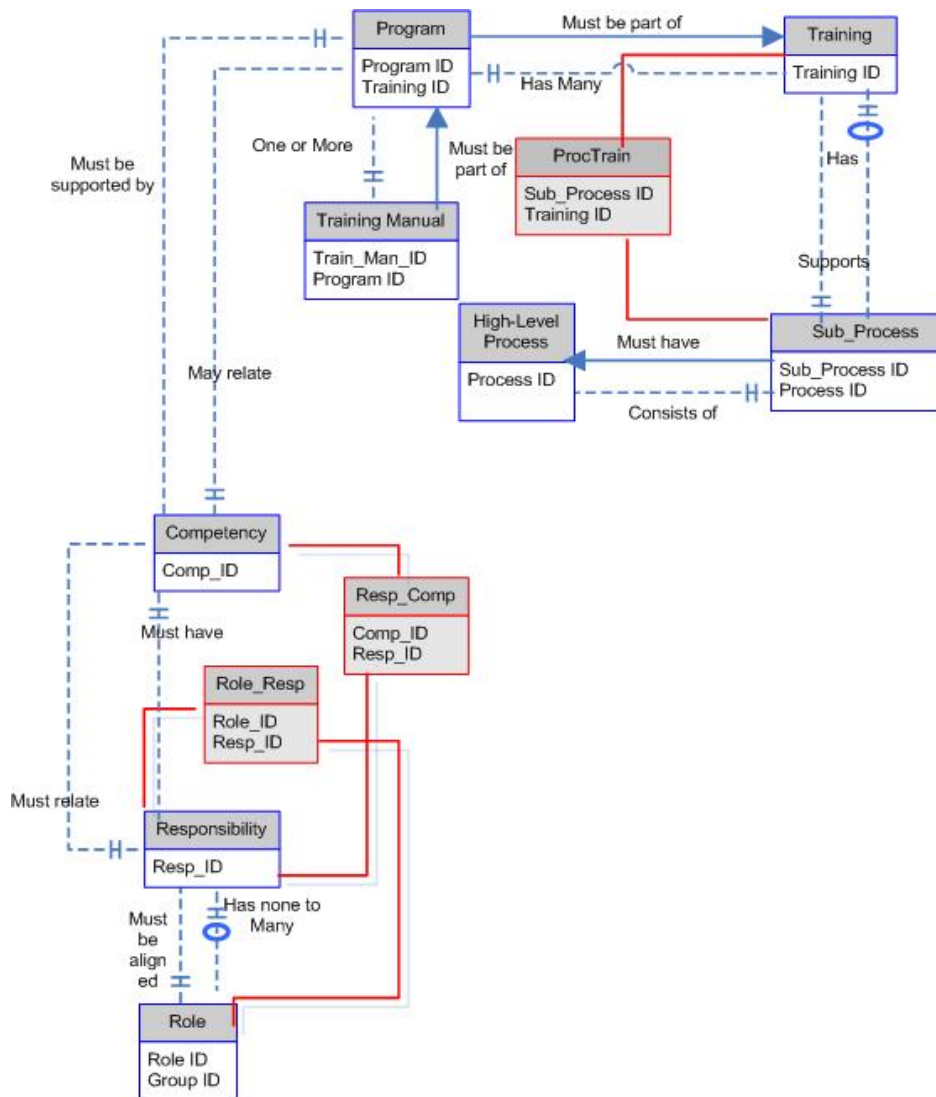
Incorporating business rules into the ACT logical schema presented an opportunity to address the Company's change management program shortfalls. For instance, building business rules into the ACT data structures had the benefit of predicting those entities most vulnerable to a change process. Another benefit was the potential to alleviate soft factors (or human subjectiveness) in relation to organisation change decision-making. This aspect is explored later in this chapter.

Entity	Benefit
'Responsibility' must be aligned with a specific role.	Change targets can be readily identified and potential workflow impacts remediated.
'Competency' (or skill) must relate to a 'responsibility' & 'responsibility' must be supported by a 'competency'.	Where change affects skill-sets, targets can be identified and the situation addressed.
'Competencies' must be supported by a [training] 'program'.	Training programs can be revised or implemented where skill-sets are impacted by change.
A [training] 'program' must be part of a 'training' module.	The training programs impacted can be quickly identified and amended, accordingly.
A 'training manual' must be part of a [training] 'program'.	Where a training module or training program has been amended, identifying all associated materials will ensure training materials remain current and relevant.
A 'training module' must support a 'sub-process' (or other process hierarchy components).	Where a process has been/will (be) impacted by change, identifying the related training module will provide a speedy turn-around time for remedial action.
A 'sub-process' must relate to a 'high-level process' (or function).	Where a high-level process has/will (be) changed, the identification of other activities that may be impacted, and the extent of the change, can be easily assessed.

**Table 10: ACT Logical Schema Business Rule Summary**







**Figure 38: ACT Logical Schema Business Rule Example**

As noted, data normalisation was the process used to identify entity and relationship cardinality (see section 3.6.3). For the most part the ACT logical schema had been normalised to 3NF. Normalisation was performed by reducing data to the lowest denomination or single record instance to ensure data integrity and to avoid redundancy (Burch 1992). Unique entity identifiers (primary keys) were assigned to the ACT logical schema to differentiate entity relationship values (or variables) (Burch 1992; Chen, P 1976; Yourdon 1989). This process formed part of the normalisation process and was performed in accordance with ERD practices. The ACT logical schema was used to document the ACT database design, providing a 'blueprint' outlining the data table arrangements and data storage requirements (Bagui & Earp 2003). As noted, data normalisation was a critical process, especially when mapping from

a logical model to a physical database. In this instance, the process involved mapping the ACT logical schema to the ACT relational database.

#### 6.4.2.2 ACT Physical Model (Meta-Schema) Analysis

Translating the ACT logical schema to the ACT physical database exposed many data redundancy instances. For example, the identification of key entity attributes (see section 3.6.3) revealed evidence of repeating groups and anomalies within the ACT schema. The ACT functionality would have been marginalised had the transition proceeded. Consequently, the key change entities were further analysed to ensure all entities were mutually independent and the entity attributes mutually dependent (Burch 1992; Yourdon 1989). The ACT meta-schema was remediated to ensure it reflected overall third normal form (3NF). The meta-schema is illustrated at Figure 39. An example of the 3NF meta-schema enhancements and their benefits are explained in Table 11.

It is not unusual for conceptual schemas to be continuously tested for completeness and accuracy during the SA&D process; in fact, Tort and Olivé (2010) and Bagui and Earp (2003) considered it good practice. Similarly, the ACT schemas were continuously revised in accordance with SA&D and qualitative case study methods to ensure their reliability.



Entity	Remediation	Benefit
Responsibility	The relationship between 'responsibility' and 'role' was identified as many-to-many. The data was normalised to effect 3NF resulting in a 'role-resp' entity.	The multiple responsibilities associated with a role can be identified as a single data instance. This enables the recording and reporting of specific responsibilities implicated in a change process against a specific role and vis-à-vis.
Competency	The relationship between 'competency' and 'responsibility' was defined as many-to-many. The data was normalised to effect 3NF resulting in a 'resp-comp' entity.	The multiple responsibilities associated with a competency can be identified as a single data instance. This enables the recording and reporting of specific responsibilities implicated in a change process against a specific competency and vice-versa.
Constraint	All constraint products (sub-entities) were mapped to their lowest level or interface, i.e. the policy-product relationship to the relevant sub clause or document paragraph.	Policies were generally identified and grouped at a high level (if at all). In this instance, the precise product and point of impact can be identified at the actual intersecting level

**Table 11: ACT Meta-Schema Enhancements**

Once the ACT meta-schema was fully normalised it was capable of reducing data to the lowest denomination or single record instance. The ACT meta-schema was labelled a meta-schema because it captured the key entities and sub-entities involved in an organisation change process. These components were required to assess the impact of organisation change and to manage the change process itself. The ACT was developed using proprietary software and its architecture is detailed in section 6.6. The ACT model validation and reliability proponents are discussed in the following section.

## **6.5 ACT Model Validation and Reliability**

As stated, the data sources used in this study provided the depth and richness needed to ensure the identification of the entities and interdependencies were objective, accurate, and appropriate to the research aims (Creswell 2009; Williamson 2000b; Yin 2009). The theoretical lens used to frame the study strengthened the external validity of the analysis findings and added robustness to the model analysis process. In addition, the ACT model development process was grounded in an accredited technology theory framework, which ensured reliability of the analysis outcomes. As stated,

triangulation (by saturation) and member checking procedures were the validity tests used in this study (Creswell 2009; Yin 2009). For example, SMEs were continuously solicited for feedback regarding the validity of the entities, interdependencies and information flows over the duration of the model development process.

The development process was iterative, resulting in a number of adjustments having been made to the models to provide an accurate record of events and accommodate stakeholder requests. This process ensured data interpretation was precise and reflected the expertise of the Company's supply-chain stakeholders, whilst retaining a collective view of the Company's change environment. Model generation was systematic and logical, adding to the reliability and vigour of the model analysis process. The validity and reliability of the model development process was also tested under the SA&D systems test, evaluation and reliability procedures, which are discussed in section 6.7.

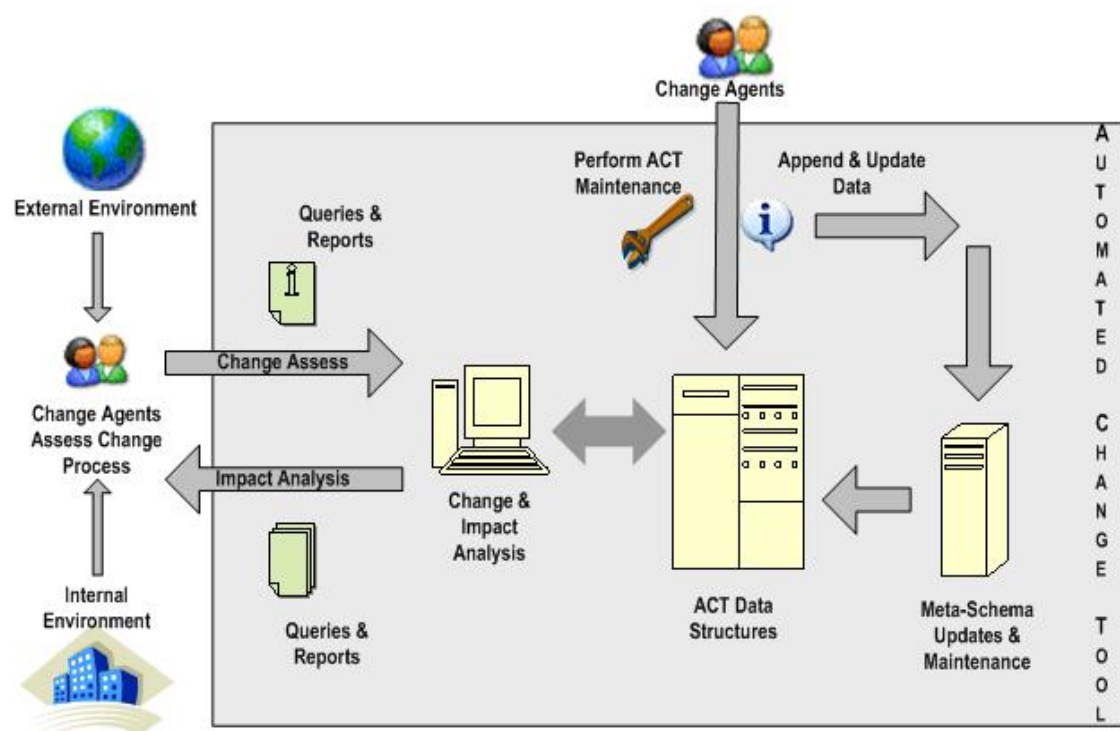
## **6.6 ACT Architecture**

The underlying principle of the ACT was that organisation processes, policies, roles competencies etc. (and their interdependencies) had *generic* properties that were shared across the organisation. For the most part, the Company's policies, roles, systems, competencies etc, were generic components applied across the organisation. However, as discussed in Chapter 4, processes (particularly procurement) proved an exception with some groups having unique acquisition requirements and, hence, were often affected by organisation-wide changes. The ACT architecture compensates for these types of anomalies through the change assessment model. The change assessment model was designed to pre-empt change irregularities, and this concept is explored in the following section.

The ACT architecture components are illustrated at Figure 40. There are specific processes, policies, roles, systems etc. involved in each instance of a change process (or event). The Company's SMEs are a core component of the ACT in their capacity as authorised 'change agents'. Change agents are responsible for updating the ACT data repository and performing data quality maintenance. Their expertise is wide and drawn from a range of Company-



based administrative and operational professionals. The change agents update the ACT via the 'Meta-Schema Updates and Maintenance' module, which is accessed through the 'Append and Update Data and Perform ACT Maintenance' module. Modifications are made to the 'ACT Data Structures' and the meta-schema as required.



**Figure 40: ACT Architecture**

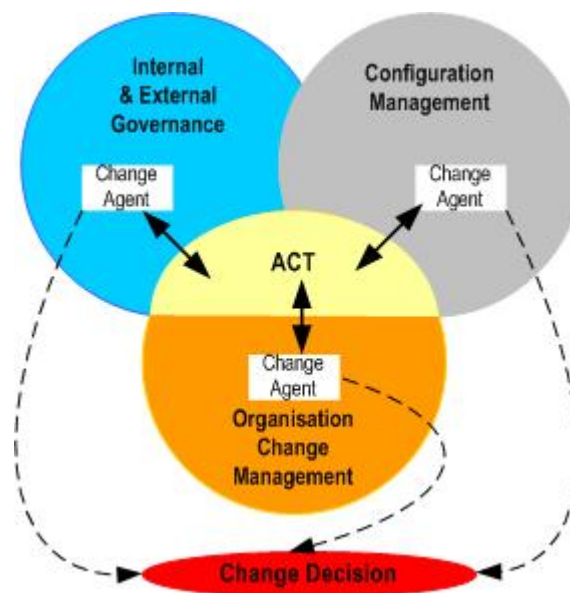
The ACT data structures were effectively an instantiation of the Company's specific operations (or part thereof). These data structures were implemented as a relational database and, consequently, the database enables the automated derivation of the key organisation change entities (components) impacted by a particular change process (or event). Having change agents perform data updates and maintenance checks ensured corporate knowledge was shared and potential change impacts were collaborated by the appropriate SMEs. The intent was that all SMEs would engage with the ACT when and as required. Change agents were also able to perform an assessment of externally and/or internally generated change events using the ACT 'Change and Impacts Analysis' module. This type of assessment used structured query language (SQL) formatted queries to interrogate the database. The ACT query results were compiled using a mix of textual formats (reports and other

graphical displays), giving change agents access to real-time information in the form of reports and scenario analysis of potential change impacts. The ACT outputs and their composition are discussed in section 6.7.1.

### 6.6.1 ACT Change Assessment Model

The ACT change assessment model facilitates a collaborated change management approach by integrating the corporate knowledge of change agents (or SMEs). The ACT change assessment model is illustrated at Figure 41 and draws on the following organisation expertise:

- internal and external governance arrangements (administration of policies and related materials, processes and responsibilities, and performance reporting);
- configuration management (encompassing systems and related materials and business process mapping and alignment); and
- organisation change management (IS project-based initiatives or corporate change programs).



**Figure 41: ACT Change Assessment Model**

The benefit of having a cross-section of SMEs involved in the change assessment (decision) process ensures a dynamic and conversant body of experts are available to adjudicate on change matters and/or contribute to decision outcomes. This is achieved by raising awareness of potential change impacts. In addition, change initiatives deemed overly obstructive can be



readily identified and, where appropriate, quickly dispersed. Collaborative change assessments also assist to identify and manage organisation decision soft factors. For example, the ACT outputs are essentially underpinned by the Company's business rules making the task of ignoring critical change components (governance, configuration management and organisation change management) difficult. Moreover, included in the ACT data structures are the relevant roles and responsibilities, which in most instances, identify the decision-maker or party responsible for authorising or implementing the change. Consequently, where a change process has occurred the responsible party can be readily identified and held to account if they have failed to engage the appropriate SMEs (or change agents).

The ACT also allows decision-makers to reference corporate data for the purpose of assessing potential change impact or to collaborate with others where an impact may be imminent. Decision-makers can then determine the extent of the impact and amend their decision accordingly, or be proactive and systematically implement the corresponding organisation change requirements. Consequently, decision outcomes may be guided by the information stored and reported through the ACT. According to Levasseur (2001), communicating change outcomes was a vital and fundamental component of organisation change management.

While the ACT does not reduce organisation change complexity it does enable change agents and decision-makers to manage change more efficiently by systematically searching the database for all 'possible' impacts. Thus, the work involved in managing change is not necessarily reduced (although, it may be when change recovery effort and costs are factored in). However, the effects of missed impacts (and the negative consequences of these) should be greatly decreased.

## **6.7 ACT Test, Evaluation and Reliability**

As noted in section 5.4.4.1, the ACT was tested in accordance with SA&D test case principles. This analysis incorporated black box testing to measure user requirements satisfaction and system performance reliability, and a usability test to evaluate the systems perceived ease of use. In the first instance, the

ACT was populated with test data compatible with the Company's operational requirements. The test data was drawn from the 'logistics management' sub-process 'purchasing', specifically, the procedure 'determine method of procurement'. This particular procedure was chosen above others because it represented multiple instances where the revised CPG implementation process had impacted several activities and tasks. The Company's stakeholders had also recommended this procedure because it demonstrated the complexity of the procurement process through the mix of cross-domain activity.

An outline of the procedural activities and tasks associated with this procedure and its relationship to the higher-level process (or function) 'logistics management' is displayed at Table 4, Chapter 4. The procedures, activities and tasks associated with the purchasing hierarchy are highlighted in bold font. The following sections describe the system test and usability test procedures and results.

#### **6.7.1 ACT System Testing**

The ACT reliability was tested using the predetermined stakeholder requirements outlined at section 6.3.4. Six of the original interviewees participated in the requirements acceptance testing, which was conducted in their operational (work) environment. The 'test group' comprised a mix of Company supply-chain SMEs with expertise in procurement policy and processes, supply-chain systems, supply training procedures, and governance and organisation change. Each test group member was asked to follow a simple 'walkthrough' procedure that involved opening a series of ACT automated outputs (reports) and data screens. The same 'walkthrough' was used for each participant. Each report corresponded to a specific user requirement and was numbered in accordance with the requirements listed at section 6.3.4 (i.e. UR1, UR2, URn, etc). The reports shown at Figures 42 through to 50 are discussed in terms of the test results and in the context of the data analysis findings. The test case procedure 'determine method of procurement' was used to test all ACT report outputs.

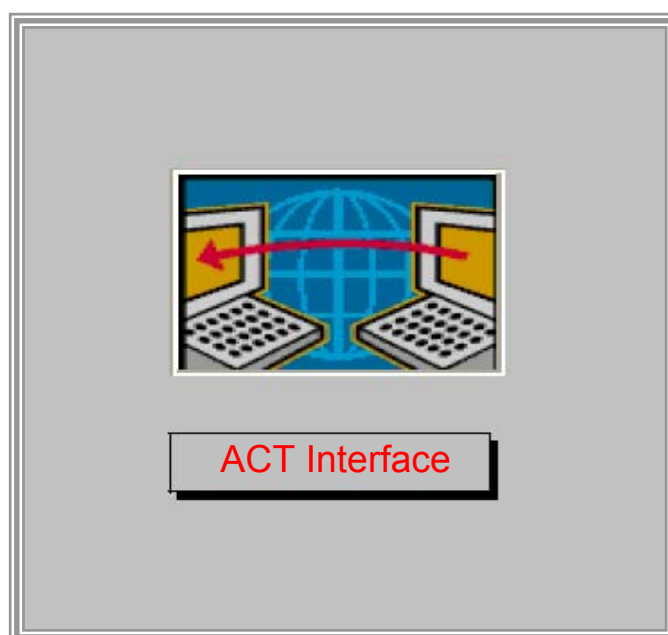
Policy	Clause	Task	Orphans
DPPM (6.0)	S01C102	Check Resource Use Compliance	
DPPM (6.0)	S04C408	Use Defence Standing Offers	
DPPM (6.0)	S05C503	Use State Period Contracts	
ESCM	V05S01C04	Comply with Engineering Requirements	
ESCM	V05S01C04A	Comply with Engineering Requirements	
ESCM	V05S03C02	Comply with Engineering Requirements	
AAP 7001.059(AM1)	B01S03C02	Comply with Engineering Requirements	
DPPM (6.0)	S01C104	Nominate Proposal Approver & Funds	Templates: AB714
CEI 2.1(4)	2.14	Nominate Proposal Approver & Funds	
CEI 2.1(4)	2.22	Validate Delegations	
CEI 4.1(4)	1.8	Validate Competency Requirements	
DPPI No 1/2009	02	Identify Covered Procurements	
DPPM (6.0)	S01C102	Identify Covered Procurements	Templates: AC565; SP20

**Figure 42: UR1 - Policy, Task & Anomalies**

This report identified the constraints (policies or products) impacted by the revised CPG implementation process, but moreover, specified the related policy clause (or paragraph). The tasks covered under the affected policies and specific clauses were also itemised, together with any anomalies (orphans). This report was critical because, as discussed in section 4.5, most tasks and data exchanges were transacted at the organisation coal-face. Consequently, most enterprise architecture (EA) or organisation change solutions overlooked the significance of lower-level interdependencies. The ACT was capable of reducing the key organisation change entities (and their sub-entities) to the lowest measurable unit of change. For example, in the report the entity 'policy' (constraint) was reduced to its lowest measurable units, which were the explicit clauses or paragraphs covered by the policy. As discussed, it was not unusual for policies to umbrella multiple documents comprising hundreds of pages of paragraphs or clauses. These policy paragraphs or clauses, in turn, covered a variety of process related tasks. The Company's policy and process hierarchy revealed that, the actual policy clause or paragraph, and the process task, were the intersecting components or impact points.

The change agents considered this report vital because it demonstrated the relationship between policy and task, which they deemed was a critical factor in determining potential change impacts. The report also illustrated the anomaly of the finance and procurement data input template. For example, the

templates were identified as orphans because they had not been formally categorised under the Company's policy, process or system hierarchies. Therefore, templates were not supported by the Company's authority and responsibility arrangements. As noted, finance and procurement templates were often used in supply-chain workflows and their oversight, in relation to the CPG changes, caused much pandemonium. Predicting potential impacts such as template anomalies enabled change agents to predetermine change impacts, and take proactive action to accommodate change at the coal-face.



**Figure 43: UR2 - Manage Organisation Components**

The ACT interface was designed to give change agents access to the relational database (the ACT data structures) allowing them to update (delete, modify or add) data relating to the ACT organisation components. The interface is essentially a database form that opens the ACT proprietary software and ensuing data structures. Change agents were able to update and amend the data structures and adjust the ACT meta-schema as required through this interface. Giving change agents access to the ACT data structures guaranteed data quality and ongoing maintenance of the meta-schema. User requirement 'UR6' was incorporated into the 'UR2' functionality. Change agents specified access to automated, on demand reports through the ACT interface. This functionality was facilitated through the 'UR2' capability.

	Role	Task	System	Module	Function	Program	Input SRC
►	Del	Comply with Engineering Requirements	SDSS	MIMS	CAT(M)	GCE	MS0101
	Prop_App	Comply with Engineering Requirements	SDSS	MIMS	CAT(M)	GCE	MS0101
	Del	Comply with Engineering Requirements	SDSS	MIMS	CAT(M)	COMREV	MS0213
	Prop_App	Comply with Engineering Requirements	SDSS	MIMS	CAT(M)	COMREV	MS0213
	Del	Comply with Engineering Requirements	SDSS	MSR	SUPREC	INTNCSUP	MSR0035
	Prop_App	Comply with Engineering Requirements	SDSS	MSR	SUPREC	INTNCSUP	MSR0035
	Del	Identify Covered Procurements	SDSS	MIMS	PUR	MPURINFO	MS0210
	Del	Identify Covered Procurements	SDSS	MSR	SUPREC	INTNCSUP	MSR0035
	Del	Identify Covered Procurements	SDSS	MIMS	PUR	RPURORD	MS0582

**Figure 44: UR3 - System Components, Tasks and Responsibilities**

The UR3 report enabled change agents (or users) to predict all system components, including the relevant transaction interfaces (or input source) impacted by a policy change. Moreover, the system changes were mapped to the corresponding task and responsibility. As noted in section 4.5, non-collaborated system changes caused supply-chain users much angst with the Company's financial and supply-systems sharing the burden of the revised CPG changes. Supply and finance system amendments were often performed on an ad-hoc basis and usually culminated in misalignment of policies, processes, system interfaces, templates and data capture screens. Users asked for a report to identify these system components as they were considered the most vulnerable to change.

The Company's enterprise systems were modular-based with the lowest measurable unit defined as the data input (or data capture) screen. Data transacts at the organisation coal-face, which is the lowest entity (or sub-entity) intersecting point. In this instance, the lowest intersecting point was the task, user (identified by their designated responsibility), and data input source. Identifying the enterprise system (i.e. SDSS) as the change target would not have provided the level of detail necessary to expose the interdependencies that transpired at the coal-face. The UR3 report illustrates this anomaly whereby the supply-system's interdependencies (modules, functions, program, and data input source (screen)) were all vulnerable to change with the data input source the most at risk because it was the lowest transaction point. Had this particular report been available when the CPG changes were

implemented, change agents could have identified those system components most likely to be impacted and taken corrective action accordingly.

Another critical issue drawn from the data analysis findings was the impact the CPG changes had on human responsibilities. Most of the Company's responsibilities were task aligned and system transaction dependent. In the test case example, two key responsibilities were affected; the delegate and proposal approver. The consequence of this was that users with these responsibilities (or users who relied on people with these responsibilities to perform their role) could not complete their duties because the responsibility profile had changed, or the way in which they performed their duties had changed. In theory the situation may have appeared less dramatic given only two responsibility types out of perhaps a hundred were affected by the CPG changes. However, in reality, the impact was severe with hundreds of people unable to perform their duties effectively. Further, had change agents been able to critically assess the impact of the changes on the workforce, the severity of the incident could have been avoided. This was the response given by the test group.

System	Module	SYS Authority	MOD Sponsor	SYS Sup	TECH Sup
SDSS	MIMS	OPS1	Corporate	Corporate	CSD
SDSS	MSR	OPS1	CSD	CSD	CSD

**Figure 45: UR4a - System Support Arrangements**

Change agents requested a report to identify the Company's authority and responsibility arrangements. To that end, three reports (UR4a, UR4b, and UR4c) were compiled to denote the Company's many (and at times illogical) responsibility demarcations. As noted, the CPG changes had a debilitating effect on the supply-chain procurement workflows with decisions made without cognisance of their pending impact. In one instance, supply-system changes were authorised by parties other than the supply-system authority. Report UR4a illustrates the complexity of the supply-system demarcations with two system-modules sponsored by opposing groups. The report identifies the authorities (or responsible parties) that should be engaged in collaborative

change-related decision-making. In this instance, those parties identified are the system owner, module sponsor, system support, and technical support.

Of concern was that the supply-system support demarcations were divided between two separate groups, with neither party the designated system authority. This was one example where the illogical responsibility arrangements triggered an unplanned change in the supply-system. The test group agreed that, had this report been available, the pending supply-system changes would have been flagged and communicated to the appropriate SMEs as part of the ACT change impact assessment process. This action would have alleviated the need for ad-hoc work-a-rounds, and the Company's supply-chain operations would not have been interrupted. At the very least, decision-makers should have been alerted to the ramifications of their decision in terms of turn-around-times for change implementation and remediation.

Policy	Sponsor	Authority_1	Authority_2
CEI 2.1(4)	FG	CFO	CEO CORP
DPPM (6.0)	Corporate	CEO CORP	
ESCM	OPS1	Head OPS1	
DPPI No 1/2009	Corporate	CEO CORP	
AAP 7001.059(AM1)	OPS2	Head OPS2	

**Figure 46: UR4b - Policy Sponsor & Authority Arrangements**

The UR4b report is similar to the UR4a report in that this report was concerned with identifying the change agents (SMEs) responsible for facilitating collaborative decision-making. At the very least, the parties would be expected to identify those SMEs that should be advised of potential change impacts. The CPG changes affected a wide range of Company policies and related products. Often the extent of the impact remained unknown until stakeholders encountered a problem and raised the matter with their line managers. On other occasions, the logistics policy and procedure SMEs searched the Company's Intranet for notices alerting users to policy amendments. The SMEs in-turn interpreted the changes amending supply-chain procedural documentation accordingly, and then forwarded the changes onto users. There were a plethora of policies and hundreds of policy documents impacted by the CPG changes: the situation was chaotic.



This report also emphasises the diversity of the authority arrangements and provides a sample of the policy documents affected by the CPG changes. Interesting was the fact that the policy document labelled 'CE2.1 (4)' had two policy authorities. This anomaly was due to the Company's finance head having jurisdiction over both finance and procurement. Further, the procurement business owner responsibility was delegated to the corporate head, which was a separate group. The report illustrates the ramifications of the CPG changes where the policy authorities (or enterprise owners), whose operations were affected by the finance and procurement policy changes, were not informed of the CPG amendments. Consequently, this report identifies those parties that should have been advised of the CPG policy changes, and moreover, should have been involved in the change decision process. The test group acknowledged the benefit of this report because it could readily identify potential change targets, and change decision-makers.

Training	Sponsor	Provider
MIMS	OPS1	Corporate
ROMAN	FG	Support
CONMAN	Corporate	MTS
PROC	Corporate	Support

**Figure 47: UR4c - Training Sponsor & Authority Responsibilities**

The UR4c report identified the training modules impacted by the CPG changes, listing the corresponding training 'sponsor' and related training 'provider'. The CPG changes impacted a plethora of supply policies, systems, processes and related activities and tasks. These in turn, had a systemic affect on the effectiveness and availability of training modules to support supply-chain activities. For instance, the CPG changes resulted in the update and redevelopment of training modules, and the scheduling of additional training services. In some instances, these changes were implemented in the absence of appropriate training modules. In other cases, where there were training materials available, these were rendered obsolete. Identifying the training products impacted by the CPG changes enabled the sponsors and training providers to be promptly recognised. Furthermore, their ready identification ensured a quick response time for training renewal and delivery.



Stakeholders requested this report be included as a system function because of the need to identify training decision-makers (training sponsors) and training providers, especially where related change assessments and training renewal programs required quick turn-around times. The stakeholders were satisfied the report met their requirements.

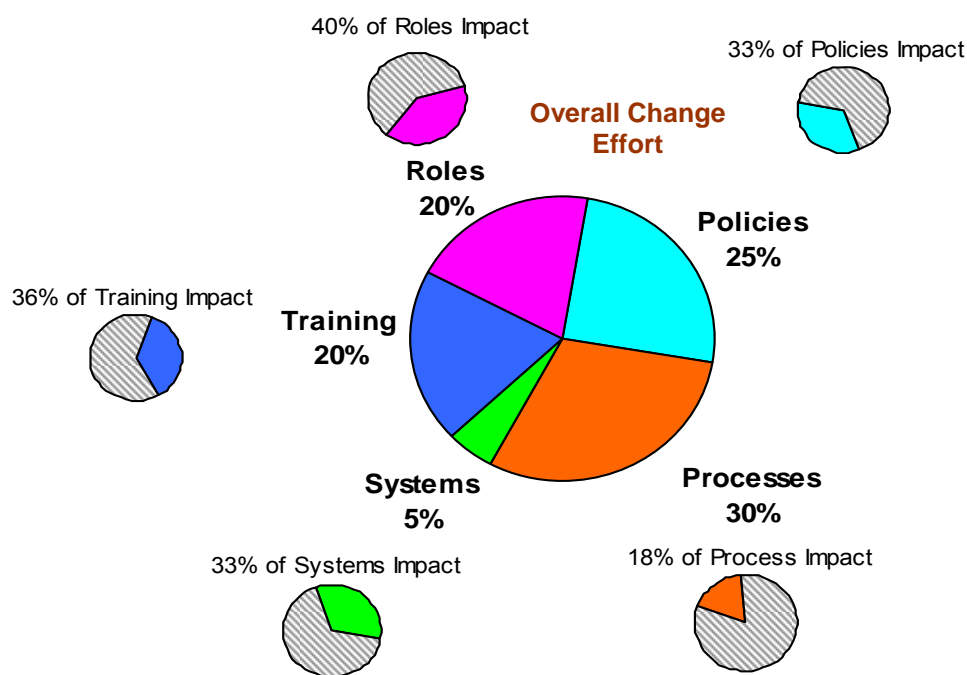
	Role	Task	Training	Training Pack	Manual
►	Del_Mgr ▼	Validate Delegations	PROC	UBP	BPROC
	Del_Mgr	Validate Delegations	PROC	COMPROC	COMPROC
	Del	Comply with Engineering Requirements	FM	UBP	BPROC
	Del	Comply with Engineering Requirements	FM	COMPROC	COMPROC
	Del	Identify Covered Procurements	FM	UBP	BPROC
	Del	Identify Covered Procurements	FM	COMPROC	COMPROC
	Del	Comply with Engineering Requirements	CONMAN	ASDEFCON	CONMAN
	Del	Identify Covered Procurements	CONMAN	ASDEFCON	CONMAN
	PO	Use State Period Contracts	PROC	UBP	BPROC
	PO	Use State Period Contracts	PROC	COMPROC	COMPROC

**Figure 48: UR5 - Role, Task & Training Products**

The UR5 report was similar to the UR4c training report with the exception that it included related training products (training packs and manuals). Stakeholders required these items to be linked to the respective supply-chain tasks and responsibilities. The UR5 report indicates that, supply-chain users were overwhelmed by the CPG changes. The implications were such that multiple training items were affected, which in turn impacted a range of training packs and manuals. The report clearly illustrates the extent of the change with the effected tasks affiliated with a range of training products. Add the fact that the CPG changes impacted a diverse number of tasks, and consequently, impinged on a range of training products, and the extent of the impact is even more significant.

The consequences of the CPG changes on the Company's training manuals were a major concern because the manuals were task-focused, providing a step-by-step implementation of the task, while identifying the required system transactions. The UR5 report allowed change agents to readily identify the training products considered more vulnerable to the CPG changes, and review and amend the materials as required, in a timely manner. This action ensured

supply-chain users maintained work-flow continuity, while operational disruptions were kept to a minimum. This report also included the responsibility arrangements to identify the delegations impacted by the changes. In this case the responsibility was mapped to the respective training manual and task. Overall, this report provided an enormous benefit to change agents who acknowledged the failure of prior attempts to comprehend the extent of organisation change on the Company's training products.



**Figure 49: UR7a - Change Impact Scenario Model**

An ACT user requirement was the ability to predict and measure the overall change impact, and assess the required change effort associated with a change process or event. In addition, change agents viewed scenario modelling as a valuable function because it gave them access to real-time graphically displayed primary data. Moreover, stakeholders (change agents) found the ACT data displays easy to understand, compared to some of the Company's exiting decision support systems (DSS). Consequently, stakeholders indicated they would be more inclined to use the ACT because of its logical yet simplistic nature. The ACT scenario modelling function was activated by exporting live data from the ACT to a third party application. This

approach allowed the data to be exported to a range of applications and displayed using a variety of formats.

This UR7a report (scenario model) illustrates the impact of the CPG changes in percentage terms. For example, the model predicted that 33% of the Company's 'policies' would be impacted by the CPG changes. This represented 25% of the overall CPG change effort. The 'systems' impact was assessed at 5% of the overall change effort; however, in real terms, this figure equated to 33% of 'systems' potentially in need of redevelopment to accommodate the changes. Perhaps the greatest impingement was the responsibility delegations, which attracted 20% of the change effort, with a massive 40% of the delegation profiles susceptible to change. It should be noted that staff perform responsibilities and, in real terms, the percentage of staff affected would be much higher. Similarly, 'processes' were assessed at 30% of the overall change effort with 18% of all supply-chain procurement processes potentially in need of review. Training emerged with 36% of training items impacted, which consumed 20% of the overall change effort. The test group agreed that this type of modelling enabled them to comprehensively assess the level of change and the required change effort. The advantage of scenario modelling was its ability to predict or pre-empt a range of situations based on the data inputs.

	Policies	Processes	Systems	Training	Roles
<b>Total</b>	15	34	3	11	10
<b># impacted</b>	5	6	1	4	4
<b>% Impacted</b>	33%	18%	33%	36%	40%
<b>% Unaffected</b>	67%	82%	67%	64%	60%

**Figure 50: UR7b - Change Impact Report**

The UR7b report was a numerical representation of the scenario model illustrated at Figure 49. The report was based on the test case data stored in the ACT, which included, in part, 15 policies, 34 processes, 3 systems, 11 training items, and 10 responsibility types or (roles). This assessment did not include the training products (programs, training packs or manuals), or the system components (programs, modules, and data capture screens),

implicated in the CPG change process. While the test case data was relatively small, in comparison to the Company's overall supply-chain activities, it was significant in terms of the percentages affected by the CPG change. Further, the report indicated that substantial effort was required to mitigate the predicted change impact. Had the training and system sub-entities (components) been included in the change impact assessment, the complexity and extent of the change would have been even more significant.

### **6.7.2 ACT System Test Results Summary**

The results of the system functionality test indicated that the ACT performed to the satisfaction of stakeholders, processing data and returning information in a reliable and timely manner. The ACT was continuously tested during the development phase, at which time most system errors were eliminated. The test group participants were the same users involved in the data, model, and ACT validation phases; hence, many potential system faults had been addressed prior to black box testing. The test group were comfortable that the ACT data input and output functionality met their requirements. Of significance was the ability of the ACT to automate and predict the entities and sub-entities implicated in a change process (event), and communicate the findings to stakeholders (or change agents) using qualitative report formats. A critical aspect of the ACT was the accessibility and useability of the change reports. The reports ensured change was widely communicated and the complexity and extent of the socio-technical implications of change were understood.

### **6.7.3 ACT Usability Test Results**

The ACT system usability test procedures (outlined in section 5.4.4.1) evaluated the level of user satisfaction. The usability test was undertaken in accordance with SA&D alpha test case principles, which were illustrated at Figure 28. The ACT usability test used the same test group, test case, test data, and walkthroughs used in the system function test process. The test group was asked to appraise the ACT against a list of 'usability factors' using the Likert Scale (Leedy 1997) usability assessment method displayed at Figure 28. The results of the test revealed that while the test group members were

content with the ACT performance, some were not satisfied with the following usability factors:

- ease of use;
- user friendliness;
- level of confidence; and
- comfort level.

Test group members were more positive about their understanding of the ACT, its conformance to their requirements and response times. The results indicated that, while test group members were capable of updating data and executing ad-hoc reports, their comfort level was marginal. The researcher attributed this negative response to the fact the ACT data structures were based on a commercial relational database application. The test group agreed their comfort level would have increased had they received training in the database application. Another issue raised by the group was the need to export ACT data to a third party application for scenario modelling. In light of the usability results and the research timeframe, the researcher deferred redevelopment of the ACT for future research. This would enable the researcher to incorporate the test group suggested changes in the next ACT version. It is proposed that a series of user interfaces (screens) will provide users with the confidence required to effortlessly navigate the data structures and compile the ad-hoc reports. Further, the ACT will be amended to perform scenario modelling within the ACT architecture.

## **6.8 Case Analysis Findings Summary**

The case study data analysis findings and interpretation process was commensurate with the research problem and research aims, and atoned with the formulation of the research propositions. Separating the analysis process into three phases enabled each phase to be substantiated and compared with the others, which added robustness to the findings validation process. The theoretical lens provided a solid frame for the data collection procedures and a firm base for evaluating the models used in the analysis process. Further, the theoretical perspectives used to frame the study, especially change theory and technology theory, were valuable in evaluating organisation change

management practices and tools, and other similar frameworks. Socio-technical theory was a major contributor in formulating the data collection process, and a key focus for identifying the key organisation change entities, which underpinned the ACT design.

Decision theory too, was an important component of the data collection and ACT development process. In particular, the organisation decision-making dynamics and the decision process itself were of interest to this study, especially the integrated decision approach proposed by Simon (1952). The ACT change assessment model was based on an integrated decision approach, in addition to the inclusion of organisation controls (such as business rules) on the data structures. Simon (1952) considered these features essential elements of the decision process. Decision support system principles also made a valuable contribution to the ACT design. For example, the ACT architecture was based on a simple automated decision process that used uncomplicated qualitative output formats. Technology theory played a significant role in selecting the qualitative modelling instruments used in the data analysis and ACT development processes.

The models used in the data analysis process were data-centric and commensurate to SA&D practices. Similarly, the data analysis process was conducive with qualitative case study data analysis methods. Various models were used in the analysis process and each performed a valuable role in identifying the key organisation change entities, and their interdependencies. The high-level models captured and grouped the key organisation entities and interdependencies, while the low-level models identified multiple entity layers and complex and dynamic interdependencies. The data, and model analysis processes were rigorous, comprising continual validation and reliability testing. Similarly, the ACT underwent ongoing assessment and modifications throughout the development process. The rigour of the analysis and testing processes added to the significance of the research findings. The findings were interpreted, in part, by comparing the case data (Company materials and interview data – including the CPG derived models) with the literature (theoretical lens).

The data comparisons revealed a number of gaps in the literature findings, which are summarised as follows:

- the literature failed to consider the process, constraint, people (in terms of the sub-entities; 'role', 'authority', and 'responsibility'), systems, and group hierarchies as organisation components, but the case materials confirmed they were sub-entity components that intersected at the organisation coal-face (or data transaction level);
- contracts and costs were not considered by the literature as vital aspects of the organisation environment but the case materials revealed they were important factors, especially in a change environment; and
- the interview data confirmed the entity training was a major key organisation component but the literature failed to recognise it as a key organisation entity or issue.

A number of inadequacies associated with existing change solutions were drawn from the literature and used to scope the development of the ACT. These shortfalls included, in part:

- organisation change solutions failed to consider the interdependencies of the key change entities and as a consequence, failed to provide a holistic change approach;
- change solutions were overly generic, document-based, and were considered ineffective; and
- change solutions and modelling tools were either industry specific, or not automated, resulting in cumbersome and time consuming solutions that were considered ineffective and expensive.

These issues were incorporated into the ACT design, while ensuring the ACT architecture was simple but, at the same time, able to provide an effective change management solution.

The case analysis findings revealed that most organisation tasks were concentrated at the operational or data transaction level. Consequently, ensuing organisation change affected various activities performed at the organisation coal-face. Organisation change solutions, or similar practices, failed to consider or capture those entities (or sub-entities) that intersected at

the lower operational levels. The low-level modelling instruments used in this study captured the dynamics and complexity of these interdependencies. Another critical issue that emerged from the findings was that change impact was not assessed or widely communicated. The literature stated that, change communication was a major change management principle. The ACT embraced this feature using various report outputs to provide and communicate an effective change solution. Further, the ACT change assessment model provided a mechanism to guide the change decision process, reducing the impact of soft factors in the decision-making process.

As stated, the ACT was rigorously tested for performance reliability and its usability. The system test results indicated that the ACT performed to the satisfaction of stakeholders, processing data and returning the required information in a reliable and timely manner. The ACT also ensured change was widely communicated with the complexity and extent of the socio-technical change impacts promulgated through qualitative reports and scenario models. The results of the usability test indicated that the ACT required some minor modifications to enable change agents (or stakeholders) to more readily manipulate the data structures and produce ad-hoc reports. The most significant factor was the ability of the ACT to holistically predict change impact, and assess the overall change effort required to manage the change process (or event). The researcher argues that the research findings can be applied to other industries or cases, and applied to extend organisation change theory. These concepts are discussed in terms of the research propositions, which are addressed in Chapter 7.

## **6.9 Chapter Summary**

Analysis of the Company's procurement environment revealed a complex network of dynamic interdependencies that indicated any change impact assessment was a far from trivial exercise. The wider literature stated that change tools had performed with less than expected results. The Company had endured a similar fate having limited success with change tools and other similar products. The Company had also failed to perform change assessments in a collaborative and comprehensive manner. This led to



procedural anomalies and inconsistencies and, in some instances, had actually increased dysfunctional activities. The complexity of the research findings demonstrates that any attempt to manage or understand organisation change should be underpinned by an automated change solution, and supported by a change assessment model, or a collaborative decision process. Finally, it should be emphasised that the automated solution is not an answer in itself but a tool that can be usefully employed to complement and underpin change management strategies.

SA&D formalisms were used to map the key organisation change entities and sub-entities, their dynamics and interdependencies involved in a change process. Modelling was a key instrument in the change assessment process exposing interdependencies which otherwise would have remained obscure. Conceptual modelling enabled organisation change complexities to be identified and logically managed. This was achieved using the CFPM and CFDM, hierarchical models, and ERD logical schema and ACT database meta-schema. Moreover, the research findings present a logical and practical argument for adopting automated change tools as a means of predicting, assessing and managing change. The ACT provides access to real-time information in the form of reports and the scenario analysis of potential change impacts, and related decision outcomes. This material gives change agents the capacity to determine the level of change impact and the overall change effort required to manage the change process.

The ACT readily analyses potential change impacts and communicates the outcome via qualitative textual and graphic data displays. In terms of the case problem, what may have appeared as an insignificant Company policy or procedural change inadvertently affected numerous supply-chain components. These components were dispersed across various organisation groups resulting in a domino effect of enterprise-wide changes. Consequently, effective change tools should capture, analyse and communicate key organisation change components and their interdependencies in order to inform an overall change solution. The ACT has been tested and evaluated against its ability to perform to that standard. It provides superior information in

relation to organisation change components and change impacts, and the overall change effort required to effect change remediation. Real-time model-based scenario building and sensitivity analyses have yet to be incorporated into change tools or other like practices. The ACT approach is a substantial advancement on current change practices and tools.

This chapter has addressed the concept that single case findings may be used to generate research propositions or imply generalisations. The argument was particularly strong where the research had been framed using a theoretical lens and followed a valid research method. This study has demonstrated its robustness and research quality by adhering to the qualitative case study, and the SA&D framework. Therefore, the reliability of the research findings has been validated. Further, the research was framed using a number of theoretical perspectives, which substantiates the external validity of the research findings. For example, a number of research propositions have emerged from this study and have been applied to extend organisation change theory. This concept is developed further in Chapter 7. Moreover, the study outcomes support the argument that the research findings can be generalised outside of the case environment. For example, similarities can be drawn between the Company and other organisations' change management issues. The researcher argues that the ACT principle could be applied to resolve organisation change problems in other industry types. These concepts are addressed in full in the next chapter.

## **Chapter 7**

### **Conclusion**

#### **7.1 Research Overview**

The theoretical lens used to frame this study revealed organisations were underpinned by a number of paradigm perceptions. These perceptions had developed in profundity and diversity alongside the evolving organisation. Consequently, a variety of theories and meta-theories were amalgamated to support the transformation of the organisation. In principle, organisations are controlled by a series of meta-theories, which, in-turn embrace a number of diverse frameworks and tools. The literature suggested a meta-theoretical approach was required to manage and understand the complexities and dynamics of the modern organisation. An important issue that emerged from the literature was the relevance of established theories to post-modern organisations. Consequently, the researcher explored those theories deemed relevant to the research problem and research objectives, together with their respective frameworks and tools.

The literature showed the industrial revolution was the precursor of organisation change, economic growth and technology innovation. Since then, organisations had been in a state of perpetual change with organisation theorists devoting much effort to change management and control. The literature also believed the events of World War II (WWII) were instrumental in furthering technology innovation and changing the modus operandi of post-industrial organisations. Organisations faced major challenges with increased demand for knowledge and technology solutions. Technology innovation was pivotal in defining the modern organisation, principally through the adoption of complex, inter - and intra - organisation processes. Notably, these processes were automated, real-time transaction-based workflows. Consequently, an organisation change solution had to provide real-time information and resolve organisation complexity.

Of particular value to this research was organisation theorists' adoption of conceptual modelling to resolve or illustrate organisation phenomena, specifically, organisation change. Most theoretical perspectives had adopted respective modelling formalisms to illustrate their underlying principles with specific modelling methods linked to explicit paradigms. Chapter 3 revealed the chronology and use of quantitative modelling from pre-industrial economies to the qualitative models used in post-modern economies. The relationship between theory and conceptual modelling was absolute, and this unanimity underpinned the automated change tool (ACT) architecture. Chapter 3 also discussed the limitations and failure of common change frameworks (and other products) and related tools to comprehensively and effectively manage change. The results of the evaluation revealed change solutions needed an end-to-end perspective where the impact of change was holistically captured, measured and assessed. Therefore, some products that were evaluated were dismissed as non-viable. Moreover, the chapter findings confirmed that a change solution had to be automated, and capable of predicting and measuring change through real-time, model-based scenario building and sensitivity analyses. In addition, the solution had to communicate change impact (or change decision outcomes) using qualitative report outputs in a format that was easily understood.

Organisation theory was the initial paradigm explored in this study. Soon after the meta-theories (sub-theories) socio-technical theory, organisation change theory, decision theory, and technical theory were considered major theory contributors. In addition, general system theory (GST) principles contributed to the study's framework. Socio-technical theory was an important consideration because it emphasised the interrelationship between the social and technical organisation components. The complexity and dynamics of these components presented a number of challenges, especially in relation to organisation change. Organisation change theory was pertinent to this research because it was the major focus of the case and research problem. The literature acknowledged the difficulties organisations faced managing and adapting to change, with large organisations particularly vulnerable to change events.

Decision theory too was an important aspect of this research from both a practical and theoretical perspective. For example, decision theory comprised a range of control mechanisms and decision protocols. Non-rational decision control and group decision protocols underpinned the ACT design. The former contributed to the elimination of soft factors in the change decision process, and the latter ensured a range of experts were included in the decision process. These features were supported by constraint modelling in the former instance, and in the latter instance, through the ACT change assessment decision model. Finally, the literature stated that users avoided, or misused, decision support systems (DSS) that were underpinned by complex decision theory protocols. The objective was to develop an automated tool that was effective, yet uncomplicated and simple to use.

Technology theory formed a significant part of this study. First, technology theory had evolved as a logical approach for reconciling human and technical problems. Early computers had integrated human cognitive elements into their design, which was primarily theory and logic focused. Therefore, the ACT design had to incorporate, or at least consider, these qualities. Second, the conclusion drawn was that technology theory, principally the modelling methods and formalisms used in systems analysis and design (SA&D) frameworks, were the instruments required to develop an automated change solution. More important, the solution had to be capable of proactively managing change, and related decision outcomes. Chapter 3 outlined and justified the instruments used in this study to develop the ACT schemas and physical database. GST too contributed to the logic of the ACT insofar that it highlighted the importance of identifying all interrelated components and relationships within the [organisation] system. Moreover, socio-technical theory was adopted as the ACT underlying design principle, primarily because it embraced both human and technical factors.

Chapter 4 justified the case participant selection process and provided a chronology of the Company's evolution, which was grounded in an incessant change cycle. The case problem revealed that any number of change events could significantly impact the organisational environment. Change could be

systemic and impact a series of components at varying levels within the organisation. The investigation showed the Company's supply-chain operations were severely compromised by a number of unplanned changes. Like most organisations, the Company's investment in various organisation-based frameworks and tools proved, largely, valueless and often resulted in more exasperating experiences. Therefore, the purpose of the study, in terms of the case problem, was to determine:

- the key change entities implicated in a change event;
- the interdependencies of these components;
- the dynamics of the interdependencies; and
- an appropriate automated change solution.

Chapter 5 discussed and justified the research method chosen for this study. In particular, the two-dimensional research approach - combining the qualitative research methods with qualitative SA&D practices - increased the robustness and significance of the data analysis findings. Moreover, the case findings were validated using the case study method and SA&D framework. This approach doubly ensured the reliability of the research process. Consequently, the research findings and research questions relationship are stated as follows:

*1. What components are implicated in an [organisation] change process?*

The depth and richness of the study's data sources revealed the diversity and complexity associated with an organisation change process. Identifying the components implicated in a change process requires the comprehensive examination of all key organisation components, to determine those most vulnerable to a particular change process. The number and type of change entities (components) identified may be dependent on a particular change process. However, the research findings indicate that the key organisation change entities identified through this study are the core components that need to be considered in an organisation change process.

2. *To what extent can a model or schema be used to effectively capture and illustrate these components?*

The modelling techniques used in this study were instrumental in exposing the dynamics of the change entities and their interdependencies, which, otherwise may have remained obscure. However, as demonstrated in the practical example shown at Chapter 3, and evident through the analysis findings, low-level formalisms deliver the intricacies needed to examine the lowest data intersecting point (or measurable unit of change). Therefore, a mix of formalisms are required to present a comprehensive view of the organisation complexities and interdependencies.

3. *Can the resultant schema be translated into a practical and responsive automated change tool?*

The translation of the ACT logical schema to the relational database (physical model) was essentially the transition from theory (conceptual) to practice. The main issue was to ensure all data instances were normalised to third normal form (3NF). The ACT has demonstrated its capacity to manage organisation complexity and change and, further, it has established its ability to communicate change complexity using real-time, model-based scenario building report outputs. The analysis findings present a logical and practical argument for adopting automated change tools as a means of predicting, assessing and managing change.

Subsequently, the following research objectives have been met, accordingly:

1. *Systematically capture, identify and simulate the entities and interdependencies involved in an organisation change process.*

The selection of appropriate data collection instruments, and interview subjects, enabled the capture of purposeful data, and together with the analysis techniques, these were able to be processed in a logical and precise manner.

2. *Translate the outputs from '1.' above into a responsive and effective automated change tool.*

The ACT meta-schema was further normalised to remove data redundancy and effect single data records. The meta-schema determined the ACT database data structures. Effective change tools should capture, analyse and communicate key organisation change components and their interdependencies in order to inform an overall change solution. The ACT provides superior information in relation to organisation change components and the prediction of potential change impacts. More significantly, the ACT provides an assessment of the overall change effort required to effect organisation change or change remediation.

## **7.2 Research Propositions and External Validity**

A number of research propositions have emerged from this study and have been applied to extend organisation change theory. The propositions are founded on the inference that:

- the ACT provides a logical and practical change solution;
- the ACT design was essentially theory-based;
- the ACT development process was validated through the data analysis findings and interpretation process; and
- the research findings were derived from multiple and diverse data sources, with comparisons drawn from the literature (theoretical lens) to extend an existing theory (organisation change).

The logic and method used to develop the research propositions, and the process for generalising the research findings to other cases, was outlined in Chapter 5, specifically sections 5.3.5 and 5.4.4. As noted, the method was based on Creswell (2009), Maxwell (2005), and Yin's (2009) respective proposals that single case findings may be generalised by extending a theory that can be applied to other cases (or situations). Therefore, this research advances the perception of current organisation change theory, and related frameworks and tools. The relationship between the research findings and the research propositions have also been substantiated using theory-building logic.



For example, each chapter of the research report contributed to the development of the research propositions. The research report was constructed to allow each chapter to methodically develop and substantiate the research propositions. The research propositions drawn from the study include:

1. organisation change solutions should be automated;
2. organisation change solutions should consider and measure the key organisation change entities and sub-entities, together with their dynamics and interdependencies;
3. automated change solutions must provide real-time, model-based scenario building and sensitivity analyses reporting capability;
4. automated change solutions must provide a maintenance program to ensure ongoing integrity of the data structures, business rules, and data inputs and outputs; and
5. automated change solutions must support a change assessment decision model that allows subject matters experts (SMEs), or change agents, access to the data, and ensures they are included in organisation change assessments, and related decision outcomes.

Chapter 6 presented the data collection and analysis process and findings outcomes. Specifically, Section 6.5 discussed the external validity of the analysis findings, while Section 6.8 summarised how the theoretical perspectives were used to frame the study. The latter section also explained the relevance of the theoretical perspectives to the data collection and analysis processes, and ACT schema development. Section 6.8 also highlighted a number of gaps in the literature, and the inadequacies evident in existing change frameworks and tools. These shortfalls were incorporated into the ACT data structures, which enhanced its functionality. The research propositions were based on the research findings and included the ACT test results. The ACT functionality was rigorously tested and evaluated with the results presented in Sections 6.7.2 and 6.7.3 respectively.

The research findings demonstrate the universality and validity of the ACT data structures and their underlying principles. The researcher argues that the research propositions extend organisation change theory; therefore, the

findings may be generalised because the propositions could be applied to manage organisation change in other industry types. This proposal is also supported by the literature findings discussed in Sections 1.4.1 and 4.4 where a plethora of industries were continuously subjected to change. The example given was the range of industries that were recurrently impacted by change cited in, for example, Becht, Bolton and Roell (2002), Chuter (2000), Drucker (1999), Earle (1940), Levin and Gottlieb (2009), Roark and Freemyer (2010), Ryden (2003), Searle (2006), Spector, Lane and Shaughnessy (2009), and Wolf (2011). The industries affected included private and public sector, and global organisations, and represented a mix of organisation sizes and level of complexity. The industry types included, in part, education, health, military, manufacturing, pharmaceutical, finance, securities, which were representative of a diverse geographical expanse.

Consequently, the researcher argues that the ACT principles may be applied outside of the case findings. The research findings support this proposition; therefore, the study's external validity has been validated. Moreover, the proposition that the findings may be used to extend organisation change theory has also been substantiated. However, any perceived limitation of the study that may arise from the sample size is addressed in the following section.

### **7.3 Limitations of the Study**

There were two perceived limitations to this study. The first relates to the sample size. The research consisted of a single case study that explored the dynamics and complexity of a change process within a large Australian organisation heavily involved in supply-chain activities. Some quarters might argue that a larger sample size was required to substantiate the external validity of the research findings. However, given the case participant's size, and the diversity and complexity of its supply-chain operations, a single case study was considered appropriate (Creswell 2009; Yin 2009). In addition, single case studies were generally in-depth investigations of phenomena and were used to provide a rich understanding of the situation or event (Creswell 2009; Darke & Shanks 2000; Leedy 1997; Yin 2009). Any perceived limitations of the research findings were compensated by using the theoretical lens to

frame the study, and theory-building logic to develop the research propositions applied to extend organisation change theory. Further, the study established that the research findings were generalised and for that reason their application to other industry types has been justified.

The second perceived limitation of the study may be the absence of any statistical conclusions. Statistical conclusions could not be drawn from a single case study. They can only be drawn from a much larger and diverse sample size. Whilst statistical conclusions maybe interesting and provide a wider view of the phenomenon, it was doubtful they would have exposed the complexity and dynamics of the change entity interdependencies as this study has revealed. Further, in the absence of any intrinsic, relevant research or hypotheses, the researcher was unable to extend the study to a broader sample base. However, this issue presents an opportunity for further research.

#### **7.4 Directions for Future Research**

The research findings have indicated the need for further research. First, the key organisation change entities (including their interdependencies) could be applied across this and other industry types, to substantiate (or contradict) the research propositions. This would involve using a larger sample size and diverse industries to enable comparisons to be made and statistical conclusions to be drawn. Moreover, extending the study to other industry types would unequivocally corroborate the ACT principles by confirming the comprehensiveness and generality of the data structures (meta-schema). Finally, as noted, the researcher intends to address the issues raised by the test group in relation to the usability factors test. In doing so, the ACT will be perceived as more user friendly and its longevity as a comprehensive change management solution will be assured.

## Glossary

Acronym	Definition
1NF, 2NF, 3NF, 5NF, 6NF	First, Second, Third, Fifth, Six normal form
ACT	Automated change tool
ATHENA IP	Applications integrated project
AUS	Australian
BEF	Business excellence framework
BERM	Binary entity relationship model
BI	Business intelligence
BIS	Business intelligence systems
BPM	Business process modelling
BPR	Business process re-engineering
BRC	Business requirements constraints
BSC	Balanced score card
C17 <sup>th</sup>	Seventeenth century
C19 <sup>th</sup>	Nineteenth century
C20 <sup>th</sup>	Twentieth century
C21 <sup>st</sup>	Twenty-first century
CAC	Commonwealth authorities and companies act 1997
CASE	Computer aided software engineering
CCC	Company central committee
CEO	Chief executive officer
CFDM	Cross-function decision model
CFPM	Cross-function process model
CM	Configuration management
CMM	Capability maturity model
CMMI	Capability maturity model integrated
CO	Chief Officer
COTS	Commercial-off-the-shelf
CPG	Commonwealth procurement guidelines
CS	Computing science
CSD	Computing services division
CSF	Critical success factors
DFD	Data flow diagrams
DQM	Data quality management
DSS	Decision support systems
EA	Enterprise architecture
EA	Enterprise architecture
EC	Executive committee
EDI	Electronic data interchange
EDVAC	Electronic discrete variable automatic computer
EER	Extended entity relationship
EI	Enterprise integration
EIS	Executive information systems

EM	Enterprise modelling
ENIAC	Electronic numerical integrator and computer
ER	Entity-relationship
ERD	Entity relationship diagram
ES.	Enterprise systems
FCFB	Financial controls framework branch
FMA	Australian government financial management accountability
FMIP	Financial management improvement program
FP&PD	Finance processes and procedures directorate
FSD	Finance systems directorate
GCMD	Generalising conceptual multidimensional data models
GEM	General enterprise model
GERM	Generalised entity relationship model
GST	General systems theory
GUI	Graphical user interface
HERM	Higher-order entity relationship model
HR	Human resources
ICT	Information and communication technology
ICT	Information communication technology
IDEF,(0), (1X),	Integration DEFinition
IEM	Integrated enterprise modelling
IPT	Integrated project team
IS	Information systems
ISD	Information systems development
ISO	International standards organisation
IT	Information technology
ITIL	Information technology infrastructure library
ITM	Information technology management
JAD	Joint application development
JIT	Just in time
KERs	Key expected results
KMS	Knowledge management systems
KPI	Key performance indicators
LANs	Local area networks
LCC	Life-cycle costing
MCDM	Multi-criteria decision making
ME	Method engineering
MIS	Management information systems
MO <sup>2</sup> GO	Method of object oriented business process optimisation
MOTS	Modified-off-the-shelf
OCM	Organisation change management
OOLAP	Object oriented local application processing
P&PB	Processes and procedure branch
P2PMM	Prince2 project management methodology
PCs	Personal computers
PERT	Program evaluation and review technique
PMB	Program management and budgeting
POP	Process organisation product

POS	Point of sale
QEMS	Quality and environmental performance system
QMS	Quality management systems
R&D	Research and development
RAD	Rapid application development
RAM	Reliability availability and maintainability
S.C.O.R.E.	Symptoms-causes-outputs-resources-effects
SA&D	Systems analysis and design
SDLC	Systems development life cycle
SE	Systems engineering
SME	Small business enterprise
SMEs	Subject matter experts
SMF	Stakeholder management framework
SOA	Service oriented architecture
SOPs	Standard operating procedures
SPO	Systems program offices
SQL	Structured query language
SRC	Systems requirements constraints
SWOT	Strengths weaknesses opportunities threats
TQM	Total quality management
UML	Unified modelling language
VO	Virtual organisation
VPNs	Virtual private networks
W3C	World wide web consortium
WANs	Wide area networks
WG	Working groups
WWII	World war II
XML	Extended mark-up language

## **List of Publications**

### **Refereed International Conference Papers**

Watters, R & McGrath, M 2010, 'Applying Technology Theory to Organisation Change: A Case Study', in 24th Australian New Zealand Academy of Management (ANZAM) Conference Proceedings, Adelaide, Australia, 8-10 December 2010, Ed(s) University of South Australia International Graduate School of Business and the School of Management.

Watters, R & McGrath, M 2009, 'A Decision Support Tool for Managing Organisation Change', in 23rd Australian New Zealand Academy of Management (ANZAM) Conference Proceedings, Melbourne, Australia, 1-4 December 2009, Ed(s) Dr Nicholas Beaumont, Monash University.

Watters, R & McGrath, GM 2008, 'A Modelling Approach for Dependency Management: A Case Study', in 22nd Australian and New Zealand Academy of Management (ANZAM) Conference Proceedings, Auckland, New Zealand, 2-5 December 2008, Ed(s) The University of Auckland Business School.

Watters, R 2007, 'An Enterprise Architecture Approach to Organisational Interoperability – A Discussion Paper', in 8<sup>th</sup> International We-B (Working for E-Business) Conference Proceedings, Melbourne, Australia, 28-30 November 2007, Ed(s) Victoria University School of Information Systems.

Watters, R & Wenn, A 2004, 'Operating in the Global e-Business Environment', in 5<sup>th</sup> International We-B (Working for E-Business) Conference Proceedings, Perth, Australia, 25-26 November 2004, Ed(s) Rosemary Stockdale, Edith Cowan University, WA.

Watters, R & Wenn, A 2002, 'Think Globally, Act Globally: What are the Enablers and Inhibitors? A Study of Factors Influencing Globalisation in a Large Organisation', in 3rd International We-B (Working for E-Business) Conference Proceedings, Perth, Australia, 28-29 November 2002, Ed(s) Rosemary Stockdale, Edith Cowan University, WA.

Watters, R & Wenn, A 2001, 'E-commerce, Management Information Technology and the Organisation: A Study of Factors Influencing Change in a Large E-enabled Company', in 2nd International We-B (Working for E-Business) Conference Proceedings, Perth, Australia, 28-29 November 2002, Ed(s) Rosemary Stockdale, Edith Cowan University, WA.

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## **Appendix 1**

### **Commonwealth Procurement Guidelines (CPG) Implementation and Decision Process Activities**

*These activities are based on the CPG implementation and decision processes illustrated in Figure 31 at 31.*

#### **Activity 01**

The Commonwealth Government Financial Management Control Committee (CGFMCC) promulgated the revised CPG instructions to the appropriate Company authority, which in this case was the Chief Finance Officer Group (CFOG) Chief Executive Officer (CEO), via the Company's Finance Executive Committee.

*There was no consultation or feedback prior to the execution of this activity.*

#### **Activity 02**

The Finance Executive officially delegated management of the CPG instructions to the relevant Branch, which was the CFO Financial Controls Framework Branch (FCFB). This Branch was responsible for managing the CPG changes. However, the policy authority was the CFOG CEO.

*There was no consultation or feedback prior to execution of this activity.*

#### **Activity 03**

The FCFB interpreted the CPG instructions then formulated and promulgated the Company-wide procurement-related finance policy changes. The respective group CEOs were notified of the policy changes for dissemination within their Group. There was no formal policy distribution process that notified all affected parties, other than the policies that were posted on the Company website.

*There was no consultation or feedback prior to execution of this activity.*

### **Activity 04a, 04b & 04c**

The Finance Systems Directorate (FSD) was responsible for coordinating the finance system related CPG changes. A change request was forwarded to the Finance Processes and Procedures Directorate (FP&PD) who amended the finance procedures, training programs & materials, and system templates (Activity 04a), as required. Where changes required the enterprise modules to be recoded, the (FP&PD) forwarded a request to the Information Communication Technology (ICT) Group, Processes and Procedure Branch (P&PB) (Activity 04b). The ICT P&PB forwarded the request to their technical staff for execution (Activity 04c). The CFOG CEO is the finance systems enterprise owner, while the ICT CEO is the enterprise owner for LANs, WANs and PCs. They also control the Company's enterprise systems change management/configuration activity. Consultation and feedback for these activities was limited to CFO and ICT personnel only.

*There was no consultation with the wider users on enterprise system changes or other system dependencies.*

### **Activity 05**

The FCFB delegated the CPG guidelines to the Legal and Procurement Services Branch (LPSB) of the Corporate Group (IAG) for interpretation and promulgation of Company-wide procurement policy changes.

*The anomaly was that the Corporate CEO was the procurement (acquisition) business owner, incorporating related contract issues, while the CFOG CEO was the Enterprise owner for Finance. Finance policy covered procurement policies and processes. There was no consultation with the wider Groups on potential procurement and related contract anomalies.*

### **Activity 06**

The LPSB implemented a series of revised procurement policies and updated the relevant financial, procurement and training programs and materials, accordingly. These products were organisation-wide publications.



*These products were disseminated via the Company's official intranet policy site. Stakeholders were not individually notified of any changes to these products. There was no formal policy development consultation or dissemination process. Consequently, there was no feedback or assessment of possible impact to existing policy, processes, training activities, or systems. Activity 06 was mapped to the Company's Logistics Processes and Procedure Directorate (LP&PD) because their SMEs alerted LPSB staff of potential conflicts or anomalies. The LP&PD falls under the Logistics Group. The issue was that personnel within the LPSB had limited skills in policy writing; consequently, it was difficult for others to understand and/or to interpret the policy intent. A policy could also span some 600 pages of instructions, which in part, might not have been relevant to the delegates' task.*

#### **Activity 07a & 07b**

This activity involved the LP&PD subject matter experts (SMEs) searching the Company's intranet for any procurement and/or finance policy changes that might affect supply-chain user workflows (Activity 07a). The SMEs interpreted the policy changes and informally notified logistics managers and supply-chain users (Activity 07b). The SMEs also took action to update the relevant components of the supply-chain manual (Activity 07b). These changes directly impacted the Company's logistics processes and related systems transactions, and supply-system interfaces.

*There was no formal process in place to advise users of the changes or to canvas their feedback. Sometimes the supply-chain users uncovered policy, process, procedural or system conflicts and notified LP&PD, accordingly.*

#### **Activity 08a & 08b**

The Company's supply-chain activities consisted of multiple domain transactions and system interfaces. This activity shows the interdependencies between the logistics processes and related transactions, and finance system changes. In this instance the CPG related finance processes and system changes directly impacted logistics procurement. These changes had a systemic impact on the supply-chain, and other enterprise system transactions.

*There was no consultation or feedback regarding enterprise systems configuration changes. This was mainly due to the fact that each Group was the respective system owner, with the exception of the Supply Group whose systems fell under the jurisdiction of the ICT and Corporate Groups. It should be noted that the CPG changes affected all finance and procurement activities. The implementation and decision processes outlined herein, represent a small portion of the logistics activities that were impacted. There were too many instances to record and to explore all instances would have exceeded the timeframe of the study.*

### **Activity 09**

The LP&PD SMEs requested a supply-system change via the Corporate Group to affect the CPG required system changes. Accommodating a policy revision that required a system change proved very difficult because of the complexity surrounding the Company's enterprise system ownership (see Activities 05 and 08a and 08b for examples). Although a system change request involved a formal procedure, there was limited or no feedback regarding the status of the change request. Sometimes the request was rejected because the Corporate Group - as the procurement business owner - had other supply-system priorities. However, there was never any formal feedback to this effect. In some instances the turn-around-time for a supply-system change was two years. To resolve this impasse the LP&PD consulted with supply-chain users to secure a systems and procedural workaround. Examples of workarounds included; the creation of manual documents instead of system generated purchase orders or reports, and manual system batch file uploads and downloads.

### **Activity 10, 10b & 10c**

The change request described in 'Activity 09' was considered a major system change. Consequently, the Corporate Group, through its Acquisition Processes and Procedures Directorate (AP&PD), forwarded the LP&PD request to the ICT Enterprise Owner via its Processes and Procedures Directorate (ICT P&PD). As noted, the latter group managed all major enterprise system changes. This was a formal system change request managed by the AP&PD

on behalf of the initiator (LP&PD). Although there was a formal feedback process in place it was generally considered ad-hoc.

*In some instances the turn-around-time to remediate a known problem had taken months to years. For example there were still outstanding change requests left over from the 2005 CPG revision. The situation was exasperated by the fact that the CPG changes were externally driven and; therefore, were not fully funded. On many occasions a major system change was progressed as a project (see Activity 10b). The implications of this activity related to project funding and management. Which Group was responsible for applying for funding and who should manage the project? These questions mostly hinged on the cost of the changes (see Activity 10c).*

### **Activity 11**

A critical consequence of the CPG changes was the profound affect on the strategic objectives of the Company's logistics operations. The CPG changes conflicted with the Company's supply-chain policies, impeding its strategic goals. The CPG changes were government initiated; therefore, there was no impact assessment or decision review. Subsequently, the Company's policies, processes etc, became misaligned with its strategic objectives. Explicit examples where this occurred included:

- 1. The revised CPGs affected mandatory changes to procurement related contract clauses and the procurement process generally. Refer to 'Activity 09' for an example of the latter where the need to find a suitable workaround put undue pressure on supply-chain practitioners. This diverted practitioner attention from their core activities causing delays in the procurement and delivery of supply items. The Company's strategic objectives to procure and deliver on time were affected.*
- 2. Another issue was the revised CPGs facilitated changes to the procurement of items of supply for capital equipment. Usually these items were meticulously procured through the supply-chain system to ensure the right part was used in equipment and not substituted for substandard or ill-fitting parts. There had been cases where non-*

*compliant parts had been used in capital equipment causing major catastrophes. The strategic objective to provide a safe environment was breached.*

- 3. In relation to the above, changing the CPGs directly conflicted with the Company's logistics policy whereby procured items under a certain value could be purchased via a Government credit card rather than through the supply-system as mandated. This meant that small items critical to the equipment's and operator's safety could be bought from any hardware store as opposed to being purchased as a compliant spares item through the supply-system. This anomaly also created issues for the Company's (and Government's) asset register, which drew data from the supply-system regarding procured items. This anomaly directly infringed the Company's logistics asset management policy.*

## **Activity 12**

From time-to-time the AP&PD consulted with LP&PD SMEs (and vice-versa) on issues relating to procurement policy changes. In these instances, the AP&PD assisted the LP&PD to implement suitable system and procedural workarounds. This was not a formal process, but was linked to employee camaraderie.

*The example given was that if AP&PD detected a problem or deficiency with a procedure arising from a policy change they would alert LP&PD (or vice-versa) to the situation. This was not a formal process but more to do with the fact that the Company's supply-chain system and policy employees were once part of the same organisation. They had forged relationships, which they maintained despite the separation of duties. This enabled the parties to informally (but readily) consult and problem-solve existing or potential issues.*

## **Activity 13a, 13b & 13c**

The CPG implementation process resulted in the need to develop additional training programs and materials, and amend existing training products. For example, LP&PD, AP&PD, LPSB and FP&PD requested additional (or

amended) training products (see Activity 13a). In some cases the changes required parties to develop additional skills, which affected the Company's authority and responsibility arrangements. Where new training packages and skills were needed, there were often delays in meeting these demands, adding to the ineffectiveness of already marginalised workflows. There was also a cost associated with developing and delivering new training products. The unit or SPO usually incurred any additional costs. Because there was no prior consultation or change impact assessment, often the consequences of a new or revised policy remained undetected until users encountered specific inconsistencies. The example given at 'Activity 13b' illustrated that a policy change resulted in the need to employ additional staff due to increased work loads or the need for specific skill sets. This situation contravened the Company's HR policy where there was a recruitment freeze. There were many instances where the CPG changes affected supply-chain users work loads, and in instances where activities were outsourced (see Activity13c) these required expensive contract amendments. Although Figures 31 and 32 show only one instance where this situation occurred, the reality was that multiple Groups were affected and responded accordingly.